COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF	)	
	)	

COLUMBIA GAS OF KENTUCKY, INC.'S RESPONSES TO THE ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION

FILED: July 21, 2021

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:

THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF) Case No. 2021-00183

VERIFICATION OF KIMRA COLE

COMMONWEALTH OF KENTUCKY)
)
COUNTY OF FAYETTE)

Kimra Cole, President of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Kimra Cole
Kimra Cole

The foregoing Verification was signed, acknowledged and sworn to before me this 19th day of July, 2021, by Kimra Cole.

Evelyn Long Dunn

Notary Commission No. 600778

Commission expiration: 5-15-2022

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF DAVID ROY

COMMONWEALTH OF KENTUCKY	)
	)
COUNTY OF FAYETTE	)

David Roy, Vice President of Operations and Construction of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

[signature]
David Roy

The foregoing Verification was signed, acknowledged and sworn to before me this 21st day of July, 2021, by David Roy.

[signature]

Notary Commission No. 600778

Commission expiration: 05-15-2022

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183
	)	

VERIFICATION OF JUDY COOPER

COMMONWEALTH OF KENTUCKY	)
	)
COUNTY OF FAYETTE	)

Judy Cooper, Director of Regulatory Affairs of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Judy Cooper

Judy Cooper

The foregoing Verification was signed, acknowledged and sworn to before me this 21st day of July, 2021, by Judy Cooper.

Evelyn Long Durr

Notary Commission No. 600778

Commission expiration: 05-15-2022

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF CHUN-YI LAI

STATE OF OHIO)
)
COUNTY OF FRANKLIN)

Chun-Yi Lai, Financial Planning Manager for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Chun Yi Lai

Chun-Yi Lai

The foregoing Verification was signed, acknowledged and sworn to before me this 16 day of July, 2021, by Chun-Yi Lai.

COURTNEY LAUREN KITCHEN - NOTARY PUBLIC
COMM EXP: NOV 3, 2024
STATE OF OHIO

Courtney Lauren Kitchen

Notary Commission No. RE-806804

Commission expiration: 11/03/2024

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF	)	

VERIFICATION OF JEFFERY GORE

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Jeffery Gore, Regulatory Manager for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain response to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

Jeffery Gore

The foregoing Verification was signed, acknowledged and sworn to before me this 15 day of July, 2021, by Jeffery Gore.

NOTARIAL SEAL STATE OF OHIO

John R Ryan III
Attorney At Law
Notary Public, State of Ohio
My commission has no expiration date
Sec. 147.03 R.C.

Notary Commission No. N/A

Commission expiration: N/A

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF JENNIFER HARDING

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Jennifer Harding, Director, Income Tax Operations for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Jennifer Harding

The foregoing Verification was signed, acknowledged and sworn to before me this 6th day of July, 2021, by Jennifer Harding.

NOTARIAL SEAL STATE OF OHIO

JOSEPH M. CLARK, Attorney At Law
NOTARY PUBLIC - STATE OF OHIO
My commission has no expiration date
Sec. 147.03 R.C.

Notary Commission No. n/a

Commission expiration: None

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183
	)	

VERIFICATION OF JOHN SPANOS

COMMONWEALTH OF PENNSYLVANIA)
)
COUNTY OF CUMBERLAND)

John Spanos, President of Gannett Fleming Valuation and Rate Consultants, LLC, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

John J. Spanos
John Spanos

The foregoing Verification was signed, acknowledged and sworn to before me this 16th day of July, 2021, by John Spanos.

Commonwealth of Pennsylvania - Notary Seal
MEGAN LYNN ECKRICH - Notary Public
Cumberland County
My Commission Expires Sep 16, 2023
Commission Number 1264513

Megan Lynn Eckrich

Notary Commission No. 1264513

Commission expiration: Sep. 16, 2023

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF JUDITH SIEGLER

STATE OF INDIANA	)
	)
COUNTY OF LAKE	)

NOTARY PUBLIC SEAL STATE OF INDIANA
CHRISTINA P. CONIGLIO
Commission Number 0732443
My Commission Expires
March 16, 2029

Judith Siegler, Lead Regulatory Studies Analyst for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Judith Siegler
Judith Siegler

The foregoing Verification was signed, acknowledged and sworn to before me this 19th day of July, 2021, by Judith Siegler.

Christina P. Coniglio

Notary Commission No. 0732443

Commission expiration: 03/16/29

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF KEVIN JOHNSON

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Kevin Johnson, Lead Regulatory Analyst for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

[signature]
Kevin Johnson

The foregoing Verification was signed, acknowledged and sworn to before me this 15 day of July, 2021, by Kevin Johnson.

[signature]

NOTARY PUBLIC STATE OF OHIO
LAWRENCE W CULVER
Notary Public State of Ohio
My Comm. Expires June 12, 2022

Notary Commission No. 2017-RE-652468

Commission expiration: 12 JUNE 2022

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF	)	

VERIFICATION OF KIMBERLY CARTELLA

STATE OF OHIO	)
	)
COUNTY OF LORAIN	)

Kimberly Cartella, Director Compensation for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Kimberly Cartella

The foregoing Verification was signed, acknowledged and sworn to before me this 19th day of July, 2021, by Kimberly Cartella.

Emily L. Brady, Attorney at Law
Resident Summit County
Notary Public, State of Ohio
My Commission Has No Expiration Date
Sec 147.03 RC

Notary Commission No. ______

Commission expiration: NO EXP.

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF MELISSA BARTOS

STATE OF MASSACHUSETTS)
)
COUNTY OF MIDDLESEX)

Melissa Bartos, Vice President for Concentric Energy Advisors, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to the Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Melissa Fay Bartos
Melissa Bartos

The foregoing Verification was signed, acknowledged and sworn to before me this 21st day of July, 2021, by Melissa Bartos.

Kristina D. Bruce

KRISTINA D. BRUCE
Notary Public
Commonwealth of Massachusetts
My Commission Expires
November 4, 2027

Notary Commission No. ________________

Commission expiration: November, 4, 2027

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF	)	

VERIFICATION OF MICHAEL ROZSA

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Michael Rozsa, Chief Information Officer for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

Michael Rozsa

Michael Rozsa

The foregoing Verification was signed, acknowledged and sworn to before me this 14th day of July, 2021, by Michael Rozsa.

NOTARIAL SEAL
STATE OF OHIO

REBECCA J VANSICKLE
Notary Public
In and for the State of Ohio
My Commission Expires
November 22, 2024

Rebecca J Vansickle

Notary Commission No. ________________

Commission expiration: 11/22/2024

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF COLUMBIA GAS OF KENTUCKY, INC. FOR AN ADJUSTMENT OF RATES; APPROVAL OF DEPRECIATION STUDY; APPROVAL OF TARIFF REVISIONS; ISSUANCE OF A CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY; AND OTHER RELIEF	)	Case No. 2021-00183

VERIFICATION OF SUSAN TAYLOR

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Susan Taylor, Director of Financial Planning for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Susan M Taylor

Susan Taylor

The foregoing Verification was signed, acknowledged and sworn to before me this 20th day of July, 2021, by Susan Taylor.

Joseph M. Clark

NOTARIAL SEAL STATE OF OHIO

JOSEPH M. CLARK, Attorney At Law
NOTARY PUBLIC - STATE OF OHIO
My commission has no expiration date
Sec. 147.03 R.C.

Notary Commission No. n/a

Commission expiration: None

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF		

VERIFICATION OF SUZANNE K. SURFACE

STATE OF OHIO	)
	)
COUNTY OF FRANKLIN	)

Suzanne K. Surface, Senior Vice President for NiSource Corporate Services Company, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that she has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of her knowledge, information and belief, formed after reasonable inquiry.

Suzanne K. Surface

The foregoing Verification was signed, acknowledged and sworn to before me this 21st day of July, 2021, by Suzanne K. Surface.

NOTARIAL SEAL STATE OF OHIO

JOSEPH M. CLARK, Attorney At Law
NOTARY PUBLIC - STATE OF OHIO
My commission has no expiration date
Sec. 147.03 R.C.

Notary Commission No. n/a

Commission expiration: None

COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

In the Matter of:	)	
	)	
THE ELECTRONIC APPLICATION OF	)	
COLUMBIA GAS OF KENTUCKY, INC. FOR AN	)	
ADJUSTMENT OF RATES; APPROVAL OF	)	
DEPRECIATION STUDY; APPROVAL OF TARIFF	)	Case No. 2021-00183
REVISIONS; ISSUANCE OF A CERTIFICATE OF	)	
PUBLIC CONVENIENCE AND NECESSITY; AND	)	
OTHER RELIEF	)	
	)	

VERIFICATION OF VINCENT REA

STATE OF NORTH CAROLINA	)
	)
COUNTY OF MOORE	)

Vincent Rea, Managing Director of Regulatory Finance Associates, LLC, on behalf of Columbia Gas of Kentucky, Inc., being duly sworn, states that he has supervised the preparation of certain responses to Attorney General's Request for Information in the above-referenced case and that the matters and things set forth therein are true and accurate to the best of his knowledge, information and belief, formed after reasonable inquiry.

Vincent Rea

The foregoing Verification was signed, acknowledged and sworn to before me this 16 day of July, 2021, by Vincent Rea.

Sanjeev Bhuta
Notary Public
Moore County, North Carolina
My Commission Expires 09/12/2023

Notary Commission No. 201826100005

Commission expiration: 9/12/2023

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

1. Refer to the Application generally. Provide a succinct list that identifies all proposed pro forma adjustments, the amount of each pro forma adjustment, along with a brief description of each adjustment.

Response:

The pro forma adjustments are included in Tab 73, Filing Requirement 807 KAR 5:001 Section 16-(8)(d) – Summary of Income Adjustments. Schedules D-2.1, D-2.2, D-2.3 and D-2.4 include a brief description and the amount of the adjustments.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

2. Refer to the Application generally. Taking into account the economic issues that were already present in a large portion of Columbia Kentucky's service area before the COVID-19 pandemic, and the exacerbated economic issues that the COVID-19 pandemic has caused, explain how Columbia Kentucky's ratepayers will be able to afford an increase in natural gas rates.

Response: Despite the impact of COVID-19, throughout the pandemic Columbia, its employees, and its contractors continue to provide essential services to its customers with minimal disruption. Indeed, as detailed in the testimony of Columbia witness Roy, in 2020, even with the global disruption to most business as a result of the pandemic, Columbia nonetheless was able to continue providing safe and reliable service to its customers and adhere to its priority pipe replacement plan in its SMRP. In light of the substantial capital investment Columbia has made since its last rate case in 2016, and the ongoing investments that will continue be made through the forecasted test period, a rate increase is necessary in order to provide the Company with a reasonable opportunity to recover its investment in its distribution system and its operation and maintenance expenditures.

As noted in the Direct Testimony of Kimra Cole, Columbia is aware of the impacts rate increases has on its customers, and the Company has taken and will continue to assist those financially insecure customers. However, the work being performed by Columbia, its employees, and contractors is essential to the Company's ability to provide safe and reliable service to its customers. Further, this essential work provides the ancillary benefit of energizing the local economies through the wages paid to the skilled labor necessary to complete the work. Indeed, in addition to employing 201 active full-time employees, Columbia retains numerous contractors on its system. The work being performed by the Columbia's employees, and contractors through the Company's ongoing investment in its system, also benefits the communities in the 30 Kentucky counties in Columbia's service territory.

An increase in Columbia's rates is necessary in order to provide an opportunity for it to earn a fair rate of return in order to attract the necessary capital to service its customers, and maintain its essential infrastructure in a safe and reliable manner for its customers and the broader public. Columbia looks forward to working with other participants in the Energy Cabinet's recently announced Energy Affordability Work Group to better understand and address the issues of affordability and utility services to Kentuckians.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

3. Refer to Columbia Kentucky's Motion for Deviation filed on May 28, 2021, in which the Company states that it is requesting a Certificate of Public Convenience and Necessity ("CPCN") to authorize Columbia to renovate its existing headquarters and to construct small structures in order to install and operate a new safety training facility for its employees. However, Columbia Kentucky asserts that it has not yet developed detailed engineering plans and specifications and therefore is unable to provide these to the Commission in accordance with the regulations.

a. Explain in full detail why Columbia Kentucky has not developed detailed engineering plans and specifications for the proposed CPCN.

b. Identify when Columbia Kentucky plans to provide the engineering plans and specifications to the Commission.

c. Provide the engineering plans and specifications when completed.

d. Explain whether the renovations to the existing headquarters are exclusively related to the proposed safety training facility. If not, explain in full detail what other renovations are being proposed.

Response:

a. Other Columbia companies have significant experience designing and building similar training facilities for their local work force. The cost estimates provided are largely based on similar setups and generalized costs for building modifications. The development of engineering plans and specifications are quite costly and Columbia felt it would be more prudent to use estimates based on past construction projects rather than pay the cost for detailed designs when the project has not been approved.
b. Columbia would have formal engineering plans and specifications produced after the approval to construct.
c. Columbia will provide the engineering plans and specifications when they are available.
d. The proposed renovations to the existing headquarters are exclusively related to the training facility additions. Any work unrelated to the proposed training renovations would be charged to its' own separate and distinct work order.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

4. Refer to the Application, page 2.

a. Provide an organizational chart of Columbia Kentucky, and designate whether each position is based in Kentucky or elsewhere.

b. Columbia Kentucky states that it is a subsidiary of NiSource Gas Distribution Group, Inc. Provide an organizational chart of NiSource Gas Distribution Group, Inc., and designate whether each position is based in Kentucky or elsewhere.

c. Columbia Kentucky states that NiSource Gas Distribution Group, Inc. is a company. Provide an organizational chart of NiSource, Inc., and designate whether each position is based in Kentucky or elsewhere.

d. Columbia Kentucky states that NiSource Corporate Services Company ("NCSC") is a management and services subsidiary of NiSource, Inc. Provide an organizational chart of NCSC, and designate whether each position is based in Kentucky or elsewhere.

Response:

a. See CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-4, Attachment A for an organizational chart (spreadsheet containing names, titles, and reporting relationships) of the Company. All positions are located in KY.

b. NiSource Gas Distribution Group, Inc. does not have any employees because it is a holding company. Holding companies are parent business entities that do not conduct business operations and whose sole purpose is to hold subsidiaries.

c. See part b. above.

d. See CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-4, Attachment B for an organizational chart (spreadsheet containing names, titles, and reporting relationships) of NCSC. The state of each position is provided, and positions that are located in KY are noted in bold.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

5. Refer to the Application generally. Provide a list of all entities that direct charge or allocate costs to Columbia Kentucky, and include the total amounts of costs that are direct charged and/or allocated to the Company in the test year.

Response:

Refer to Columbia's Response to KY PSC Case No. 2021-00183, Staff 1-10, Attachment A for a listing of entities other than NiSource Corporate Services that charged Columbia of Kentucky in calendar year 2020. The majority of the costs included in this Attachment relate to interest on the Company's debt. The remaining amounts are generally minor in nature and are included in the Company's forecast but specifically identified.

The O&M costs charged by NiSource Corporate Service Company ("NCSC") are specifically identified in the forecast. Refer to Columbia's Response to the Attorney General's First Set of Requests for Information, No. 145 for detail regarding actual direct and allocated costs billed by NCSC for actual months in the base period.

The NCSC O&M forecasted information is not detailed between direct versus allocated. The forecasted O&M for March – August 2021 is $10,529,272. The forecasted O&M for the forecasted test period is $20,913,572.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

6. Refer to the Application, page 9. Columbia Kentucky asserts that it is requesting the rate case expense to be allowed recovery in the rates, and amortized over a three-year period.

a. Provide the total rate case expense that has been accrued thus far. Consider this a continuing request.

b. Provide a breakdown of the total rate case expense that has been accrued thus far by category.

c. Provide the estimated total rate case expense.

d. Provide a breakdown of the estimated total rate case expense.

e. Provide copies of invoices supporting the level of incurred rate case costs to date and supply such new invoices as they become available.

Response:

a. Please refer to Columbia's Response to Staff's First Request for Information No. 12.

b. Please refer to Columbia's Response to Staff's First Request for Information No. 12.

c. Please refer to 807 KAR 5:001 Section 16-(8)(f), Schedule F-8.

d. Please refer to 807 KAR 5:001 Section 16-(8)(f), Schedule F-8

e. Please refer to Columbia's Response to Staff's First Request for Information No. 12.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

7. Refer to the Direct Testimony of Kimra H. Cole ("Cole Testimony"), page 5.

a. Ms. Cole states that Columbia Kentucky's current operations resemble a long history of consolidations of other natural gas distribution companies. Provide a summary of the above-referenced history of consolidations.

b. Ms. Cole states that Columbia Kentucky employs 201 active full-time employees. Identify the number of active full-time employees that Columbia Kentucky employed for the years 2010 – 2021.

Response:

a. Please see the summary of the consolidations of the natural gas distribution companies provided below, which was originally prepared to trace the history of the former Central Kentucky Natural Gas Company. Please note that this is limited to essentially the Lexington Division:

HISTORY OF COLUMBIA GAS OF KENTUCKY, INC.

(Lexington District)

In 1905, Joseph Seep of Oil City, Pa., a general purchasing agent for the Standard Oil Company, was drilling for oil in Menifee County, Kentucky. As often happens, however, Mr. Seep struck natural gas instead. Thus began the long history of Central Kentucky Natural Gas Company, predecessor to Columbia Gas of Kentucky, Inc.

Mr. Seep decided Lexington, Kentucky, would provide a good market for his fuel, so together with several other men who were willing to risk their resources in the new venture, he organized Central Kentucky Natural Gas Company. The company was incorporated under the laws of the Commonwealth of Kentucky on October 11, 1905. It acquired franchise rights to sell gas in Lexington, Winchester and Mount Sterling. Also acquired were 34,000 acres of leaseholds with nineteen producing wells located on Slate Creek and Hawkins Branch in Menifee, Powell and Montgomery Counties, which comprise the area known as the Menifee County gas Field.

Consideration for this property was the company's entire authorized stock of 60,000 shares at a par value of $25, each which represented a total investment of $1.5 million. A value of $100,000 was placed on franchises obtained which was paid in cash. First mortgage bonds in the amount of $600,000 were issued to raise money.

Central Kentucky's principal office and place of business was Lexington, Kentucky. The life of the company was set for ninety-nine years unless sooner dissolved by mutual agreement or in a manner prescribed by law.

The original stock was issued as follows:

Joseph Seep, 44,400 shares; E. Strong, Robert S. Hampton and John Tonkin, all of Oil City, Pa., each 4,000 shares; and J.S. Hazelrigg of Frankfort, Ky., 3,600 shares.

Control of the company was vested in Joseph Seep because of large holdings of stock.

Construction of a distribution system to supply natural gas to customers in Lexington was started immediately. At that time, manufactured gas was being furnished in the City of Lexington under a franchise held by the Lexington Gas Company. Because of the expensive competition which would result from two gas companies operating in

Lexington, an agreement was entered into under which the facilities constructed by Central Kentucky within the city, together with all the pipe and material purchased by the company to be used in the construction of its distribution plant, were sold to the Lexington Gas Company at cost. Also under the agreement, all the facilities of Lexington Gas Company within the city were leased to Central Kentucky.

In 1906, the distribution plant was converted from manufactured gas service to natural gas. It was operated by Central Kentucky under lease until 1948, when Central Kentucky purchased the distribution plant.

Also, in 1906, Central Kentucky laid pipelines from its Menifee field to Mount Sterling, Winchester and Lexington and constructed a compressor station in Menifee County, which it called the Menifee Compressor Station.

In Central Kentucky's early days, gas was used primarily for lighting and cooking. The company started business with about 400 customers, and all their natural gas needs were provided for by nineteen producing wells in the Menifee County Fields.

In fact, Menifee produced all the company's gas until 1913, when depletion of that source forced Central Kentucky to look elsewhere for its natural gas supply. By the end of 1912, the company had drilled 119 wells in the field, of which 37 were dry holes. The producing area had been completely defined and drilled with no prospects for success in additional drilling.

Central Kentucky met the challenge in 1913 by constructing a ten-inch pipeline from the eastern terminal of its system in the Menifee Field to Inez, Martin County, Kentucky, 70 miles away. There, the ten-inch line connected with the United Fuel Gas Company system, and Central Kentucky began purchasing natural gas from United Fuel.

In the spring of 1919, Central Kentucky made gas industry history when it stored a significant volume of gas underground. From 1919 to 1931 the company pumped gas into the depleted wells of the Menifee Field during the summer and removed it in the winter to meet the heavier demands. The experiment was abandoned in 1931 because the cost was considered excessive.

The number of producing wells owned by Central Kentucky in 1915 was 90. Five years later the figure was down to 84 and the search began for additional gas supplies.

Natural gas had been found in 1917 in the Red Bush Field of Lawrence and Johnson Counties, Ky., and this looked like a promising area. Central Kentucky began drilling there in 1923 and during its first year, 26 producing wells were drilled with no dry holes. The following year three more wells were drilled, all productive.

In 1928, Central Kentucky began negotiations to become affiliated with the Columbia Gas & Electric Corporation. Stockholders of Central Kentucky readily accepted an offer to exchange two and one-fourth shares of their common stock for one share of cumulative 6 per cent preferred stock of Columbia and on December 31, 1927, more than 96 per cent had been deposited for such exchange.

Thus on the first day of 1928, after 23 years of independent operations in the Blue Grass section of the state, central Kentucky became a part of the Columbia System.

At the time it was acquired, Central Kentucky was distributing natural gas at retail to about 14,000 customers and supplied at wholesale the companies serving Frankfort, the capital of the state, Paris, Versailles, Midway and North Middletown. In addition to its facilities for production and distribution, it owned valuable gas rights in the Eastern Kentucky field. It fitted perfectly into the system as it was already connected with the pipelines of Columbia and had been purchasing gas from United Fuel Gas Company to augment the supply from its own wells.

It should be noted here that prior to this acquisition, Columbia, in 1924, purchased the stock of the Huntington Gas Company, which owned a majority of the Huntington Development and Gas Company. The latter firm's natural gas transmission and distribution system directly served 5,900 gas users in Huntington, West Virginia, and Ashland, Kentucky. The Ashland area became a part of Columbia's Kentucky company in 1958.

From 1911 to 1929, Central Kentucky had some small gasoline production operations in connection with its natural gas business. It also had a small investment in oil. On January 1, 1930, both the oil and gasoline properties were sold to Virginia Gasoline and Oil Company for $1,999.90. In 1937, wells and lines of the once-productive Red Bush Field were disposed of and the field was abandoned.

Following World War II, Central Kentucky acquired the properties of the Cincinnati Gas Transportation Company, an affiliate which at that time owned a transmission line extending from near Kenova, West Virginia, to near Cincinnati, together with the Kenova Compressor Station, Tollesboro Compressor Station and additional transmission lines in Lincoln and Wayne counties, W. Va. The properties in West Virginia were sold to United Fuel. Central Kentucky then ceased to engage in the production of natural gas.

To meet peak hour emergency requirements for periods of short duration the company built near Lexington a liquefied petroleum gas plant. This was in 1947. In the same year, construction was completed on a 70-mile line of 14-inch pipe extending from a connection with the Tennessee Gas Transmission Company at Means, Ky., to Foster in Bracken County. This line later was looped and a compressor station was constructed. The original 10-inch line to Menifee was completely looped with a 12-inch high pressure main and a 24-inch line was built from Foster to a point on the Ohio River near Brent, Ky.

Because of the ever-increasing demands, the company in 1947 embarked on a program of increasing the storage capacity and utilization of its Menifee fields. New wells were drilled and certain existing wells were rehabilitated. Well and field lines were put back into use and a new high pressure system was installed.

Menifee Compressor Station was revamped and its capacity increased from 1,740 horsepower to 4,740 horsepower. Storage field capacity was boosted from 10,000,000 MCF in 1947 to 14,700,000 in 1952. Peak day deliverability rose from 8,000 MCF to 42,000 MCF.

On May 31, 1955, Central Kentucky purchased the Frankfort Kentucky Natural Gas Company in exchange for Columbia stock. Acquired in the sale were the customer areas of Frankfort, Midway and Versailles. The more than 7,000 new customers got a rate reduction through the transfer of ownership and the 33 employees of the Frankfort company were retained in good standing.

The rapid growth of the company since World War II is reflected in the following comparisons: Retail customers increased from 25,219 in 1947 to 45,694 at the end of 1956 – an increase of 81 per cent. During the same period, the volume of sales climbed 162 per cent and the number of customers heating with gas jumped from 13,196 to 36,412.

On January 1, 1957, Central Kentucky's operations were confined strictly to the local distribution of natural gas. As a part of Columbia's realignment plan, it sold its transmission and storage facilities to an affiliate, Kentucky Gas Transmission Corporation.

The following year, Central Kentucky Natural Gas Company changed its name to Columbia Gas of Kentucky, Inc., and acquired the retail distribution facilities of the United Fuel Gas Company in Kentucky. These facilities serve about 22,000 customers, principally in the Ashland area, in nine southeastern counties.

As a result, Columbia Gas of Kentucky, Inc., owned property serving 70,000 retail customers in approximately 40 cities and communities located in 27 counties.

The communities being served are:

Lexington District – Lexington, Cynthiana, Georgetown, Irvine, Ravenna, Foster, Mt. Sterling, Winchester, Frankfort, Midway and Versailles.

Ashland District – Ashland, Pilgrim, Biggs, South Portsmouth, South Shore, Catlettsburg, Westwood, Flatwoods, Fullerton, Greenup, Raceland, Riverview, Russell, Worthington, Wurtland, Hindman, Louisa, Beauty, Inez, Lovely, Warfield and South Williamson.

b. See Columbia's Response to Staff's First Set of Requests for Information, No. 36 for the number of active full-time employees from January 1, 2018-2021.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

8. Refer to the Cole Testimony, page 9. Ms. Cole states that the assistance programs that Columbia Kentucky provides are LIHEAP Subsidy and LIHEAP Crisis programs, WinterCare program, and Columbia Kentucky's own home energy assistance program. Explain in full Columbia Kentucky's home energy assistance program.

Response:

Columbia has operated a home energy assistance program since the year 2003. On October 28, 2019 the Kentucky Public Service Commission established Case No. 2016-00366, an Investigation of Home Energy Assistance Programs offered by investor-owned utilities pursuant to KRS 278.285(4). As a result of the investigation the Commission issued its Order in Case No. 2019-00366 dated May 4, 2020.

Columbia Kentucky's home energy assistance program, the Energy Assistance Program "EAP" provides assistance to low-income customers via bill credits during the winter heating months of January through March. It is administered in accordance with the Kentucky Public Service Commission's Order in Case No. 2019-00366 dated May 4, 2020.

COLUMBIA GAS OF KENTUCKY, INC.
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9. Refer to the Cole Testimony, page 11.

a. Identify the monetary amount associated with rolling in Columbia Kentucky's Safety Modification and Replacement Program ("SMRP") Rider charge into the monthly customer base rates.

b. Explain whether Columbia Kentucky is requesting the SMRP Rider charges to roll into the monthly customer base rates or just base rates.

c. Explain where these amounts are stemming from since customers pay a monthly SMRP Rider charge to pay for those projects.

d. Explain whether the inclusion, or rolling in, of the SMRP Rider charge into the monthly customer base rates, are included in the revenue request of $26,694,986, or if it is a separate amount that Columbia Kentucky is requesting to include in base rates.

Response:

a. The SMRP rider provides for $15,165,108 in the Annualized Test Year Revenues at Current Rates. The following details the amounts as presented in Schedule M2.2:

	Schedule M2.2	
Annualized Test Year Revenues at Current Rates		
Page	**Line**	**Amount**
8	21	8,706,920
12	5	3,377,291
13	5	15,024
14	5	-
14	25	4,987
15	5	1,107,164
15	21	930,733
16	5	3,501
17	6	410,327
17	25	603,278
18	6	3,841
18	27	2,042
		$ 15,165,108

b. The proposed design of rates for the Residential class includes a $29.20 customer charge that would generate approximately 55% of the total residential revenue requirement. The 55% is the same percentage of existing residential fixed charge revenues (inclusive of the current customer charge of $16.00 plus the $6.63 SMRP Rider charge) generated from existing rates. The proposed rate design maintains the fixed portion of the residential bill at rates in effect when this case was filed.

The remaining portion of the revenue requirement is included in the proposed volumetric rates.

c. The SMRP rider will be reset to $0.00 (zero) upon implementation of new base rates reflecting the inclusion of all SMRP investments into the rate base used for determining the revenue requirement.

d. The $26,694,986 revenue requirement increase reflects the net impact of the increase in base rates offset by the reduction in SMRP revenues.

COLUMBIA GAS OF KENTUCKY, INC.
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10. Refer to the Cole Testimony, page 11.

a. Identify when NiSource began using the Safety Management System ("SMS").

b. Identify when Columbia Kentucky began using the SMS.

c. Explain whether this Commission has approved the SMS in past cases, and if so provide the case number reference.

d. Provide the total project cost of SMS.

e. Provide the monetary amount that NiSource paid for the SMS project cost.

f. Confirm whether Columbia Kentucky is requesting any costs associated with the SMS to be included in the revenue requirement in the pending rate case. If so, identify the costs included in the revenue requirement by amount and by type.

g. Provide the allocated total cost that Columbia Kentucky has to pay for the SMS.

h. Provide the allocated total cost that the other natural gas distribution company subsidiaries of NiSource have to pay for the SMS.

i. Is Columbia Kentucky aware whether any other natural gas utility in Kentucky has an SMS? If so, provide examples of the same.

Response:

a. NiSource first began implementing elements of a Safety Management System ("SMS") in 2016 with Columbia Gas of Virginia and Northern Indiana Public Service Company.
b. Columbia Gas of Kentucky began SMS implementation in 2018.
c. The Company established SMS pursuant to American Petroleum Institute Recommended Practice (or "RP") 1173. RP-1173 provides guidance to pipeline operators for developing and maintaining a pipeline safety management system, and is intended to augment existing practices while not duplicating any other requirements. The Commission was informed of the Company's decision to implement SMS in Case No. 2019-00257[1], and, through SMS, the Company continues to focus its efforts and resources on the top risks to the Company's

[1] *The Electronic Application of Columbia Gas of Kentucky, Inc. for: 1) A Declaration that Construction of a Low Pressure System Safety Improvement is an Extension in the Ordinary Course of Business, 2) In the Alternative, for the Issuance of a Certificate of Public Convenience and necessity for such Construction; 3): Approval of an Amendment and Expansion of its Accelerated Main Replacement Tariff to its Safety Modification and Replacement Tariff; and 4) Approval to Modify the 2019 AMRP Construction Plan*, Application filed July 29, 2019.

systems, and is expanding focus in several critical areas to maintain and enhance its operational capabilities. SMS is not a discrete project or something Columbia has requested for approval. Rather, SMS is a proactive and systematic and all-encompassing approach to managing safety, including the structures, policies and procedures an organization uses to direct and control activities. Please see David A. Roy's prepared direct testimony on pages 14 and 15 as well as Kimra Cole's prepared direct testimony at pages 11-18.

d. Please see the response to part c. above. In addition, with SMS being more of an operating model, there is no reasonable way to account for costs.

e. See the answers to parts c. and d.

f. There are costs to the activities that Columbia has, and continues to, pursue after the adoption of the SMS framework. While the decision to pursue these activities could have been informed by Columbia's SMS paradigm, to tie these costs specifically to SMS is to misinterpret what SMS truly represents: an operating model (see response to c and d above). Please refer also to the responses to Attorney General's First Request for Information Nos. 39 and 50..

g. Please see responses c through f.

h. Please see responses c through f.

i. Columbia is not aware whether any other Kentucky utility has implemented an SMS.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
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11. Refer to the Cole Testimony, page 19. Ms. Cole states that Columbia Kentucky has implemented the ability for customers to make bill payments via PayPal, PayPal Credit, Amazon Pay, and Venmo. Ms. Cole further states that Columbia Kentucky is proposing to waive fees associated with payments made by using a credit card.

a. Explain whether Columbia Kentucky is charged any monetary fees when customers use PayPal, PayPal Credit, Amazon Pay, and Venmo to pay utility bills.

b. If so, identify the amount of monetary fees that are charged for each payment type.

c. Identify the total amount of fees associated with PayPal, PayPal Credit, Amazon Pay, and Venmo that Columbia Kentucky is proposing to include in base rates.

d. Identify the fees that Columbia Kentucky is charged when a customer uses a credit card to pay for a utility bill.

e. Identify the total monetary amount of waived credit card fees that Columbia Kentucky is proposing to include in base rates.

f. Explain why Columbia Kentucky believes it is fair to force customers who use cash or check to pay utility bills to subsidize the costs of customers who choose to use credit cards.

Response:

a. Columbia is not charged a fee when customers use PayPal, PayPal Credit, Amazon Pay, and Venmo to pay utility bills, the customer is assessed the transaction fee.

b. When customers use PayPal, PayPal Credit, Amazon Pay, and Venmo to pay utility bills, the customer is charged $1.75 for the transaction.

c. Please refer to Columbia witness Gore testimony and Attachment JTG-3. Of the 188,944 transactions on Line 1, 453 were Pay Pal transactions and there were no Amazon Pay and Venmo transactions. The 453 transactions @ $1.35 would calculate to $612. Note the Pay Pal transactions started in December 2019.

d. See response to item A.

e. The projected costs on an annual basis for credit cards, debit cards, ACH, and walk-in payments in the initial year, and included in the Company's pro forma level of NCSC billed O&M expense in this Application, are estimated to be $277,800, of this amount $251,190 is estimated for credit, debit card, ACH and check transactions while $26,610 is estimated for walk-in transactions.

f. Currently, Columbia customers can make bill payments via mail, monthly debit from their financial account, or by a one-time electronic payment as a registered on-line account holder without paying a fee at the time of the transaction. The processing fees associated with these methods of payment are included in current base rates, and in the Cost of Service calculation of this case. Columbia, however, believes that credit card transactions will continue to increase over time as customers migrate to the use of credit cards to pay their gas bill. This follows a general trend of migration to credit and debit cards as the preferred payment method for the purchase of all consumer goods. Columbia is proposing that the costs associated with credit card be included in the Cost of Service calculation to allow for consistency with these other methods of payment. If approved, all residential customers will be able to select the payment channel of their choice without consideration of additional convenience or transaction fees.

COLUMBIA GAS OF KENTUCKY, INC.
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12. Refer to the Direct Testimony of David Roy ("Roy Testimony"), page 6. Explain what is meant by 4 miles of "other" type of pipeline.

Response:

Other pipe is a category on the PHMSA annual reports where the materials are unknown or do not meet one of the other categories of pipe such as bare steel, coated steel, cast iron, wrought iron, plastic, ductile iron, copper, or reconditioned cast iron.

COLUMBIA GAS OF KENTUCKY, INC.
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13. Refer to the Roy Testimony, pages 6 and 7. Mr. Roy states that an odorant known as mercaptan is "often" added to the natural gas at the city gate, or upstream by the natural gas supplier, before it is delivered into Columbia's distribution system.

a. Explain Columbia Kentucky's process to determine whether mercaptan should be added to the natural gas at the city gate or not.

b. When Columbia Kentucky does not add mercaptan to the natural gas, explain whether there is already an existing odor in the natural gas that can alert its customers to a potential natural gas leak.

Response:

a. The majority of the gas Columbia receives from its suppliers is processed gas where the heavier hydrocarbons are removed from the gas. Those processes also remove many of the constituents that give natural gas its distinctive odor. Natural gas supplied to distribution systems that have had the natural odorant removed must have mercaptan added to fulfill the requirement of 49 CFR 192.625. However, there are supply points in eastern Kentucky that originate from unprocessed local production fields. These deliveries contain a sufficient level of natural odorant to also fulfill the requirements of 49 CFR 192.625. Whether Columbia injects mercaptan on relies on natural odorant, Operations personnel conduct weekly odorant sampling to ensure the concentration of odorant is readily detectable by a person with an ordinary sense of smell.

b. When Columbia does not add mercaptan, there is a level of natural odorant that is sufficient to alert customers of a potential gas leak. As mentioned above, weekly sampling is conducted to ensure this condition continues.

COLUMBIA GAS OF KENTUCKY, INC.
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14. Refer to the Roy Testimony, pages 13 and 22.

a. Explain what enhanced techniques Columbia Kentucky utilizes for finding difficult to locate facilities. If Columbia is referring to "vacuum excavation" then please provide a detailed explanation of the same.

b. Mr. Roy states that excavator error remains the highest cause of damages to Columbia Kentucky's system, at 34% of total damages in 2020.

i. Provide the other causes of damage to Columbia Kentucky's system that account for the other 66%.

ii. Explain in full detail whether Columbia Kentucky always pursues the responsible party for all monetary damages. If not, explain why not.

Response:

a. When a facility is deemed to be un-locatable by traditional locating means – 'traditional' refers to above ground conductive or inductive locating techniques that in turn can be verified by maps and records – Columbia Gas of Kentucky will use enhanced techniques to accurately find and locate the facility. In no particular order, these techniques include:

i. Vacuum Excavation

- Vacuum Excavation uses either water (Hydro Vacuum Excavation) or air (Pneumatic Vacuum Excavation) to non-intrusively unearth the facility for locating. Both methods use hand held nozzles that either use water or air to disrupt the earth. A large vacuum is then used to remove the disrupted earth from the excavation. This continues until the facility is unearthed.

ii. Direct Insertion – also known as 'Jameson Reel' or 'Fish Tape'

- Service lines: This method requires disrupting the customers service (if active) by shutting off service at the meter valve and inserting a metallic wire through the stop and into the service line. The devices used block the flow of gas at the insertion point providing safety throughout the procedure. Once inserted into the service line a conductive locating transmitter is attached to the inserted wire and the locate is performed with a corresponding locate receiver. After completion of the locate the wire is removed, Columbia Gas of Kentucky will restore service to the customer.

- Main lines: This method requires the mainline to first be unearthed – primarily via vacuum excavation or hand digging – at which point technicians are able to install specialized equipment that will tap the facility and allow for the safe insertion of a wire into the facility without the escape of gas. Once the wire is inserted the facility will be located by attaching a conductive locating transmitter to the inserted wire and a locate is performed with a corresponding locate receiver.

iii. Hand digging

- Technicians will dig by hand to unearth facilities for locating.

iv. Replacement

- Columbia Gas of Kentucky will install new facilities and abandon the old un-locatable facilities in an effort to make the facility locatable.

b.

i. The following table provides the root causes for all damages in 2020.

Cause of damage	2020
Excavator Error	53
Failure To Call	51
Locator Error	23
Poor Records	28
Grand Total	155

ii. Columbia attempts to recover monetary losses from responsible parties. Columbia does not pursue damages wherein Columbia is the responsible party.

COLUMBIA GAS OF KENTUCKY, INC.
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15. Refer to the Roy Testimony, page 35. Mr. Roy states that Columbia Kentucky proposes to pilot the Picarro system for three months in 2022, by utilizing one of the Picarro equipped vehicles owned by another NiSoure company to assess approximately 300 miles of the distribution system. Mr. Roy further stated that the total cost of the pilot to determine whether the Picarro system has viable application for Columbia Kentucky and its customers should not exceed $300,000.

a. Provide a detailed breakdown of the $300,000 proposed expenditure.

b. Explain whether Columbia Kentucky deems $100,000 per 100 miles of pipeline for leak detection in the pilot program as a reasonable cost.

c. If the Commission approves the pilot project, and Columbia Kentucky decides to move forward with purchasing the Picarro system, provide detailed estimates of all associated costs, including but not limited to the price of the Picarro system, operating and maintenance expense, depreciation, etc.

d. Provide the estimated timeframe that a Picarro system will accurately work before having to be replaced with a new system.

Response:

a. Please see Columbia's Response to KY PSC Case No. 2020-00378 Staff's Request for Information Set Two No. 9.

b. Yes. The $100,000 per 100 miles includes estimated repair costs for the incremental leaks expected to be found. This is a one-time pilot intended to assess the technology for future use. Additionally, as a part of the PIPES Act of 2020, Congress directed the PHMSA to create rules to require the use of advanced leak detection equipment. Columbia Kentucky plans to use the Picarro pilot as an opportunity to understand equipment that would comply with this mandate.

c. **Unit Costs**

   1. $1,200,000 one-time capital cost
   2. $60,000 O&M per year of service charge
   3. $4,000 per year for vehicle lease
   4. $1,000 per year for annual vehicle maintenance costs

   Driver - $100,000 per unit, per useful year of operation

   Analysis - $22,500 per year

d. The Picarro Surveyor system will work accurately for 5 years. Within its service agreement, Picarro requires the replacement of the system at the end of its 5-year useful life.

COLUMBIA GAS OF KENTUCKY, INC.
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16. Refer to the Roy Testimony, pages 27 and 28. Mr. Roy states that Columbia Kentucky intends to assess storm and sanitary sewers within close proximity to approximately 155 miles of plastic main and associated services installed between January 1, 2010 and December 31, 2016, over a five-year period beginning in 2022.

a. Provide a breakdown of the average annual cost of $1.3 million for the operation and maintenance of the cross bore program.

b. Explain whether Columbia Kentucky has discussed this program with the owners of the storm and sanity sewers, and whether those owners will contribute any funds towards the program. If not, explain in full detail why not.

c. Identify any other Kentucky natural gas utility that has a separate cross bore program.

d. Explain why inspecting for cross bores cannot be combined with Columbia Kentucky's already existing pipeline inspection programs so as to not have to implement a separate five-year $6.5 million dollar cross bore project.

e. Mr. Roy states that at the end of the five-year program, Columbia Kentucky would only extend the assessment for cross bores for years prior to 2010 if the data shows the threat is still significant and should be addressed. Elaborate as to the criteria that would factor into the decision as to whether or not the cross bore program should be extended past the initial five-year period.

Response:

a. Internal Labor ~$150,000

   Contract Labor ~$1,150,000

   Total: $1,300,000

b. Columbia has held small, localized meetings with some of the owners of the storm and sanitary sewers as the pilot program is conducted and plan to hold additional meetings with other system owners operating in areas targeted by the pilot. The meetings provide awareness and support. Columbia has not requested these owners pay for part of the program, but if a cross-bore is discovered to be caused by an identified third party, Columbia will attempt to seek reimbursement for the repair.

c. Columbia is not aware of other cross-bore programs operated by other Kentucky natural gas utilities.

d. Cross-bore inspection work is unlike any other inspection work performed by Columbia. The work is generally performed on sewers and septic lines with camera technology. There are no synergies that exist between this work and other inspection work Columbia performs.

e. The primary criteria would be the discovery of material cross-bores during the assessment. Should Columbia discover few to no cross-bores at the conclusion of the assessment, Columbia would re-evaluate the means by which it categorizes the threat presented by cross bores and may discontinue the cross-bore program.

COLUMBIA GAS OF KENTUCKY, INC.
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17. Refer to the Roy testimony, page 38. Mr. Roy states that new training facilities were built in Ohio, Virginia, and Pennsylvania for other Columbia Gas states, and Columbia Kentucky began sending employees to the new training facilities in 2017.

a. Identify the cities in which the new training facilities are located.

b. Provide the number of employees and the general job titles of each employee that Columbia Kentucky sent to each of the above-referenced training facilities in 2017, 2018, 2019, 2020, and 2021.

c. Provide the total cost to send Columbia Kentucky's employees to the above-referenced training facilities in 2017, 2018, 2019, 2020, and 2021.

d. Provide a breakdown of the total cost provided in (b) for 2017, 2018, 2019, 2020, and 2021.

Response:

a. The cities where new training facilities were built are Gahanna, Ohio, Monaca, Pennsylvania and Chester, Virginia.

b. We sent the following number of employees to the different sites in years 2017-2021:

2017-2021 Employee Trips to Training Facilities					
Site	**2017**	**2018**	**2019**	**2020**	**2021 YTD***
Ohio	117	85	182	83	47
Pennsylvania			3	0	0
Virginia			9	0	0
* YTD through June					

Columbia does not have records that show what titles employees had at the time they attended training. However, every person attending training was, at the time, a front line field employee or front line field leader.

c. Training costs are not tracked in such a way that can be easily pulled as requested. However, the following schedule was developed showing estimated costs based on trips taken:

2017-2021 Estimated Cost to Send Employees to Training Facilities					
Site	**2017**	**2018**	**2019**	**2020**	**2021 YTD***
Ohio	$288,300	$191,500	$399,100	$162,500	$ 76,900
Pennsylvania			$ 6,400		
Virginia			$ 22,500		
* YTD through June					

Costs are expected to substantially climb in 2022 as enhanced operator qualification training gets implemented. Columbia expects to average approximately $460,000 per year going forward on travel expenses.

d. See answer to part c.

COLUMBIA GAS OF KENTUCKY, INC.
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18. Refer to the Roy Testimony, page 41.

a. Provide a breakdown of the $5.6 million up front capital costs to build the proposed new training facility.

b. Provide a breakdown of the ongoing operations and maintenance (O&M) expense of $140,000 per year.

Response:

a. Please refer to KY PSC Case No. 2021-00183, AG 1-18, Attachment A
b. Internal Labor: ~$125,000

   Utilities: ~$15,000

Project Name	CKY Training Improvements					4/8/2021
Line Item	**Safety Town & Site Scenarios**	**Plant / Service Lab (1560 SF)**	**Plant / Service Classrooms (1560 SF, Mezz.)**	**OQ Prometric Testing (600 SF)**	**OQ Hands On / Plant Fusion Lab (750 SF)**	**Storage Building at Propane Site (40 ft x 80 ft)**
General Conditions Allowance	$ 75,000	$ 20,000	$ 20,001	$ 20,000	$ 20,000	$ 20,000
Demolition Allowance ($10 / SF)	$ 75,000	$ 31,000	$ 31,000	$ 7,500	$ 24,000	$ 24,000
Site Work Allowance (Paving, gravel, stormwater , Conduit, gas extension, fence)	$ 500,000	$ -	$ -	$ -	$ -	$ 75,000
Electrical Allowance	$ 325,000	$ 20,000	$ 20,000	$ 20,000	$ 15,000	$ 25,000
Training Village (buildings, leaks, plumbing)	$ 1,300,000	$ -	$ -	$ -	$ -	$ -
Storage / Compressor Metal Buildings	$ 250,000	$ -	$ -	$ -	$ -	$ 250,000
Compressor Allowance	$ 200,000	$ -	$ -	$ -	$ -	$ -
Building Renovation Cost ($140 / SF)	$ -	$ 218,400	$ 218,400	$ 84,000	$ 105,000	$ -
Prometric Testing Fee	$ -	$ -	$ -	$ 60,000	$ -	$ -
Fees / Overhead / Contingency / Misc.(10%)	$ 272,500	$ 28,940	$ 28,940	$ 13,150	$ 16,400	$ 39,400
Subtotal Capital Spend Construction	**$ 2,997,500**	**$ 318,340**	**$ 318,341**	**$ 204,650**	**$ 180,400**	**$ 433,400**
Professional Services	$ 200,000	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)
IT	$ 150,000	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)
Security (card readers)	$ 30,000	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)
Cabling	$ 75,000	$ 15,000	$ 5,000	$ 10,000	$ -	$ -
Furniture	$ 20,000	$ 25,000	$ 50,000	$ 25,000	$ 25,000	$ -
Cabling / Shelving / Racking	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 5,000	$ 15,000
Appliances	$ -	TOOLING BY BU	TOOLING BY BU	$ -	TOOLING BY BU	$ -
Audio/Visual	$ 150,000	$ 25,000	$ 25,000	Included in Prometric Fee	$ 25,000	$ -
Window Treatments	$ -	$ 10,000	$ 10,000	$ 10,000	$ 10,000	$ -
Signage (exterior)	$ 10,000	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	$ -
Arts / Graphics	$ 10,000	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	(SAFETY TOWN)	$ -
Miscellaneous	$ -	TOOLING BY BU	TOOLING BY BU	$ -	TOOLING BY BU	$ -
Decommissioning Existing Site	$ -	$ -	$ -	$ -	$ -	$ -
Tenant Improvements (Non-Reimbursable)	$ -	$ -	$ -	$ -	$ -	$ -
Tenant Allowance (Reimbursable)	$ -	$ -	$ -	$ -	$ -	$ -
Contingency (20%)	$ 130,000	$ 16,000	$ 19,000	$ 10,000	$ 13,000	$ 3,000
Subtotal Capital Spend FF&E	**$ 780,000**	**$ 96,000**	**$ 114,000**	**$ 60,000**	**$ 78,000**	**$ 18,000**
TOTAL	**$ 3,777,500**	**$ 414,340**	**$ 432,341**	**$ 264,650**	**$ 258,400**	**$ 451,400**

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

19. Refer to the Roy Testimony, pages 47 and 48. Mr. Roy states that Columbia originally estimated that the total Accelerated Main Replacement Program ("AMRP") would cost $120 million to replace 525 miles of Priority Pipe. However, Mr. Roy also states that from 2008 – 2020 Columbia Kentucky has replaced 199 miles of priority pipe and 7,412 steel service lines for approximately $220 million.

a. Explain why Columbia Kentucky's initial approximation of cost for the replacement of 525 miles of priority pipe was greatly underestimated.

b. Provide an updated estimation of the total cost to replace the remaining 326 miles of priority pipe.

c. Confirm that Columbia Kentucky only has 326 miles of priority pipe to replace. If not, explain in full detail.

d. Mr. Roy states that after the AMRP transitioned to the Safety Modification and Replacement Program ("SMRP") in 2019, Columbia Kentucky completed Phase 1 of a Low Pressure Program that was to be made up of two phases.

i. Confirm that the Low Pressure Program had a total cost of $8.8 million.

ii. Explain why Phase II is still under evaluation.

Response:

a. Assumptions were made in the various cost categories that make up a replacement project that turned out to be profoundly underestimated. When the program was developed, the estimated costs were based on construction pricing at that time. Construction pricing has significantly increased since then. Additionally, added paving requirements from some of the various cities and the state were unknown at the time. For instance, the state often allowed Columbia to bury at various depths depending on the Kentucky Transportation Cabinet (KYTC) district. Since that time, the standard burial depth has been increased to 60 inches. This means added contractor costs, added backfill, added labor, and often times added rock excavation.
b. An updated estimate requires a study that has not been performed yet.
c. Columbia confirms that 326 miles of priority pipe remain.
d. i. Columbia is still in the process of completing the replacements and closing out the job orders. The remaining replacement is expected to be completed in July of 2021. The current forecast for that phase of the project is $9.3 million.

ii. Phase II is still under evaluation because Phase I is still in progress. Phase II will be evaluated against other threats and brought to the Commission for inclusion in the SMRP if prioritized over threats.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

20. Refer to the Roy Testimony, page 48. Mr. Roy states that Columbia Kentucky is planning to spend $121.6 million in SMRP over the next three years - $40 million in 2021, $40 million in 2022, and $41.6 million in 2023 to replace priority pipe.

a. Provide a breakdown of the $40 million proposed expenditures in 2021.

b. Provide a breakdown of the $40 million proposed expenditures in 2022.

c. Provide a breakdown of the proposed $41.6 million expenditures in 2023.

d. Provide the total expenditures of the AMRP/SMRP for each year between 2010 – 2021, as well as how many miles of pipeline were replaced.

Response:

a-c. Please refer to KY PSC Case No 2021-00183, AG Set 1-20, Attachment A. It should be noted that the SMRP is a subset of Columbia's Age and Condition Budget. As a result, the Age and Condition budget is determined first, then a percentage is allocated to SMRP with the remainder going to other age and condition needs that are not eligible for the program. When the work is planned, Columbia utilizes an accounting code to identify only those projects/job orders that are eligible for the program.

d. Please refer to KY PSC Case No 2021-00183, AG Set 1-20, Attachment B.

Columbia Gas of Kentucky, Inc.
Case No. 2021-00183
SMRP / Age and Condition Breakdown for 2021 to 2023
Years 2020 - 2023

Line No.	**Type of Spend**	**2021 ($000)**	**2022 ($000)**	**2023 ($000)**
1	Replacement Mains	31,635	31,184	35,299
2	Replacement Services	7,937	7,897	8,793
3	Meters	530	546	563
4	Meter Install	52	53	55
5	House Regulators Replace	68	70	72
6	Plant Regulators Replace	900	900	900
7	Regulator Structures Replace	64	66	68
8	Large Volume Excess Pressure Measuring Stations	185	185	185
9	Corrosion Mitigation	140	140	140
10	Intercompay Transfers	63	65	67
	Total Age and Condition Allocation	41,574	41,106	46,142
	Percent Allocated to SMRP	96%	97%	90%
	SMRP Capital Allocation	39,911	39,873	41,528

Columbia Gas of Kentucky, Inc.
KY PSC Case No. 2021-00183
Total AMRP/SMRP Expendatures &
Mileage for 2010-2021

Line No.	Year	SMRP Spend ($000)	Miles of pipe Replaced
1	2010	4,770	6
2	2011	9,220	5
3	2012	11,360	19
4	2013	15,900	12.9
5	2014	15,200	12.4
6	2015	17,300	13.1
7	2016	15,200	17.4
8	2017	19,200	15.7
9	2018	28,500	17.5
10	2019	31,700	19.5
11	2020	41,200	21.7
12	2021	21,200 (YTD)	6.04 (YTD)

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

21. Refer to the Roy Testimony, pages 51 – 52. Mr. Roy states that Columbia Kentucky is proposing to include the replacement of first generation plastic pipe (pre-1982 and sometimes called Aldyl-A) as part of the SMRP.

a. Mr. Roy states that the Pipeline and Hazardous Materials Safety Administration ("PHMSA") issued four advisory bulletins to owners and operators of natural gas pipeline distribution systems in the past concerning the susceptibility of older plastic pipe to premature brittle-like cracking. Provide copies of all four PHMSA advisory bulletins.

b. Explain whether the PHMSA advisory bulletins instructed owners and operators of natural gas pipeline distribution systems to immediately replace the older plastic pipe, or if it recommended monitoring the pipe.

c. Provide the specific years of pipeline that the PHMSA advisory bulletins were concerning. For example, were the bulletins applicable to all pre-1982 plastic pipelines as Columbia Kentucky is requesting to include in the SMRP, or was it pre-1973 plastic pipelines?

d. Identify how many miles of Aldyl-A pipeline Columbia Kentucky has in its system.

e. Explain whether bare steel and cast iron pipeline in Columbia Kentucky's system pose a greater safety risk than Aldyl-A pipeline.

f. Explain why Columbia Kentucky should not continue to replace Aldyl-A pipeline when an issue is found instead of accelerating its replacement through the SMRP.

Response:

a. Please refer to the attachments titled KY PSC Case No 2021-00183, AG 1-21, Attachment A-D.
b. The advisory bulletins did not instruct Operators to immediately replace the older plastic pipe rather, in general, PHMSA recommended that Operators closely monitor and analyze leakage histories on this pipe for leaks with increased leakage survey frequency and if was installed, repaired, or operating in and environment that impairs pipe strength it should be replaced in a timely manner.
c. Advisory Bulletin ADB-99-02 advises owners and operators identify all pre-1982 plastic pipe installations.
d. Columbia has 241 miles of pre-1982 first generation plastic pipe that is subject to the brittle-like cracking identified in the advisory bulletins.

e. In general, bare steel and cast iron pose a greater safety risk than first generation plastic pipe; however, there are sometimes segments of first generation plastic whose risk scores exceed that of lower risk bare steel pipe.

f. Generally, Columbia's maintenance replacement budget gets spent on numerous smaller projects that are of urgent need, typically due to leakage. Most planned SMRP projects are larger in nature and allow for an area of poor performing pipe to be modernized in the most cost effective way possible. Allowing riskier, first generation plastic pipe to be included as planned SMRP projects enables Columbia to utilize the most cost effective and long term preferred design to be used. Based on budget constraints, it's not practical to allow a larger first generation plastic project of that type to absorb so much of the maintenance replacement budget. Additionally, Columbia's SMRP is structured such that the Company would present any proposed poor performing segments of first generation plastic pipe to the Commission to review and approve as part of the project list for the next construction year.

Advisory Bulletin ADB-1999-01

March 5, 1999.

[Notices] [Page 12211-12212]

DEPARTMENT OF TRANSPORTATION

Research and Special Programs Administration

Potential Failure Due to Brittle-Like Cracking Certain Polyethylene Plastic Pipe Manufactured by Century Utility Products Inc

AGENCY: Research and Special Programs Administration (RSPA), DOT.

ACTION: Notice; issuance of advisory bulletin on Century polyethylene gas pipe to owners and operators of natural gas distribution systems.

SUMMARY: This advisory bulletin is directed at owners and operators of natural gas distribution systems that have installed plastic pipe extruded by Century Utility Products Inc. from Union Carbide Corporation's DHDA 2077 Tan medium density polyethylene resin (Century pipe). Pipe manufactured between 1970 and 1973 may fail in service due to its poor resistance to brittle-like cracking. Operators with Century pipe in their systems should closely monitor this pipe for leaks with increased leak survey frequency. Century pipe that may be improperly installed, repaired, or operating in an environment that impairs pipe strength should be replaced.

ADDRESSES: This document can be viewed on the Office of Pipeline Safety (OPS) home page at: http://ops.dot.gov.

FOR FURTHER INFORMATION CONTACT: Gopala (Krishna) Vinjamuri at (202) 366-4503, or by E-mail at vinjamuri@rspa.dot.gov.

SUPPLEMENTARY INFORMATION:

I. Background

The National Transportation Safety Board (NTSB) recently published the results of a special investigation into accidents that involved plastic pipe currently in use to deliver natural gas to residential and business use. The report, Brittle-Like Cracking in Plastic Pipe for Gas Service (NTSB/SIR-98/01; April 23, 1998) suggested that "[d]espite the general acceptance of plastic piping as a safe and economical alternative to piping made of steel and other materials,

[a] number of pipeline accidents investigated have involved plastic piping that cracked in a brittle-like manner." Copies of this report may be obtained from NTSB Public Inquiry Office by calling 202-314-6551.

The phenomenon of brittle-like cracking in plastic pipe as described in the NTSB report and generally understood within the plastic pipeline industry relates to a part-through crack initiation in the pipe wall followed by stable crack growth at stress levels much lower than the stress required for yielding, resulting in a very tight slit-like opening and gas leak. This failure mode is difficult to detect until significant amount of gas leaks out of the pipe, and potentially migrates into closed space such as basements of dwellings. Premature brittle-like cracking requires relatively high localized stress intensification that may be a result from geometrical discontinuities, excessive bending, improper fitting assemblies, and/or dents and gouges. Because this failure mode exhibits no evidence of gross yielding at the failure location, the term brittle-like cracking is used. This phenomenon is different from brittle fracture, in which the failure results in fragmentation of the pipe.

NTSB also alleged that the guidance provided by manufacturers and industry standards for the installation of plastic pipe is inadequate for limiting stress intensification, particularly at plastic service connections to steel mains, many of these connections may have been installed without adequate protection from shear and bending forces that may result in brittle-like cracking.

Century Pipe

Between 1970 and 1973, Century Utility Products Inc. (a/k/a AMDEVCO), now defunct, marketed medium density polyethylene plastic pipe and fittings (Century pipe) in sizes ranging from \1/2\ inch to 4 inches for use in natural gas distribution. These plastic pipes and fittings were manufactured by extrusion from Union Carbide Corporation's DHDA 2077 Tan resin, and was marked PE 2306 in accordance with American Society for Testing and Materials (ASTM) standards. Following investigation of a series of incidents, including the December 2, 1979, explosion in a residence in Tuscola, Illinois, and the October 17, 1994, accident in Waterloo, Iowa, that resulted in several fatalities, it was established that the Union Carbide's DHDA 2077 Tan resin lacks adequate resistance to brittle-like cracking and is prone to relatively short life when subjected to high local stress concentration. The pipe in the Tuscola, Illinois, accident failed in less than 8 years, and the pipe in the Waterloo, Iowa, accident failed within 23 years in service. It has been established that Century pipe exhibited significantly higher leak rate in comparison with other polyethylene, steel, and cast iron pipe used in natural gas distribution systems.

Following the Waterloo, Iowa, accident, RSPA has taken number of actions, including gathering Century pipe installation data. Also, remedial action has been taken by various operators in mid-western states where much of the Century pipe produced was known to have been installed. It is RSPA's understanding that the operators having Century pipe in their systems have initiated close monitoring and some have replacement program in progress.

NTSB recommended that RSPA notify owners and operators of natural gas systems who continue to use Century pipe of the potential for premature failures by brittle-like cracking and the need to "[d]evelop a plan to closely monitor the performance of and to identify and replace, in a timely manner, any piping that indicates poor performance based on such evaluation factors as installation, operating and environmental conditions, piping failure characteristics and leak history."

II. Advisory Bulletin (ADB-99-01)

To: Owners and Operators of Natural Gas Distribution Pipeline Systems.

Subject: Susceptibility of certain polyethylene pipe manufactured by Century Utility Products Inc. to premature failure due to brittle-like cracking.

Purpose: To advise natural gas distribution pipeline owners and operators of the need to closely monitor and replace as necessary polyethylene natural gas pipe manufactured by Century Utility Products Inc. between 1970 and 1973 that is susceptible to brittle-like cracking.

Advisory: All owners and operators of natural gas distribution systems who have installed and continue to use polyethylene pipe extruded by Century Utility Products Inc, (now defunct) from the resin DHDA 2077 Tan resin manufactured by Union Carbide Corporation during the period 1970 to 1973 (Century pipe) are advised that this pipe may be susceptible to premature failure due to brittle-like cracking. Premature failures by brittle-like cracking of improper joints, improper installation, and environments detrimental to pipe long-term strength. All distribution systems containing Century pipe should be monitored to identify pipe subject to brittle-like cracking. Remedial action, including replacement, should be taken to protect system integrity and public safety.

In addition, in light of the potential susceptibility of Century pipe to brittle-like cracking, RSPA recommends that each natural gas distribution system operator with Century pipe revise their plastic pipe repair procedure(s) to exclude pipe pinching for isolating sections of Century pipe. Additionally, RSPA recommends replacement of any Century pipe segment that has a significant leak history or which for any reason is of suspect integrity.

Authority: 49 U.S.C. Chapter 601; 49 CFR 1.53.

Issued in Washington, DC on March 5, 1999.

Richard B. Felder,

Associate Administrator for Pipeline Safety.

[FR Doc. 99-6013 Filed 3-10-99; 8:45 am]

BILLING CODE 4910-60-P

Advisory Bulletin ADB-1999-02

March 3, 1999

[Notices][Page 12212-12213]

DEPARTMENT OF TRANSPORTATION

Research and Special Programs Administration

Potential Failures Due to Brittle-Like Cracking of Older *Plastic Pipe* in Natural *Gas* Distribution Systems

AGENCY: Research and Special Programs Administration (RSPA), DOT.

ACTION: Notice; issuance of advisory bulletin on brittle-like failures of plastic pipe to owners and operators of natural gas distribution systems.

SUMMARY: RSPA is issuing this advisory bulletin to owners and operators of natural gas distribution systems to inform them of the potential vulnerability of older plastic gas distribution pipe to brittle-like cracking. The National Transportation Safety Board (NTSB) recently issued a Special Investigation Report (NTSB/SIR-98/01), Brittle-like Cracking in Plastic Pipe for Gas Service, that described how plastic pipe installed in natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public and property. RSPA has also issued an additional advisory bulletin (ADB-99-01) reminding natural gas distribution system operators of the potential poor resistance to brittle-like cracking of certain polyethylene pipe manufactured by Century Utility Products, Inc.

ADDRESSES: This document can be viewed on the Office of Pipeline Safety (OPS) home page at: http://ops.dot.gov.

FOR FURTHER INFORMATION CONTACT: Gopala K. Vinjamuri, (202) 366-4503, or by email at gopala.vinjamuri@rspa.dot.gov.

SUPPLEMENTARY INFORMATION:

I. Background

The National Transportation Safety Board (NTSB) recently issued a Special Investigation Report (NTSB/SIR-98/01), Brittle-like Cracking in Plastic Pipe for Gas Service, that described how plastic pipe installed in natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public and property. An NTSB survey of the accident history of plastic pipe suggested that the material may be susceptible to premature brittle-like cracking under conditions of local *stress* intensification because of improper joining or installation procedures. Hundreds of thousands of miles of plastic pipe have been installed, with a significant amount installed prior to the mid-1980s. NTSB believes any vulnerability of this material to premature failure could represent a potentially serious hazard to public safety.

The NTSB report addressed the following safety issues:

- The vulnerability of plastic pipe to premature failures due to brittle-like cracking;
- The adequacy of available guidance relating to the installation and protection of plastic pipe connections to *steel* mains; and
- Performance monitoring of plastic pipeline systems as a way of detecting unacceptable performance in piping systems.

Copies of this report may be obtained by calling NTSB's Public Inquiry Office at 202-314-6551.

The phenomenon of brittle-like cracking in plastic pipe as described in the NTSB report and generally understood within the plastic pipeline industry relates to a part-through crack initiation in the pipe wall followed by stable crack growth at stress levels much lower than the stress required for yielding, resulting in a very tight slit-like opening and gas leak. Although significant cracking may occur at points of stress concentration and near improperly designed or installed fittings, small brittle-like cracks may be difficult to detect until a significant amount of gas leaks out of the pipe, and potentially migrates into an enclosed space such as a basement. Premature brittle-like cracking requires relatively high localized stress intensification that may be a result from geometrical discontinuities, excessive bending, improper fitting assemblies, and/or dents and gouges. Because this failure mode exhibits no evidence of gross yielding at the failure location, the term brittle-like cracking is used. This phenomenon is different from brittle fracture, in which the failure results in fragmentation of the pipe.

The report suggests that the combination of more durable plastic pipe materials and more realistic strength testing has improved the reliability of estimates of the *long-term hydrostatic strength* of modern plastic pipe and fittings. The report also documents that older polyethylene pipe, manufactured from the 1960s through the early 1980s, may fail at lower stresses and after less time than was originally projected. NTSB alleges that past standards used to rate the long-term strength of plastic pipe may have overrated the strength and resistance to brittle-like cracking of much of the plastic pipe manufactured and used for gas service from the 1960s through the early 1980s.

In 1998, NTSB made several recommendations to trade organizations and to the Research and Special Programs Administration (RSPA) on the need for a better understanding of the susceptibility of plastic pipe to brittle-like cracking. NTSB recommended that RSPA "[d]etermine the extent of the susceptibility to premature brittle-like cracking of older plastic piping (beyond that marketed by Century Utilities Products Inc.) that remains in use for gas service nationwide."

II. Advisory Bulletin (ADB-99-02)

To: Owners and Operators of and Natural Gas Distribution Pipeline Systems

Subject: Potential susceptibility of plastic pipe installed between the 1960 and the early 1980s to premature failure due to brittle-like cracking.

Purpose: To inform natural gas distribution pipeline operators of the need to determine the extent of susceptibility to brittle-like cracking of plastic pipe installed between the years 1960 and early 1980s.

Advisory: A review of Office of Pipeline Safety (OPS) reportable natural gas pipeline incidents and the findings of NTSB Special Investigation Report (NTSB/SIR-98/01) indicates that certain plastic pipe used in natural gas distribution service may be susceptible to brittle-like cracking. The standards used to rate the long-term strength of plastic pipe may have overrated the strength and resistance to brittle-like cracking of much of the plastic pipe manufactured and used for gas service from the 1960s through the early 1980s.

It is recommended that all owners and operators of natural gas distribution systems identify all pre-1982 plastic pipe installations, analyze leak histories, and evaluate any conditions that may impose high stresses on the pipe.

Authority: 49 U.S.C. Chapter 601; 49 CFR 1.53.

Issued in Washington, D.C. on March 3, 1999.

Richard B. Felder,

Associate Administrator for Pipeline Safety.

[FR Doc. 99-6051 Filed 3-10-99; 8:45 am]

BILLING CODE 4910-60-P

Advisory Bulletin ADB-2002-07

November 21, 2002.

[Notices][Page 70806-70808]

Billing Code: 4910-60-P

DEPARTMENT OF TRANSPORTATION

Research and Special Programs Administration

Notification of the Susceptibility to Premature Brittle-like Cracking of Older Plastic Pipe.

AGENCY: Research and Special Programs Administration (RSPA), DOT.

ACTION: Notice; issuance of advisory bulletin.

SUMMARY. RSPA is issuing this follow-up advisory bulletin to owners and operators of natural gas distribution systems to inform them of the susceptibility to premature brittle-like cracking of older plastic pipe and the voluntary efforts to collect and analyze data on plastic pipe performance. A Special Investigation Report issued by the National Transportation Safety Board (NTSB) described how plastic pipe installed in natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public and property. On March 11, 1999, RSPA issued two advisory bulletins on this issue. The first bulletin reminded natural gas distribution system operators of the potential poor resistance to brittle-like cracking of certain polyethylene pipe manufactured by Century Utility Products, Inc. The second bulletin advised natural gas distribution system operators of the potential vulnerability of older plastic pipe to brittle-like cracking.

ADDRESS: This document can be viewed on the Office of Pipeline Safety (OPS) home page at: http://ops.dot.gov.

FOR FURTHER INFORMATION CONTACT: Gopala K. Vinjamuri, (202) 366-4503, or by email at gopala.vinjamuri@rspa.dot.gov.

SUPPLEMENTARY INFORMATION

I. Background

On April 23, 1998, NTSB issued a Special Investigation Report (NTSB/SIR-98/01), Brittle-like Cracking in Plastic Pipe for Gas Service, that describes how plastic pipe installed in natural gas distribution systems from the 1960s through the early 1980s may be vulnerable to brittle-like cracking resulting in gas leakage and potential hazards to the public and property. An NTSB survey of the accident history of plastic pipe suggested that the material may be susceptible to premature brittle-like cracking under conditions of local stress intensification because of improper joining or installation procedures. Hundreds of thousands of miles of plastic pipe have been installed, with a significant amount installed prior to the early-1980s. NTSB believes any vulnerability of this material to premature cracking could represent a potentially serious hazard to public safety. Copies of this report may be obtained by calling NTSB's Public Inquiry Office at 202-314-6551.

RSPA has already issued two advisory bulletins on this issue. The first advisory bulletin, ADB-99-O1, which was published in the Federal Register on March 11, 1999 (47 FR 12211), reminded natural gas distribution system operators of the potential poor resistance to brittle-like cracking of certain polyethylene pipe manufactured by Century Utility Products, Inc. The second advisory bulletin, ADB99-02, also published in the Federal Register on March 11, 1999 (47 FR 12212), advised natural gas distribution system operators of the potential brittle-like cracking vulnerability of plastic pipe installed between the 1960s and early 1980s.

The phenomenon of brittle-like cracking in plastic pipe as described in the NTSB report and generally understood within the plastic pipeline industry relates to a part-through crack initiation in the pipe wall followed by stable crack growth at stress levels much lower than the stress required for yielding, resulting in a very tight slit-like openings and gas leaks. Although significant cracking may occur at points of stress concentration and near improperly designed or installed fittings, small brittle-like cracks may be difficult to detect until a significant amount of gas leaks out of the pipe, and potentially migrates into an enclosed space such as a basement. Premature brittle-like cracking requires relatively high localized stress intensification that may be a result from geometrical discontinuities, excessive bending, improper installation of fittings, and dents and gouges. Because this failure mode exhibits no evidence of gross yielding at the failure location, the term brittle-like cracking is used. This phenomenon is different from brittle fracture, in which the pipe failure causes in fragmentation of the pipe.

The NTSB report suggests that the combination of more durable plastic pipe materials and more realistic strength testing has improved the reliability of estimates of the long-term hydrostatic strength of modern plastic pipe and fittings. The report also documents that older polyethylene pipe, manufactured from the 1960s through the early 1980s, may fail at lower stresses and after less time than was originally projected. NTSB alleges that past standards used to rate the long-term strength of plastic pipe may have overrated the strength and resistance to brittle-like cracking of much of the plastic pipe manufactured and used for gas service from the 1960s through the early 1980s.

In 1998, NTSB made several recommendations to trade organizations and to RSPA on the need for a better understanding of the susceptibility of plastic pipe to brittle-like cracking. This advisory bulletin responds to one of the NTSB recommendations. It is that RSPA "[d]etermine the extent of the susceptibility to premature brittle-like cracking of older plastic piping (beyond that marketed by Century Utilities Products Inc.) that remains in use for gas service nationwide. Inform gas system operators of the findings and require them to closely monitor the performance of the older plastic piping and to identify and replace, in a timely manner, any of the piping that indicates poor performance based on such evaluation factors as installation, operating, and environmental conditions; piping failure characteristics; and leak history."

In order to obtain the most complete information on the extent of the susceptibility to premature brittle-like cracking of older plastic pipe, a meeting was convened in May 1999 with all the stakeholders to determine how information on older plastic pipe could be assembled. The meeting included representatives of the American Gas Association (AGA), the American Public Gas Association (APGA), the Gas Research Institute (GRI) (now the Gas Technology Institute), the Midwest Energy Association (MEA), and the Plastic Pipe Institute (PPI).

As a result of the May 1999 meeting, the Joint Government-Industry Plastic Pipe Study Committee was formed to address the recommendations of the NTSB Special Investigation Report. The committee held three separate meetings to prepare a draft response to the NTSB recommendations and a draft industry notification of brittle-like cracking problems, the subject of this advisory bulletin. The committee membership consisted of a representative from OPS, a gas distribution operator from AGA, and the Transportation Safety Institute. Meetings were facilitated by General Physics Corporation, Columbia, MD. One of the committee findings was that there is a lack of data available from the industry to completely identify older plastic pipe that is still in service and may be susceptible to brittle-like cracking.

This finding led to the formation of the Plastic Pipe Database Committee (PPDC) to develop a process for gathering data on future plastic pipe failures with involvement from the states, which have assumed the authority from OPS over gas distribution systems, where most of the plastic pipe is installed. The PPDC is comprised of representatives from Federal and State regulatory agencies and from the natural gas and plastic pipe industries. Members include AGA, APGA, PPI, the National Association of Regulatory Utility Commissioners (NARUC), the National Association of Pipeline Safety Representatives (NAPSR), and OPS.

The PPDC database is expected to improve the knowledge base of gas utility operators and regulators and is intended to help reveal any failure trends associated with older plastic piping materials. The PPDC's mission is "to develop and maintain a voluntary data collection process that supports the analysis of the frequency and causes of in-service plastic piping material failures." It provides an opportunity for government and industry to work together to evaluate the extent of plastic pipe performance problems and to mitigate any risks to safety. The PPDC started gathering data in January 2001 from OPS and State pipeline safety agencies. For more information on the PPDC, go to the AGA web page (www.aga.org), and enter "PPDC" in the keyword search.

II. Advisory Bulletin (ADB-02-7)

To: Owners and Operators of Natural Gas Distribution Pipeline Systems

Subject: Notification of the Susceptibility to Premature Brittle-like Cracking of Older Plastic Pipe.

Advisory: In recent years, brittle-like cracking has been observed in some polyethylene pipes installed in gas service through the early 1980s. This brittle-like cracking (also known as slow crack growth) can substantially reduce the service life of polyethylene piping systems.

The susceptibility of some polyethylene pipes to brittle-like cracking is dependent on the resin, pipe processing, and service conditions. A number of studies have been conducted on older polyethylene pipe. These studies have shown that some of these older polyethylene pipes are more susceptible to brittle-like cracking than current materials. These older polyethylene pipe materials include the following:

- Century Utility Products, Inc. products.
- Low-ductile inner wall "Aldyl A" piping manufactured by Dupont Company before 1973.
- Polyethylene gas pipe designated PE 3306. (As a result of poor performance this designation was removed from ASTM D-2513.)

The environmental, installation, and service conditions under which the piping is used are factors that could lead to premature brittle-like cracking of these older materials. These conditions include, but are not limited to:

- Inadequate support and backfill during installation
- Rock impingement

- Excavation in close proximity to polyethylene piping
    - Directional drilling in close proximity to polyethylene piping
    - Frost heave
- Bending stresses due to pipe installations with bends exceeding recommended practices
- Damaging squeeze-off practices

Service temperatures and service pressures also influence the service life of polyethylene piping. Piping installed in areas with higher ground temperatures or operated under higher operating pressures will have a shorter life.

Gas system operators may experience an increase in failure rates with a susceptible material. A susceptible material may have leak-free performance for a number of years before brittle-like cracks occur. An increase in the occurrence of leaks will typically be the first indication of a brittle-like cracking problem. It is the responsibility of each pipeline operator to monitor the performance of their gas system. RSPA issues the following recommendations to aid operators in identifying and managing brittle-like cracking problems in polyethylene piping involving taking appropriate action, including replacement, to mitigate any risks to public safety.

Because systems without known susceptible materials may also experience brittle-like cracking problems, RSPA recommends that all operators implement the following practices for all polyethylene piping systems:

1. Review system records to determine if any known susceptible materials have been installed in the system. Both engineering and purchasing records should be reviewed. Based on the available records, identify the location of the susceptible materials. More frequent inspection and leak surveys should be performed on systems that have exhibited brittle-like cracking failures of known susceptible materials.

2. Establish a process to identify brittle-like cracking failures. Identification of failure types and site installation conditions can yield valuable information that can be used in predicting the performance of the system.

3. Use a consistent record format to collect data on system failures. The AGA Plastic Failure Report form (Appendix F of the AGA Plastic Pipe Manual) provides an example of a report for the collection of failure data.

4. Collect failure samples of polyethylene piping exhibiting brittle-like cracking. Evidence of brittle-like cracking may warrant laboratory testing. Although every failure may not warrant testing, collecting samples at the time of failure would provide the opportunity to conduct future testing should it be deemed necessary.

5. Whenever possible record the print line from any piping that has been involved in a failure. The print line information can be used to identify the resin, manufacturer and year of manufacture for plastic piping.

6. For systems where there is no record of the piping material, consider recording print line data when piping is excavated for other reasons. Recording the print line data can aid in establishing the type and extent of polyethylene piping used in the system.

(49 U.S.C. chapter 601; 49 CFR 1.53)

Issued in Washington, DC, on November 21, 2002.

Stacey L. Gerard

Associate Administrator for Pipeline Safety

[FR Doc. 02-30055 Filed 11-25-02; 8:45 am]

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22. Refer to the Roy Testimony, page 46, and Attachment DAR-2, Annual Budget to Actual Capital. Explain why the annual actual capital expenditures have increased from approximately $14 million in 2011 to a projected $69 million in 2022.

Response:

The capital expenditures have increased in large part due to Columbia increasing the annual rate of mileage replaced to meet the 30 year commitment to have bare steel and cast iron eliminated. Additionally, costs in about every other cost category have increased especially in the areas of contractor costs, labor costs, restoration costs, inspection costs, and flagging costs. Some of these increases have been a reaction to higher expectations from permitting agencies or changes in municipal ordinances. Flagging costs have increased as a result of increased incidents of work zone intrusions.

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23. Refer to the Roy Testimony, page 50, in which he states that Optimain DS will be replaced in 2021 with Uptime MRP. Mr. Roy further states that Columbia is making the change because Optimain's provider, Opvantek, was acquired by a firm named Urbint and it is understood that Optimain will be retired and replaced with another product.

a. Explain whether Columbia Kentucky has already purchased the Uptime MRP.

b. Explain whether Optimain has been retired and replaced by another product, or if it still just "understood" that it will be retired and replaced.

c. If Optimain has not been retired and replaced by another product yet, explain why Columbia Kentucky purchased the Uptime MRP until Optimain was no longer able to be used and useful.

Response:

a. Columbia has contracted with DNV to purchase Uptime MRP. Uptime MRP is expected to go live in Q3 of 2021, so that engineers can begin training on the new tool.

b. Optimain has not been retired, it is just understood that it will be retired and replaced.

c. Optimain is very near the end of its useful life. Columbia determined that it was prudent to begin the implementation of the new tool, to allow for time to stand up the new tool and train users on how to use it. In addition, Uptime MRP is being implemented in conjunction with the implementation of a new probabilistic risk assessment (PRA) model called Synergi Pipeline. Synergi Pipeline calculates the risk score that is being used by Uptime MRP. Columbia Kentucky wanted to be able to use the risk score from Synergi Pipeline, to prioritize mains for replacement, because it takes more threats and consequences into account than Optimain DS does. This provides a greater level of understanding of risk to our assets, providing a better opportunity to prioritize mains for replacement.

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24. Refer to the Direct Testimony of Judy Cooper ("Cooper Testimony"), pages 7 – 8. Ms. Cooper asserts that Columbia Kentucky does not maintain a cost allocation manual pursuant to exemption provisions of KRS 278.2203 and KRS 278.2205. Ms. Cooper further states that the only non-regulated activity that Columbia engages in is the provision of incidental billing services for two entities that were previously affiliates, but were sold in 2003 and are no longer affiliates. Ms. Cooper concludes that Columbia Kentucky's rendering of billing services are "incidental" as defined in KRS 278.2203(4), and Columbia is not required to file a cost allocation manual.

a. Explain whether the Commission has ever ruled that Columbia Kentucky was exempt from filing a cost allocation manual, and if so, provide the case citation to the same.

b. Identify the two entities that Columbia Kentucky provides billing services for, as well as the amount of revenue received by Columbia Kentucky for these services.

c. Explain how Columbia Kentucky uses the revenues acquired for the billing services.

Response:

a. KRS 278.2205 requires any utility that engages in a nonregulated activity whose revenue exceeds the amount provided for incidental nonregulated activities to develop and maintain a cost allocation manual. Columbia's exemption from filing a cost allocation manual is pursuant to the exemption provisions of KRS §§ 278.2203 and KRS 278.2205 and does not require a Commission Order.

b. Columbia provides billing services for NICOR-AGL and for Columbia Service Partners ("Service Partners"). Service Partners was previously an affiliate, but was sold in 2003 and is no longer an affiliate. Total revenues in 2020 from NICOR-AGL were $20,399.69, and $24,815.80 from Service Partners.

c. The revenues are booked to FERC account 495.

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25. Refer to the Direct Testimony of Jeffery T. Gore ("Gore Testimony"), page 10. Mr. Gore states that an adjustment was made to add $2.6 million to 2021 in-service additions to account for the 2020 capital spend that was not placed into service as portrayed in the forecast.

a. Provide a breakdown by project and category of the $2.6 million dollar in-service addition.

b. Provide an itemized explanation of the 2020 capital spend that was not placed into service.

Response:

a & b. The $2.6 million was calculated as the forecasted decline in Construction Work In Progress ("CWIP") that would occur in 2021. The December 2020 actual CWIP balance was $12.9 million or $2.6 million higher than the forecasted December 2021 CWIP balance of $10.3 million. There is not a specific identification of balances in the December 2020 CWIP that relate to this adjustment.

The $2.6 million was added into the 2021 additions in the following Gas Plant Accounts:

- $2.1 million – Mains – Gas Plant Account 376
- $0.5 million – Services – Gas Plant Account 380

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26. Refer to the Gore Testimony, pages 10 – 11.

a. Explain what Cloud Computing Investments entails.

b. Provide the total cost of Cloud Computing Investments.

Response:

a. Refer to testimony of Columbia witness Rozsa. Page 14, Line 18. Cloud Computing, or Software-as-a-Service (SaaS), describes the use of web-based technology to access computer applications operated and maintained by outside vendors on their own IT platform/infrastructure. This methodology differs from the traditional method of acquiring software applications and implementing them on the Company's IT hardware. The benefits of Cloud Computing are discussed in Columbia witness Rozsa testimony on page 15.

b. As of February 28, 2021, the company had investments totaling $488,067 in Gas Plant Account 303.99 – Cloud Software.

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27. Refer to the Gore Testimony, page 14.

a. Explain what Account 252 is currently used for, and why the balance is zero.

b. Provide the total amount of customer advances for construction that Columbia Kentucky used as a reduction to rate base.

Response:

a. The statement in Gore Testimony, page 14, line 16, "As of February 28, 2021, the balance in Account 252 is zero" should have been "As of February 28, 2021, the balance in Account 25200000 is offset by the balance in Account 18600400". Customer Advances are recorded as a credit to Account 25200000 offset by a debit to Cash (Account 13100000) when received. An additional entry is made to credit the appropriate plant account (Construction Work in Progress – Account 107) and debit Account 18600400. The net result is the customer advance is included as a reduction to plant in service when the project is placed into service. The balance sheet also carries a debit in Account 18600400 and a credit to Account 2520000 for customer advances. Due to the timing of the accounting closing, the two entries are not always made within the same accounting closing which causes month end balances in Account 25200000 and Account 18600400 to not completely offset.

b. Please see below for the per book amounts related to Customer Advances as of February 28, 2021.

	Customer Advances Post 12/31/99 Account 25200000	Customer Advances Post 12/31/99 Account 18600400
February 28, 2021	(2,824,444.26)	2,827,732.35

The offset to the Account 18600400 balance has been recorded in plant account balances. Therefore the plant in service balance includes the appropriate reduction for customer advances and no further adjustment is needed to rate base. Also note for the projected periods in this filing, Columbia's capital expenditures are net of Customer Advances.

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28. Refer to the Gore Testimony, pages 23 and 24. In reference to credit card payments, Mr. Gore states, "[b]ased on history obtained from other NiSource jurisdictions, the cost of the expected customers utilizing this payment option are calculated and offset by the costs that would discontinue as customers switch from other payment options." Provide clarification for this sentence.

Response:

The request in this case covers the transaction fees associated with projected payment volumes resulting from the elimination of fees for credit card, debit card, ACH electronic payments, and walk-in customer payments for residential customers. The projected growth in credit and debit card payments is based on the growth experienced by other utilities that offer cards at no convenience fee, as well as information from the third party credit card, debit card and ACH vendor. Columbia estimates that credit card, debit card, and ACH payment volumes will increase by 21.88 percent as a result of plans to offer these payment channels at no additional charge per transaction. This percentage increase is based on the historical residential customer credit/debit card and

ACH payment volume increases experienced by affiliate operating companies. The payment volume increase was applied to Columbia's credit card, debit card and ACH payment volumes experienced for the twelve-month period ended March 31, 2020. The historical transactions for the twelve-month period ended March 31, 2020 was chosen due to the impact of COVID-19 on customer payment behavior. The credit card, debit card and ACH payment volume increase is off-set by affiliate operating companies' reduction in lockbox, in-house, and walk-in transactions experienced. The projected costs on an annual basis for credit cards, debit cards, ACH, and walk-in payments in the initial year, and included in the Company's pro forma level of NCSC billed O&M expense. The calculation and supporting documentation utilized to project the annual level of residential transaction fee costs are included in Attachment JTG-3 of Columbia witness Gore's testimony.

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29. Refer to the Gore Testimony, page 24. Mr. Gore states that the costs reflecting carrying charges related to financing the arrearage payment plans accumulated between March 16, 2020 and October 1, 2020, are included in the pending case.

a. Provide the total cost for the aforementioned carrying charges.

b. Provide the rate applied to these arrearages.

c. Provide Columbia Kentucky's weighted average long-term debt rate.

d. Confirm that pursuant to the Commission's September 21, 2020 Order in Case No. 2020-00085, the rate applied to these arrearages is to be no more than Columbia Kentucky's weighted average long-term debt rate.

Response:

a. The carrying costs recorded through June 2021 are detailed below:

Carrying Cost Calculation				
	Balance	Annual Rate	Monthly Rate	Carrying Cost
Nov-20	2,088,252	5.64%	0.47%	9,814.79
Dec-20	1,603,318	5.64%	0.47%	7,535.60
Jan-21	1,368,724	5.64%	0.47%	6,433.00
Feb-21	1,230,361	5.64%	0.47%	5,782.70
Mar-21	999,680	5.64%	0.47%	4,698.49
Apr-21	823,424	5.64%	0.47%	3,870.09
May-21	643,996	5.64%	0.47%	3,026.78
Jun-21	446,973	5.64%	0.47%	2,100.77
Total				**43,262.23**

Note, the total COVID costs included in Adjustment 16 in Schedule D-2.4 were $33,954. This amount reflected the carrying costs noted above through April 2021 of $38,135 along with a credit of $4,181 related to a tax incentive earned for keeping employees on the payroll during the beginning of the pandemic. The information provided above includes May and June carrying costs that were not available when the case was filed.

b. Rate applied to arrearages: 5.64%.

c. The carrying cost calculation detailed in part a. uses 5.64% which is the same as the Long Term Debt rate used in the annual SMRP filing. The most recent SMRP filing (Case No. 2021-00151, approved on May 5, 2021) reflected the annual true-up of calendar year 2020 using this same Long Term Debt rate.

d. The rate utilized in the carrying charge calculation is the Company's average LTD interest rate.

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30. Refer to the Direct Testimony of Kevin L. Johnson ("Johnson Testimony"), pages 17 – 18. Mr. Johnson states that the test year working capital requirement resulting from the application of the lead lag method was a negative $6,942,997; however, Columbia Kentucky made no adjustment for the negative cash working capital.

a. Provide the amount of cash working capital that Columbia Kentucky is requesting in the pending case.

b. Provide the amount of cash working capital that Columbia Kentucky was awarded in the past three rate cases based upon the 1/8 of Operating and Maintenance Expense Methodology.

c. Explain how it is fair, just, and reasonable for Columbia Kentucky to refuse to make the almost $7 million dollar adjustment that would benefit the Columbia Kentucky ratepayers.

d. Explain why Columbia Kentucky believes that not selling receivables to a third party is justification to not make an adjustment for cash working capital.

Response:

a. Columbia Kentucky is requesting a $0 Cash Working Capital adjustment in this case.

b. In the three previous cases, Columbia Kentucky was permitted to use the 1/8th of Operating & Maintenance Expenses method of calculating Cash Working Capital. These three rate cases were blackbox settlements so the amount of Cash Working Capital awarded was not stated.

The Cash Working Capital amounts filed for in Rate Base in each of the cases were:

Case No. 2016-00162 - $5,636,879

Case No. 2013-00167 - $4,081,898

Case No. 2009-00141 - $3,800,230

c. The calculated negative Cash Working Capital requirement is driven by the company's effective cash management processes. Reducing Rate Base for Cash Working Capital creates a disincentive to effectively manage its cash and does not encourage efficiency and cost minimization.

d. In both Case No. 2019-00271 and 2020-00174, the Commission reduced the cash working capital adjustment to zero as a result of the sale of accounts receivable even though the results could have resulted in a negative amount. Please also see the response to part c above.

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31. Refer to the Johnson Testimony, page 38. Mr. Johnson states that it is reasonable and appropriate to collect a proportion of fixed non-gas costs through the fixed monthly customer charge.

a. Explain in detail how it is fair, just, and reasonable to increase the General Service Residential ("GSR") monthly customer charge from $16.00 to $29.20, or an 82.5% increase, in addition to raising the delivery charge per Mcf.

b. Explain in detail how this comports with the longstanding principles of gradualism.

Response:

a. The current fixed costs on a residential customer's bill are the Customer Charge ($16.00) and the SMRP Rider ($6.63) for a total of $22.63. With Columbia's proposed increase, the fixed charge for the SMRP Rider will be rolled into the Customer Charge which would result in the residential customers seeing an approximately 29% increase in fixed charges on their bills, not the 82.5% increase noted in this request (See Attachment KLJ-RDES-1, Page 2 of Witness Johnson's Direct Testimony). The approximately 29% increase in the residential class is slightly above the total company increase of 27.95% representing a gradual increase to parity.

b. While there is no hard and fast rule with respect to applying the concept of gradualism in developing a revenue distribution, typically an increase of 1.5 to 2.0 times the system average increase is considered a maximum range to still be consistent with the concept of gradualism. Certainly comparing the approximately 29% increase in the residential class to the total company increase of 27.95%, a factor of 1.04 is well below the standard of gradualism. It is also important to note that the 29% increase is caused by the change in the Company's cost of service over the 5 years since base rates were last changed (about 5.8% per year).

Please also see the response to Columbia's Response to the Staff's Second Set of Requests for Information, No. 18 for an explanation of how the company's proposed increase is in the interest of gradualism.

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32. Refer to the Johnson Testimony generally.

a. Provide an executable Excel format of all three of the class cost of service studies.

b. Provide all workpapers in Excel format used to develop every allocation factor.

c. Provide all workpapers, regression analyses, and data inputs in Excel format used to develop design day demands.

d. Provide proof of present and proposed revenues by rate schedule in excel format.

e. Provide all workpapers and analyses supporting Columbia Kentucky's calculated customer costs in excel format.

Response:

a & b. Please see the following attachments for each of the three allocated cost of service studies presented. The workpapers to develop the allocation factors are included in each of the files.

- KY PSC Case No. 2021-00183, AG 1-032, Attachment A - Electronic version of KLJ-ACOS-1 – Customer / Demand ACOS

- KY PSC Case No. 2021-00183, AG 1-032, Attachment B - Electronic version of KLJ-ACOS-2 – Demand / Commodity ACOS
- KY PSC Case No. 2021-00183, AG 1-032, Attachment C - Electronic version of KLJ-ACOS-3 – Average of Customer/Demand and Demand/Commodity

c. Please see the following attachments:

- KY PSC Case No. 2021-00183, AG 1-032, Attachment D - Work papers used to develop the 2020 Design Day Forecast
- KY PSC Case No. 2021-00183, AG 1-032, Attachment E - Firm Design Day Forecast analysis
- KY PSC Case No. 2021-00183, AG 1-032, Attachment F - Non-Firm Design Day Forecast analysis

d. Please refer to Columbia's Response to Staff's First Request for Information No. 55 for the present and proposed revenues by rate schedule in excel format.

e. Please refer to Attachment R in Columbia's Response to Staff's First Request for Information No. 55 and see tabs "Rate Design KLJ-RDES-1", "Rate Design KLJ-RDES-2", "Rate Design KLJ-RDES-3", and "Rate Design KLJ-RDES-4" for the electronic versions of Witness Johnson's rate design attachments.

Please also refer to Attachment S in Columbia's Response to Staff's First Request for Information No. 55 showing Schedule N (Typical Bill Comparisons) in excel format.

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33. Refer to the Direct Testimony of Melissa Bartos ("Bartos Testimony"), pages 7 – 10. Ms. Bartos avers that the residential customer count forecast produced by the econometric model for March 2021 is increased by 630 customers to account for the additional residential customers that are estimated to be on the system as a result of the Covid-19 Moratorium. Ms. Bartos states that although terminations of service resumed in late February 2021, Columbia Kentucky did not automatically terminate delinquent customers, but instead, worked with customers to develop payments arrangements and identify newly available assistance funding. Ms. Barton concludes that it is expected over time that the differential of 630 additional residential customers will phase out as termination procedures are reinstated and the normal cycle of customer counts returns, and therefore, residential customers had to be removed for several months in the 2021 period.

a. Confirm that Ms. Bartos removed 630 residential customers from the March 2021 – October 2021 base and forecasted test periods.

b. Confirm that there is no evidence of record to indicate that any of the 630 customers will break the payment arrangements and be terminated as Columbia Kentucky customers.

c. Explain whether the 630 residential customers were added back in for the period beginning in November 2021. If not, explain why not.

Response:

a. Not confirmed. 630 residential customers were added to the raw model output for March 2021. 551 customers were added to the raw model output for April 2021. The number of customers added to the raw model output decreases each month through October 2021, with 79 customers added to the raw model output for October 2021. There are no customers added to the raw model output for November 2021-December 2022.

b. The 630 customers that were added to the raw model output for March 2021 represent an estimate for the level of customer count inflation over what would have been expected if there had not been a COVID-19 Moratorium on shut-offs. There are no specific customers identified that represent the 630 customer adjustment, therefore there cannot be any evidence that any of the specific 630 customers will break payment arrangements; however, CKY has experienced a net loss of 1,600 residential customers since February 2021.

c. No, the 630 residential customers were not added back in for the period beginning November 2021 because it is expected that the artificial increase in customer counts caused by the COVID-19 moratorium is temporary and by the beginning of next winter customer counts will return to normal, expected levels as produced by the raw model output.

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34. Refer to the Bartos Testimony, page 11. Ms. Bartos states that an indicator variable was added to the residential use per customer count model for the months of April 2020, May 2020, October 2020, December 2020, January 2021, and February 2021, because data indicates that residential use per customer was significantly affected in those months. Ms. Bartos later states that because the effects from the short-term Covid-19 shutdowns are expected to be over, no adjustment to the forecasted use per customer is necessary.

a. Provide a detailed explanation as to the indicator variable that was applied.

b. Confirm that "significantly affected" means that the residential usage was much higher in April 2020, May 2020, October 2020, December 2020, January 2021, and February 2021, than in prior years.

c. Explain in full detail why the aforementioned months were chosen to add an indicator variable to the residential use per customer count.

d. Provide evidence that moving forward residential customer usage will not continue to be higher than prior years due to the Covid-19 pandemic.

Response:

a. As explained in the Direct Testimony of Melissa Bartos, footnote 1, page 5, an indicator variable represents 1 during a time related event, and 0 otherwise. Separate indicator variables were applied for each month in which residential use per customer ("UPC") was affected by COVID-19. The table below shows the values of the indicator variables in the residential UPC model for the months identified. (Format = DYYYYMM, so D202004 = April 2020; D202005 = May 2020, etc.)

Variable	DF	Estimate
D202004	1	-0.7848
D202005	1	-0.8306
D202010	1	-0.7472
D202012	1	-0.8339
D202101	1	-0.8629
D202102	1	-1.1249

b. Not confirmed. As shown in the table above, the coefficients on the indicator variables are negative, indicating that actual residential UPC in these months was *lower* than what would have otherwise been expected.

c. The aforementioned months were chosen to add an indicator variable to the residential UPC model because it was expected that the shutdowns associated with the COVID-19 pandemic may have an impact on residential UPC, and indicator variables were statistically significant in those months. See also Columbia's Response to the Staff's Second Set of Requests for Information, No. 24.

d. As explained in sub-part b above, residential UPC during the COVID-19 pandemic was *lower* than would have otherwise been expected, so the premise of the question is false.

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35. Refer to the Bartos Testimony, page 16, Table 1 – Forecasted Customer Counts (Year End).

a. Under the heading "Sales Customers by Class," identify the two wholesale customers.

b. Under the heading "Sales Customers by Class," identify the one electric generation customer.

c. Provide the actual residential sales customer counts for each year between 2016 - 2020.

d. Under the heading "Transportation Customers by Class," explain why Columbia Kentucky is forecasting to lose a significant amount of residential customers.

e. Provide the actual residential transportation customer counts for each year between 2016 – 2020.

f. Under the heading "Transportation Customers by Class," explain why Columbia Kentucky is forecasting to lose a large amount of commercial customers.

g. Provide the actual commercial transportation customer counts for each year between 2016 – 2020.

Response:

a. The two wholesale sales customers are [redacted]

b. The electric generation customer is [redacted]

c. The following table contains actual residential sales customer counts for 2016 - 2020.

	Residential Sales Customers (year end)
2016	100,406
2017	102,443
2018	104,305
2019	105,929
2020	108,375

d. As a preliminary matter, the Company would not characterize the forecasted loss in residential transportation customers as "significant" as it is consistent with history. Please also see Columbia's Response to Staff's Second Set of Requests for Information, No. 25a.

e. The following table contains actual residential transportation customer counts for 2016 – 2020.

	Residential Transportation Customers (year end)
2016	20,958
2017	19,187
2018	17,843
2019	16,719
2020	15,552

f. As a preliminary matter, the Company would not characterize the forecasted loss in commercial transportation customers as "large" as it is consistent with history. Please also see Columbia's Response to Staff Second Set of Requests for Information , No. 25a.

g. The following table contains actual commercial transportation customer counts for 2016 – 2020.

	Commercial Transportation Customers (year end)
2016	3,639
2017	3,432
2018	3,199
2019	2,977
2020	2,822

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36. Refer to the Bartos Testimony, page 16, Table 2 – Forecasted Annual Volume (CCF).

a. Under the heading "Sales Volumes by Class," explain why Columbia Kentucky is forecasting lower sales volume for the residential class in 2022 than in 2021.

b. Provide the actual sales volumes for the residential class for each year between 2016 – 2020.

c. Under the heading "Sales Volumes by Class," explain why Columbia Kentucky is forecasting lower sales volumes for the commercial class in 2022, 2023, and 2024 than in 2021.

d. Provide the actual sales volumes for the commercial class for each year between 2016 – 2020.

e. Under the heading "Sales Volumes by Class," explain why Columbia Kentucky is forecasting lower sales volumes for the wholesale class in 2022, 2023, and 2024 than in 2021.

f. Provide the actual sales volumes for the wholesale class for each year between 2016 – 2020.

g. Under the heading “Transportation Volumes by Class,” explain why Columbia Kentucky is forecasting to lose a significant amount of transportation volumes from the residential class.

h. Provide the actual residential class transportation volumes for each year between 2016 – 2020.

i. Under the heading “Transportation Volumes by Class,” explain why Columbia Kentucky is forecasting to lose a small amount of transportation volumes from the commercial class.

j. Provide the actual commercial class transportation volumes for each year between 2016 – 2020.

Response:

a. Residential sales volumes forecasted for 2022 are lower than 2021 primarily because 2021 data contains actuals for January and February 2021, and February 2021 was materially colder than normal (February 2021 had over 11% higher HDD than normal).

b. The following table contains actual residential sales volumes for 2016 – 2020:

	Residential Sales Volumes (CCF)
2016	57,196,950
2017	57,393,590
2018	73,925,180
2019	68,584,320
2020	62,990,940

c. Commercial sales volumes forecasted for 2022, 2023, and 2024 are lower than 2021 primarily because 2021 data contains actuals for January and February 2021, and February 2021 was materially colder than normal (February 2021 had over 11% higher HDD than normal).

d. The following table contains actual commercial sales volumes for 2016 – 2020:

	Commercial Sales Volumes (CCF)
2016	29,768,420
2017	30,812,360
2018	39,307,580
2019	37,256,710
2020	33,349,140

e. The wholesale sales volume forecast is an allocation from the total commercial sales volume forecast, and therefore the wholesale sales volume forecast follows a similar growth pattern as commercial sales. Please also see the response to subpart c above.

f. The following table contains actual wholesale sales volumes for 2016 – 2020:

	Wholesale Sales Volumes (CCF)
2016	99,210
2017	102,500
2018	116,200
2019	101,960
2020	105,870

g. As a preliminary matter, Columbia Gas of Kentucky would not characterize the forecasted loss in residential transportation volumes as "significant" as it is consistent with history. The forecasted loss in residential transportation volume is due to the forecasted loss of residential transportation customers. Please also see Columbia's Response to Staff's Second Set of Information Requests, No. 25a, and Columbia's Response to the Attorney General's First Set of Information Requests, No. 35f.

h. The following table contains actual residential transportation volumes for 2016 – 2020:

	Residential Transportation Volumes (CCF)
2016	14,063,110
2017	12,641,900
2018	14,623,280
2019	12,431,030
2020	10,611,410

i. The forecasted loss in commercial transportation volume is due to the forecasted loss of commercial transportation customers. Please also see Columbia's Response to Staff's Second Set of Information Requests, No. 25a.

j. The following table contains actual commercial transportation volumes for 2016 – 2020:

	Commercial Transportation Volumes (CCF)
2016	45,116,230
2017	43,878,540
2018	49,239,120
2019	46,339,540
2020	42,374,550

**COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021**

37. Refer to the Direct Testimony of Vincent V. Rea ("Rea Testimony"), page 13.

a. Mr. Rea states that approximately 70% of Columbia Kentucky's gas throughput to transportation customers is concentrated amount five industrial customers. Identify the five industrial customers referenced in this statement.

b. Explain why high customer concentration levels cause Columbia Kentucky to be more vulnerable to the threat of bypass.

Response:

(a) The five industrial customers include [redacted]

(b) High customer concentration levels cause Columbia to be more vulnerable to the threat of bypass because the Company's top five industrial customers constitute approximately 70% of Columbia's total gas throughput. Therefore, to the extent that any of the Company's largest industrial customers elected to pursue an alternative bypass option, this would result in the loss of a significant portion of Columbia's overall gas throughput.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

38. Refer to the Rea Testimony, page 50, lines 12 – 15.

a. Provide the basis for Mr. Rea's estimated debt cost rate of 3.90% for the debt issues for the remainder of 2021 and 4.00% for those expected to occur during 2022.

b. Provide the actual cost of debt issue(s) for 2021 when issued.

Response:

Please refer to KY PSC Case No. 2021-00183, AG 1-038, Attachment A for support of the forecasted debt cost rates. The actual debt cost rate of the June 2021 issuance was 3.272%.

Long-Term Debt Borrowing Rate

	6/30/21	9/30/21	3/31/22	6/30/22
30-Year US Treasury Forward Rate (1)	2.4269%	2.4559%	2.5139%	2.5420%
Average BBB+ Credit Spread (2)	1.4500%	1.4500%	1.4500%	1.4500%
Long-Term Borrowing Rate	3.8769%	3.9059%	3.9639%	3.9920%
Long-Term Borrowing Rate - Rounded	3.90%	3.90%	4.00%	4.00%

(1) Bloomberg data as of March 29, 2021
(2) Bloomberg historical data from 2017 - 2020

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

39. Refer to the Rea Testimony, Appendix C, page 4 of 6. Provide all supporting documentation and work papers, including spreadsheets with cell formulas intact, of the Required Financial Leverage Adjustments of 0.81%.

Response:

Please see KY PSC Case No. 2021-00183, AG 1-039, Attachment A for the requested information. Also, all calculations supporting Mr. Rea's financial leverage adjustment can be found within pages 5-6 of Appendix C to Mr. Rea's direct testimony.

Capital Structure Ratios - Book vs. Market Capitalization Ratios for Leverage Calculations
Gas LDC Group - 12/31/2020 or Fiscal Year End

	[Source is 10-K] Carrying Values (Book Value)		[Source is 10-K and Yahoo Finance] Market Values (Fair Value)		Common Shares	Recent 40-Day
$ in thousands	Dollars 2020	Percentage 2020	Dollars 2020	Percentage 2020	Outstanding at Fiscal Y/E	Average Stock Price
Atmos Energy Corp.						
Long-Term Debt (1)	4,531,779	39.8%	5,568,962	33.0%	@ 9/30/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	6,848,792	60.2%	11,308,025	67.0%		
Total Permanent Capitalization	$ 11,380,571	100.0%	$ 16,876,987	100.0%	125,882.5	$ 89.83
New Jersey Resources Corp.						
Long-Term Debt (1)	2,259,466	54.5%	2,395,499	39.7%	@ 9/30/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	1,889,007	45.5%	3,643,191	60.3%		
Total Permanent Capitalization	$ 4,148,473	100.0%	$ 6,038,690	100.0%	95,949.2	$ 37.97
Northwest Natural Gas Co.						
Long-Term Debt (1)	860,081	48.8%	1,040,967	41.8%	@ 12/31/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	901,635	51.2%	1,451,448	58.2%		
Total Permanent Capitalization	$ 1,761,716	100.0%	$ 2,492,415	100.0%	30,589.0	$ 47.45
ONE Gas, Inc.						
Long-Term Debt (1)	1,582,428	41.4%	1,982,428	34.1%	@ 12/31/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	2,241,088	58.6%	3,838,104	65.9%		
Total Permanent Capitalization	$ 3,823,516	100.0%	$ 5,820,532	100.0%	53,166.7	$ 72.19
South Jersey Industries, Inc.						
Long-Term Debt (1)	2,776,400	62.0%	3,009,423	55.2%	@ 12/31/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	1,699,097	38.0%	2,446,395	44.8%		
Total Permanent Capitalization	$ 4,475,497	100.0%	$ 5,455,818	100.0%	100,591.9	$ 24.32
Southwest Gas Corp.						
Long-Term Debt (1)	2,732,200	50.0%	3,101,097	46.3%	@ 12/31/2020	
Preferred Stock	-	-	-	-		
Common Equity (2)	2,735,956	50.0%	3,599,721	53.7%		
Total Permanent Capitalization	$ 5,468,156	100.0%	$ 6,700,818	100.0%	57,192.9	$ 62.94
Spire, Inc.						
Long-Term Debt (1)	2,423,700	48.6%	2,848,200	43.9%	@ 9/30/2020	
Preferred Stock	242,000	4.9%	242,000	3.7%		
Common Equity (2)	2,321,500	46.5%	3,394,764	52.3%		
Total Permanent Capitalization	$ 4,987,200	100.0%	$ 6,484,964	100.0%	51,600.0	$ 65.79
Average of Gas LDC Proxy Group						
Long-Term Debt (1)	2,452,293	49.3%	2,849,511	42.0%		
Preferred Stock	34,571	0.7%	34,571	0.5%		
Common Equity (2)	2,662,439	50.0%	4,240,235	57.5%		
Total Permanent Capitalization	$ 5,149,304	100.0%	$ 7,124,318	100.0%		

(1) Long-term debt balances exclude the current portion of long-term debt and short-term debt. In cases where a company's SEC debt disclosure for fair value vs. carrying value only discloses total debt (including short-term debt and current maturities), the difference between fair value and carrying value was fully applied to the long-term debt balance.

(2) Includes common stock account and retained earnings account; excludes other comprehensive income (loss) and shares in a deferred compensation trust.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

40. Refer to the Rea Testimony generally.

a. Provide all work papers and supporting documentation used and relied upon by Mr. Rea in the preparation of his Direct Testimony and Attachments. Provide all spreadsheets in Excel format with cell formulas intact.

b. Provide copies of all articles and publications cited by Mr. Rea in his Direct Testimony.

c. Provide the native spreadsheet(s) for Mr. Rea's exhibits in Excel format with cell formulas intact.

d. If not provided previously, provide all supporting documentation and spreadsheet analyses for Mr. Rea's analyses in Attachment VVR-3.

e. Provide a copy of the RRA Regulatory Focus article cited by Mr. Rea in footnote 15.

f. Provide an update of the RRA Regulatory Focus article cited by Mr. Rea in footnote 15 using the most recent month available in 2021.

g. Provide the historical 12-month and 13-month average capital structures for Columbia Kentucky for the years 2015 - 2020.

h. Refer to Attachment VVR-6. Provide the issuance dates for all of the current debt issues shown on the Attachment.

i. Provide the current authorized ROE for each NiSource operating company and the date that each ROE was authorized.

j. Provide the Commission Order authorizing each ROE listed in (i) above.

k. State whether each ROE was authorized pursuant to a fully litigated rate case or if it was based on a settlement for the NiSource operating companies listed in (i) above.

Response:

(a) Please refer to Columbia's Response to Staff's Second Set of Requests for Information, No. 26 for a copy of all work papers in Excel format. Mr. Rea's work papers are included in these Excel files.

(b) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment A through Attachment AI.[1] KY PSC Case No. 2021-00183, AG 1-40, Attachment A provides an index of all of the articles and publications cited by Mr. Rea in his direct testimony.

(c) Please see Columbia's Response to Staff's Second Set of Requests for Information, No. 26 for the requested information.

(d) Please see Columbia's Response to the Attorney General's First Set of Information Requests, No. 39 for the requested information.

(e) Please see CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-40, Attachment AJ for the requested information.

(f) Please see CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-40, Attachment AK for the requested information.

(g) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment AL for the requested information.

(h) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment AM for the requested information.

(i) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment AN for the requested information.

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[1] Please note that there are attachments inclusive of this list that are confidential. See CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-40, Attachment B and CONFIDENTIAL KY PSC Case No. 2021-00183, AG 1-40, Attachment F

(j) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment AN for the requested information.

(k) Please see KY PSC Case No. 2021-00183, AG 1-40, Attachment AN for the requested information.

AG 1-040 – Index of Requested Documents

Attachment A – Index of requested documents

Footnote #1
See *Direct Testimony of Kimra H. Cole (Case No. 2021-00183), at 22*

Footnote #2
See *www.marketwatch.com/story/fed-sees-no-rate-hikes-through-2023-despite-some-inflation-overshoot-11616004261*

Footnote #3 – Attachment B
Blue Chip Financial Forecasts, (CCH Incorporated, Wolters Kluwer), Volume 40, No. 4, April 1, 2021, at 2.

Footnote #4 – Attachment C
Labor Market Tighter Than It Looks, The Wall Street Journal, April 22, 2021, at A2.

Footnote #5
See *https://www.nbcnews.com/now/video/millions-of-job-openings-go-unfilled-as-millions-collect-some-form-of-unemployment-110278213770*

Footnote #6 – Attachment D
Labor Market Tighter Than It Looks, The Wall Street Journal, April 22, 2021, at A2.

Footnote #7 – Attachment E
Jobless Claims Fall to New Pandemic Low, The Wall Street Journal, April 23, 2021, at A2.

Footnote #8 – Attachment F
Blue Chip Financial Forecasts, Volume 40, No. 4 (April 1, 2021), the *Blue Chip Forecasts,* Volume 39, No. 12 (December 1, 2020).

Footnote #9
Discussion only

Footnote #10 – Attachment G
Robert A. Morin, *New Regulatory Finance* (Public Utilities Reports, Inc., 2006), at 181, 187.

Footnote #11 – Attachment H
See Eugene F. Fama and Kenneth R. French, "Industry Costs of Equity," *Journal of Financial Economics,* 43 (1997): 153-193; and

Footnote #11 – Attachment I
Eugene F. Fama and Kenneth R. French, "The Capital Asset Pricing Model: Theory and Evidence," *The Journal of Economic Perspectives,* 18 (Summer 2004), at 25-46.

Footnote #12
Discussion Only

Footnote #13 – Attachment J
Roger A. Morin, *New Regulatory Finance* (Public Utilities Reports, Inc., 2006) at 402.

Footnote #14 – Attachment K
The Cost of Capital – A Practitioner's Guide, D. Parcell, Society of Utility and Regulatory Financial Analysts, (2010), quoting Regulatory Research Associates, at 91.

Footnote #14 – Attachment L
RRA Regulatory Focus, Major Rate Case Decisions -January-December 2020, Regulatory Research Associates, February 2, 2021, at 1.

Footnote #15 – Attachment M
RRA Regulatory Focus, Major Rate Case Decisions – January-December 2020, Regulatory Research Associates, February 2, 2021, at 1.

Footnote #16 – Attachment N
Bluefield Water Works and Improvement Company v. Public Service Commission of the State of West Virginia, 262 U.S. 679, 692 (1923).

Footnote #17 – Attachment O
Federal Power Commission et.al. v. Hope Natural Gas Company, 320 U.S. 591, 603 (1944).

Footnote #18 – Attachment P
David C. Parcell, *The Cost of Capital – A Practitioner's Guide* (Society of Utility and Regulatory Financial Analysts, 2010), at 84.

Footnote #19 – Attachment Q
Irving Fischer, *The Rate of Interest,* (The Macmillan Company 1907).

Footnote #20 – Attachment R
Irving Fischer, *The Theory of Interest,* (The Macmillan Company 1930), Part I, Chapter I, Section 7.

Footnote #21 – Attachment S
John Burr Williams, *The Theory of Investment Value,* (Cambridge, MA, Harvard University Press, 1938) 55, 57-58.

Footnote #22 – Attachment T
Myron J. Gordon and Eli Shapiro, "Capital Equipment Analysis: The Required Rate of Profit," *Management Science*, 3 (October 1956) 102-110.

Footnote #23
Discussion Only

Footnote #24
Discussion Only

Footnote #25
Discussion Only

Footnote #26 – Attachment U
Ibbotson® SBBI*® 2013 Valuation Yearbook* (Morningstar, Inc.) at 43.

Footnote #27 – Attachment V
Michael Ehrhardt and Eugene Brigham, *Corporate Fiannce: A Focused Approach,* (South-Western Cengage Learning 2008) at 303.

Footnote #28 – Attachment W
Roger A. Morin, *New Regulatory Finance* (Public Utility Reports, Inc., 2006) at 172.

Footnote #29 – Attachment X
Robert S. Harris, "Using Analysts' Growth Forecasts to Estimate Shareholder Required Rates of Return", *Financial Management* (Spring 1986), at 58-67.

Footnote #30 – Attachment Y
Robert S. Harris and F. Marston, "Estimating Shareholder Risk Premia Using Analysts' Growth Forecasts," Financial Management, 21 (Summer 1992), at 63-70.

Footnote #31 – Attachment Z
Farris M. Maddox, Donna T. Pippert and Rodney N. Sullivan, "An Empirical Study of Ex. Ante Risk Premiums for the Electric Utility Industry," Financial Management, 24 (Autumn 1995), at 89-95.

Footnote #32 – Attachment AA
Roger A. Morin, *New Regulatory Finance* (Public Utility Reports, Inc., 2006) at 129, 132 (citing Roger A. Morin, *Prepared Testimony on Fair Rate of Return on Equity for Hydro-Quebec* (Utility Research International, 2005).

Footnote #33 – Attachment AB
Roger A. Morin, *New Regulatory Finance* (Public Utility Reports, Inc., 2006), at 129

Footnote #34 – Attachment AC
See, Robert S. Hamada, The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks," *The Journal of Finance,* 27 (May 1972) at 435-452.

Footnote #35
Discussion Only

Footnote #36
Discussion Only

Footnote #37 – Attachment AD
See, Michael Annin, "Equity and the Small-Stock Effect," *Public Utilities Fortnightly*, October 15, 1995, 42-43; and Eugene F. Fama and Kenneth R. French, "The Cross-Section of Expected Stock Returns," *The Journal of Finance,* 48 (June 1992), at 427-465.

Footnote #38 – Attachment AE
2021 *SBBI Yearbook,* (Duff & Phelps, a Kroll Business), at 7-1, 7-3 and 7-5.

Footnote #39 – Attachment AF
Roger A. Morin, *New Regulatory Finance* (Public Utilities Reports, Inc., 2006), at 190.

Footnote #40
Discussion Only

Footnote #41 – Attachment AG
M. Ehrhardt and E. Brigham, *Corporate Finance: A Focused Approach* (South-Western Cengage Learning, 2008), at 294.

Footnote #42
Discussion Only

Footnote #43 – Attachment AH
Roger A. Morin *New Regulatory Finance* (Public Utilities Reports, Inc., 2006), at 114.

Footnote #44 – Attachment AI
2017 *SBBI Yearbook* (Duff & Phelps, John Wiley & Sons, Inc.), at 10-22.

Footnote #45
Discussion Only

A2 | Thursday, April 22, 2021

U.S. N

CAPITAL ACCOUNT | By Greg Ip

Labor Market Tighter

One set of numbers shows a labor market in dire straits. Total employment, despite March's jump, is still down 8.4 million from its pre-pandemic peak, on a par with the worst point of the 2007-09 recession and its aftermath.

While the unemployment rate at 6% is lower than in 2009, it is above 9% after including people not counted as unemployed because they dropped out of the labor force or were misclassified, according to the Federal Reserve. In short, the labor market seems awash in slack, with job seekers swamping demand for workers.

Weirdly, that isn't what a different set of numbers suggests. It shows a labor market starting to look, well, tight.

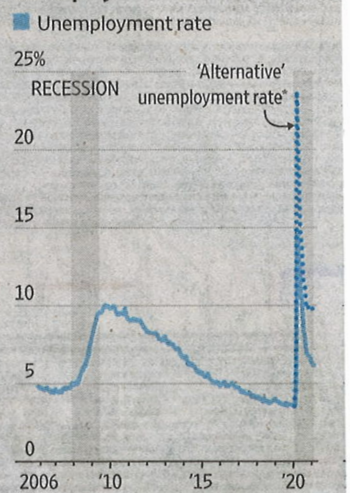
Consider wages. In a truly bad labor market, desperate workers would accept much lower pay, dragging down earnings growth. That hasn't happened.

The Labor Department's widely followed average earnings data are distorted by the disproportionate drop in low-wage work, so you need to consult measures that filter out these compositional effects. One measure, median wage growth as tracked by the Federal Reserve Bank of Atlanta, was 3.4% in February, barely changed from before the pandemic. Another, the Labor Department's employment cost index, shows earnings up 2.8% in the fourth quarter of 2020, compared with 3% a year earlier. In 2010, both measures of wage growth fell below 2%.

Another sign of a tightening labor market: employers having trouble staffing up. In October 2009, businesses contacted for the Fed's beige book, an anecdotal survey of economic conditions, overwhelmingly described the labor market as weak and wage pressures as subdued. By contrast, this month's beige book reported shortages of drivers; entry-level, low-wage and skilled workers; child-care and information-technology staff; specialty trades; and nurses. "A homebuilder related that a landscaper had hired 20 laborers in early February and none showed up for work," the latest beige book said. "One restaurant had begun offering $1,000 if workers stayed for at least 90 days."

One shouldn't put too much weight on anecdotes, but these are corroborated by data. Some 7.4 million jobs were open in February, above the pre-pandemic level. By contrast, job vacancies plummeted by half in 2007-09. A mismatch might be at work: sectors and regions unscathed by the pandemic want to hire, but the available workers are in the wrong place or have the wrong skills. Nonetheless, job vacancy rates are above pre-pandemic levels in most sectors, even leisure and hospitality.

Two ways of looking at unemployment



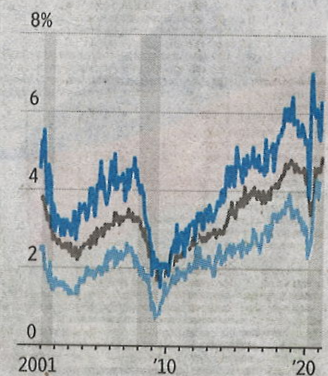
*Assumes labor force participation remained at Jan
workers

Sources: Labor Department (unemployment rate, sh
unemployment)

So why does one set of numbers suggest the labor market is slack while another suggest it is tight? The discrepancy goes back to how this recession was fundamentally different from the previous one. The 2008-09 financial crisis wiped out wealth and dried up credit. That sapped demand for goods and services as consumers stopped spending, and for workers as employers stopped hiring. By contrast, the pandemic clobbered both demand for workers as businesses closed, and the supply as workers withdrew to look after their children or their health.

As businesses reopen and stimulus checks juice sales, the demand for workers is now re-

Than It Looks



t January 2020 level and adds back misclassified

te, share); Federal Reserve and WSJ ('alternative'

covering, but the supply of workers, not so much. Adjusted for population growth, the labor force—people working or looking for work—is roughly five million smaller than before the pandemic.

Only a small share of those labor-market dropouts want a job. Covid-19 is keeping most of the others out of the job market. A Census Bureau survey in late March found that 2.6 million people weren't working because they were sick or caring for someone who was, and 4.2 million were afraid of catching or spreading the virus. (The two groups might overlap.) Indeed, fear might be the single most important difference between this recession and its predecessors. Millions are also caring for children, but it wasn't clear how many were because of Covid-19 closures.

Stimulus checks and unemployment insurance, which has been extended to gig workers and made more generous, might also have kept potential job seekers on the sidelines. Several studies found that the aid didn't depress employment last year because there were no jobs to be had. That may be changing as demand for workers ramps up.

All in all, while unemployment is indeed elevated, the job market isn't as "loose" as the 8.4 million shortfall suggests. This partly undercuts the rationale for the aggressive fiscal and monetary stimulus injected into the economy: to fuel spending that soaks up all of those out-of-work people. Many simply aren't available to be hired.

That is likely to change. As vaccination spreads, the virus-related obstacles to working should recede and economists expect the labor force to rebound. That is a Goldilocks scenario: historically high levels of employment and the sort of robust wage growth workers, especially the lowest-paid, were enjoying pre-pandemic.

But what if workers are slow to return? As stimulus-stoked demand for labor meets stubbornly reduced supply, the result should be even faster wage gains for those who do work, and one more reason to worry about inflation.

A2 | Friday, April 23, 2021

THE WALL STREET JOURNAL.

U.S. NEWS

Jobless Claims Fall to New Pandemic Low

By Amara Omeokwe

Worker filings for jobless benefits declined to 547,000 last week, a new pandemic low that adds to evidence of a strengthening labor market and overall economic recovery.

Initial unemployment claims, a proxy for layoffs, fell 39,000 last week from an upwardly revised 586,000 the prior week, the Labor Department said Thursday. That put new claims on a seasonally adjusted basis below 600,000 for two consecutive weeks in mid-April, their lowest levels since early 2020. The four-week moving average, which smooths out volatility in the weekly figures, was 651,000, also a pandemic low.

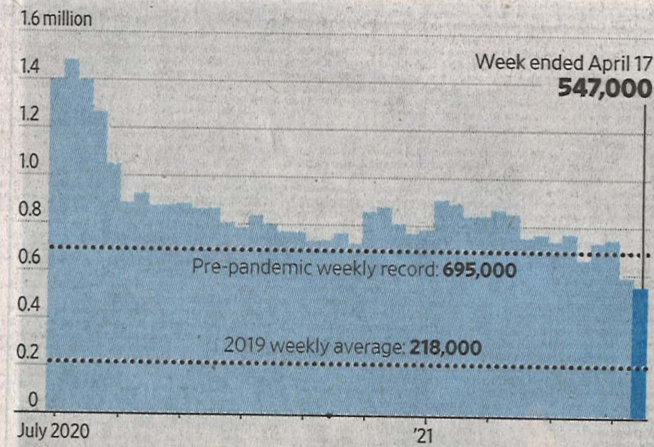
The median sales price for previously owned homes climbed to a record in March as a shortage of homes during the pandemic limited transactions, the National Association of Realtors said separately. Existing-home sales dropped 3.7% in March from February to a seasonally adjusted annual rate of 6.01 million, marking the second straight month of sales declines.

Jobless claims remain higher than their pre-pandemic levels—the weekly average in 2019 was about 218,000—but last week's drop extended a downward trend since the start of this year and raised expectations for further declines in coming weeks.

"This dip in jobless claims looks good in isolation but what really matters is that it confirms that last week's unexpected plunge was no fluke," said Ian Shepherdson, chief economist at Pantheon Macroeconomics, in a note to clients.

A confluence of factors has offered signals that the economic recovery is accelerating, including a surge last month in retail sales and jobs

Filings for jobless benefits



Note: Seasonally adjusted
Source: U.S. Employment and Training Administration via St. Louis Fed

added as Covid-19 vaccination totals increased and the economy more fully reopened. Economists surveyed by The Wall Street Journal in April forecast on average that U.S. gross domestic product grew at a 5.59% annual rate in the first quarter of 2021. That was up from an average forecast of 2.21% growth from the January survey.

Recent federal stimulus aid has sent many households direct cash payments. Meanwhile, about a third of U.S. adults age 18 or over have been fully vaccinated, and more than half have received at least one dose, according to the Centers for Disease Control and Prevention.

Continuing jobless claims—a proxy for the number of people receiving benefits through regular state programs—fell to 3.67 million in the week ended April 10, a decline of 34,000 from the prior week. The four-week moving average in continuing claims also fell.

"I do think that we are seeing real improvement in the labor market, and claims will continue to gradually move lower probably through the rest of this year," said Gus Faucher, chief economist at PNC Financial Services Group.

He added that the pace of vaccinations and business reopenings bodes especially well for activity at services businesses, such as dining as well as leisure and hospitality.

Consumer spending is the driving factor for U.S. economic growth, accounting for roughly two-thirds of output.

Peggy Shell, chief executive and founder at Creative Alignments, a Boulder, Colo.-based staffing firm, said she recently added three new staffers to the company, bringing the total to 26 part- and full-time workers.

Two more workers are scheduled to start. Ms. Shell said vaccines are helping drive the optimism she is hearing among clients.

"I do think that this hope of the country opening even more has allowed people to feel even more comfortable in their growth plans," she said.

Still, the U.S. economy as of March had roughly 8.4 million fewer jobs than before the pandemic started. Overall, about 17.4 million Americans were collecting unemployment benefits through state, federal and pandemic-related programs in the week ended April 3, up from 16.9 million the prior week.

yield effects in Figure 6-2 can be imagined, substituting a skewness line for the dividend yield line.

California water utilities in the late 1990s and continuing in the 2000s provide a good example of skewness effects. Because of the asymmetry in the future water supply, there is a greater probability of downside returns to investors under adverse supply conditions, but essentially no probability of correspondingly large positive returns. That is, these water utilities' future profitability is constrained by both the regulatory process and by a negatively skewed water supply. Hence, measures of variability and covariability, such as standard deviation and beta, are likely to provide downward-biased estimates of the true risk relative to that of unregulated firms and other utilities.

Another example is provided by some regulatory incentive plans where the risks of potential losses are borne exclusively by shareholders due to an absence of any return floor and the presence of a limit on the allowable recovery of cost increases. The benefits of added efficiencies and productivity gains achieved by the company over and above the allowed return are absorbed totally by ratepayers. Such lack of symmetry ("heads I win, tails you lose") clearly increases risk and results in a deterioration of the regulatory climate and higher capital costs.

In both of these examples, the implication is that an additional risk premium must be added to the business-as-usual return on equity to compensate for the added risks. The lack of symmetry in investor returns must be considered. A risk premium sufficient to compensate investors for the limited upside returns/unlimited downside returns versus comparable risk companies and other utilities is required. To wit, in California's New Regulatory Framework designed to regulate large telecommunications companies, a 50 basis point increment was added to the benchmark rate of return on equity in order to compensate for the lack of symmetry in the plan.

Size Effect

Investment risk increases as company size diminishes, all else remaining constant. Small companies have very different returns than large ones, and on average they have been higher. The greater risk of small stocks does not fully account for their higher returns over many historical periods. The size phenomenon is well-documented in the finance literature. Empirical studies by Banz (1981) and Reinganum (1981A) have found that investors in small-capitalization stocks require higher returns than predicted by the standard CAPM. Reinganum (1981A) examined the relationship between the size of the firm and its P/E ratio, and found that small firms experienced average returns greater than those of large firms that were of equivalent systematic risk (beta). He found that small firms produce greater returns than could be explained by their risks. These results were confirmed in a separate test by

Although much research effort has gone into investigating the size effect, the economic rationale for the size effect is difficult to unravel.[7] Smaller companies are less able to deal with significant events that affect revenues and cash flows than large companies. For example, the loss of sales from a few large customers would exert a far greater effect on a small company that on a larger company with a large customer base. Presumably, small stocks provided less utility to the investor, and require a higher return. The size effect may be a statistical mirage, whereby size is proxying for the effect of different economic variables. Small firms may have low price-earnings ratios or low market prices, for example. The size effect is most likely the result of a liquidity premium, whereby investors in small stocks demand greater returns as compensation for lack of marketability and liquidity. Investors prefer high to low liquidity, and demand higher returns from less liquid investments, holding other factors constant. Another plausible explanation for the size effect is the higher information search costs incurred by investors for small companies relative to large companies. In short, size is a significant factor that increases both business risk and financial risk and, therefore, the cost of capital.

Cost of Equity and Size Premium

Given the evidence of a small firm premium, that is, small market-cap stocks experience higher returns than large market-cap stocks with equivalent betas, the CAPM understates the risk of smaller utilities, and a cost of equity based purely on a CAPM beta will therefore produce too low an estimate for these small companies. This has led some analysts to add a premium to the estimated cost of equity for smaller companies. For example, let us say that small-cap stocks have earned about 2% more than large stocks over the past decade. In order to estimate the cost of equity for a small-cap stock with a beta of 0.80, a risk-free rate of 5% and a market risk premium (''MRP'') of 7%, you would perform the following calculation:[8]

$$\begin{aligned} K &= R_F + \beta\,(MRP) + \text{Small size premium} \\ &= 5\% + 0.80\,(7\%) + 2\% \\ &= 12.6\% \end{aligned}$$

[7] See Roll (1981).

[8] This procedure opens the door to a whole series of similar adjustments reflecting numerous market inefficiencies (e.g., dividend yield, skewness, low M/B ratio, etc.). In order to resist this temptation, a superior alternative to considering the size premium explicitly is to identify the economic reasons for the premium and develop more direct measures of risk. For example, if the higher risk of small water utilities comes from the higher operating leverage associated with their operations relative to larger utilities, the betas could be adjusted for operating leverage and use these higher betas for small-cap utilities.

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Industry costs of equity

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Abstract

Estimates of the cost of equity for industries are imprecise. Standard errors of more than 3.0% per year are typical for both the CAPM and the three-factor model of Fama and French (1993). These large standard errors are the result of (i) uncertainty about true factor risk premiums and (ii) imprecise estimates of the loadings of industries on the risk factors. Estimates of the cost of equity for firms and projects are surely even less precise.

Key words: Cost of equity; Asset pricing models; Risk loadings
JEL classification: G12; G31

1. Introduction

Textbooks in corporate finance advise managers to evaluate an investment project by comparing the required outlay to the present value of the expected future cash flows. Most textbooks emphasize the uncertainty in projections of cash flows. Our main point is that the cost of capital estimates used to discount cash flows are also unavoidably imprecise.

There are at least three cost of capital problems. First, it is not clear which asset pricing model should be used. The capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) is the common choice. Recent evidence suggests, however, that the CAPM is not a good description of expected returns. As an alternative, Fama and French (1993, 1995) propose a three-factor pricing model. But some argue that this model is empirically inspired and lacks strong

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theoretical foundations. Other multifactor models have been used to estimate the cost of capital (Bower, Bower, and Logue, 1984; Goldenberg and Robin, 1991; Bower and Schink, 1994; Elton, Gruber, and Mei, 1994), but there is no consensus about which is best. And the choice of model is important. In the tests below, differences of 2% per year between estimates of the cost of equity from the CAPM and our three-factor model are common.

We do not take a stance on which is the right asset pricing model. Instead we use both the CAPM and our three-factor model to estimate industry costs of equity (*CE*'s). Our goal is to illustrate in detail two problems that plague *CE* estimates from any asset pricing model.

The first problem is imprecise estimates of risk loadings. Estimates of CAPM and three-factor risk loadings for industries would be precise if the loadings were constant. We find, however, that there is strong variation through time in the CAPM and three-factor risk loadings of industries. As a result, if we are trying to measure an industry's current risk loadings and cost of equity, estimates from full sample (1963–1994) regressions are no more accurate than the imprecise estimates from regressions that use only the latest three years of data. And industries give an understated picture of the problems that will arise in estimating risk loadings for individual firms and investment projects.

The second problem is imprecise estimates of factor risk premiums. For example, the price of risk in the CAPM is the expected return on the market portfolio minus the risk-free interest rate, $E(R_M) - R_f$. The annualized average excess return on the Center for Research in Security Prices (CRSP) value-weight market portfolio of NYSE, AMEX, and NASDAQ stocks for our 1963–1994 sample period is 5.16%; its standard error is 2.71%. Thus, if we use the historical market premium to estimate the expected premium, the traditional plus-and-minus-two-standard-error interval ranges from less than zero to more than 10.0%.

Our message is that uncertainty of this magnitude about risk premiums, coupled with the uncertainty about risk loadings, implies woefully imprecise estimates of the cost of equity.

We start with a brief discussion of the CAPM and the three-factor model (Section 2). Section 3 explores variation through time in the CAPM and three-factor risk loadings of industries. Sections 4 and 5 compare different ways to estimate the loadings and the cost of equity. Section 6 examines uncertainty about factor risk premiums. In Section 7 we present standard errors for *CE* estimates that allow for uncertainty about both risk loadings and risk premiums. Section 8 concludes.

2. The CAPM and the three-factor model

In the CAPM, the expected return on stock i or, equivalently, the cost of equity for firm i is

$$E(R_i) = R_f + \beta_i[E(R_M) - R_f]\,, \tag{1}$$

where R_f is the risk-free interest rate, $E(R_M)$ is the expected return on the value-weight market portfolio, and β_i, the CAPM risk of stock i, is the slope in the regression of its excess return on the market's excess return,

$$R_i - R_f = \alpha_i + \beta_i[R_M - R_f] + e_i \,. \quad (2)$$

Recent empirical work questions the adequacy of the CAPM as a model for expected returns. Specifically, many papers argue that market beta does not

Table 1
Factor risk premiums for the CAPM and the three-factor model: 7/63–12/94

$R_i - R_f = a_i + b_i[R_M - R_f] + e_i$, $\quad R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$

The returns here and in all following tables are in percents. R_f is the one-month Treasury bill rate observed at the beginning of the month. The explanatory returns R_M, SMB, and HML are formed as follows. At the end of June of each year t (1963–1994), NYSE, AMEX, and NASDAQ stocks are allocated to two groups (small or big, S or B) based on whether their June market equity (ME, stock price times shares outstanding) is below or above the median ME for NYSE stocks. NYSE, AMEX, and NASDAQ stocks are allocated in an independent sort to three book-to-market-equity (BE/ME) groups (low, medium, or high; L, M, or H) based on the breakpoints for the bottom 30%, middle 40%, and top 30% of the values of BE/ME for NYSE stocks. BE is the Compustat book value of stockholders' equity, plus balance sheet deferred taxes and investment tax credit (if available), plus post-retirement benefit liability (if available), minus the book value of preferred stock. Depending on availability, we use the redemption, liquidation, or par value (in that order) to estimate the book value of preferred stock. The BE/ME ratio used to form portfolios in June of year t is then book common equity for the fiscal year ending in calendar year $t-1$, divided by market equity at the end of December of $t-1$. Six size-BE/ME portfolios (S/L, S/M, S/H, B/L, B/M, B/H) are defined as the intersections of the two ME and the three BE/ME groups. Value-weight monthly returns on the portfolios are calculated from July of year t to the following June. SMB is the difference, each month, between the average of the returns on the three small-stock portfolios (S/L, S/M, and S/H) and the average of the returns on the three big-stock portfolios (B/L, B/M, and B/H). HML is the difference between the average of the returns on the two high-BE/ME portfolios (S/H and B/H) and the average of the returns on the two low-BE/ME portfolios (S/L and B/L). We do not use negative BE firms, which are rare prior to 1980, when calculating the breakpoints for BE/ME or when forming the six size-BE/ME portfolios. Also, only ordinary common equity (as classified by CRSP) is included in the tests. This means that ADR's, REIT's, and units of beneficial interest are excluded. The market return R_M is the value-weight average of the returns on all stocks in the six size-BE/ME portfolios, plus the negative BE stocks excluded from the portfolios. The sample size is 378 months.

	$R_M - R_f$	SMB	HML
Monthly			
Average premium	0.43	0.27	0.45
Standard deviation (SD)	4.39	2.86	2.56
Standard error ($SD/378^{1/2}$)	0.23	0.15	0.13
Annualized (12 times monthly)			
Average premium	5.16	3.24	5.40
Standard error	2.71	1.77	1.58

suffice to explain expected stock returns. (See Fama and French, 1992, and the references therein.) Multifactor variants of Merton's (1973) intertemporal asset pricing model (ICAPM) or Ross' (1976) arbitrage pricing theory (APT) seem to give better descriptions of expected stock returns (e.g., Chen, Roll, and Ross, 1986; Fama and French, 1993, 1996).

Fama and French (1993) propose a three-factor model in which a security's expected return depends on the sensitivity of its return to the market return and the returns on two portfolios meant to mimic additional risk factors. The mimicking portfolios are *SMB* (small minus big), which is the difference between the returns on a portfolio of small stocks and a portfolio of big stocks, and *HML* (high minus low), the difference between the returns on a portfolio of high-book-to-market-equity (*BE/ME*) stocks and a portfolio of low-*BE/ME* stocks. (See Table 1.) The expected-return equation of the three-factor model is

$$E(R_i) - R_f = b_i[E(R_M) - R_f] + s_i E(SMB) + h_i E(HML), \tag{3}$$

where b_i, s_i, and h_i are the slopes in the regression

$$R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i. \tag{4}$$

Using *SMB* to explain returns is in line with the evidence of Huberman and Kandel (1987) that there is covariation in the returns on small stocks that is not captured by the market return and is compensated in average return. Using *HML* to explain returns is in line with the evidence of Chan and Chen (1991) that there is return covariation related to relative distress (proxied here by *BE/ME*, the ratio of the book value of a firm's common stock to its market value) that is missed by the market return and is compensated in average return. Fama and French (1993, 1996) show that the three-factor model captures much of the spread in the cross-section of average returns on portfolios formed on size, *BE/ME*, and other variables (earnings/price, cash flow/price, and long-term past return) known to cause problems for the CAPM.

3. Time-varying risk loadings

A manager using an asset pricing model to measure the discount rate for a project must estimate the project's sensitivities to the model's risk factors. Table 2 shows estimates of CAPM and three-factor risk loadings for 48 value-weight industries. The industries are defined with the goal of having a manageable number of distinct industries that cover all NYSE, AMEX, and NASDAQ stocks. (See Appendix A.) Because the sample of firms on Compustat is rather limited in earlier years, the sample period is July 1963 to December 1994.

The full-period risk loadings in Table 2 seem to be estimated precisely. The average standard error for the CAPM market slopes is only 0.04. The average standard errors for the market, *SMB*, and *HML* slopes in the three-factor model

Table 2
CAPM and three-factor industry regressions: 7/63–12/94

$R_i - R_f = a_i + b_i[R_M - R_f] + e_i, \qquad R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$

The industries are defined in Appendix A. The monthly explanatory returns, $R_M - R_f$, SMB, and HML, are described in Table 1. $t(a)$ is the t-statistic for the regression intercept. The regression R^2 are adjusted for degrees of freedom. Mean is the average across the 48 industries. The average standard error of the $R_M - R_f$ slopes in the CAPM regressions is 0.04. The average standard errors of the $R_M - R_f$, SMB, and HML slopes in the three-factor regressions are 0.05, 0.07, and 0.07.

	CAPM				Three-factor					
Industry	a	$t(a)$	b	R^2	a	$t(a)$	b	s	h	R^2
Drugs	0.23	1.29	0.92	0.59	0.61	3.88	0.84	− 0.25	− 0.63	0.68
MedEq	0.11	0.57	1.17	0.67	0.39	2.24	0.99	0.26	− 0.60	0.73
Hlth	0.28	0.91	1.56	0.56	0.43	1.54	1.24	0.93	− 0.59	0.66
Comps	− 0.11	− 0.55	1.04	0.59	0.13	0.66	0.90	0.17	− 0.49	0.63
Chips	0.07	0.32	1.38	0.69	0.15	0.83	1.15	0.69	− 0.39	0.77
BusSv	0.12	0.76	1.34	0.80	0.14	1.26	1.13	0.72	− 0.29	0.89
LabEq	− 0.15	− 0.91	1.29	0.77	− 0.08	− 0.56	1.13	0.49	− 0.29	0.82
Hshld	− 0.00	− 0.02	0.97	0.72	0.14	1.04	0.91	0.00	− 0.27	0.73
Meals	0.25	1.18	1.32	0.66	0.25	1.30	1.12	0.74	− 0.24	0.74
Beer	0.37	2.12	0.92	0.59	0.51	2.90	0.90	− 0.13	− 0.22	0.60
PerSv	− 0.08	− 0.35	1.25	0.59	− 0.16	− 0.79	1.00	1.00	− 0.20	0.74
Cnstr	− 0.28	− 1.50	1.28	0.70	− 0.27	− 1.43	1.21	0.21	− 0.09	0.71
Rtail	0.07	0.48	1.11	0.73	0.06	0.37	1.04	0.27	− 0.06	0.75
Fun	0.21	0.91	1.35	0.64	0.08	0.40	1.17	0.83	− 0.04	0.73
Food	0.32	2.36	0.87	0.68	0.35	2.51	0.88	− 0.07	− 0.03	0.68
Agric	− 0.07	− 0.27	1.00	0.44	− 0.18	− 0.77	0.85	0.71	− 0.02	0.53
Mach	− 0.11	− 0.86	1.16	0.82	− 0.15	− 1.22	1.11	0.25	− 0.00	0.83
Books	0.12	0.73	1.17	0.71	0.04	0.26	1.08	0.45	0.00	0.75
Aero	0.03	0.14	1.26	0.68	− 0.07	− 0.34	1.15	0.51	0.00	0.72
Coal	0.04	0.12	0.96	0.36	− 0.05	− 0.18	0.86	0.46	0.01	0.39
Guns	0.17	0.80	1.04	0.55	0.09	0.42	0.95	0.41	0.01	0.59
Whlsl	− 0.10	− 0.81	1.15	0.81	− 0.24	− 2.89	1.01	0.71	0.01	0.92
Fin	0.19	1.14	1.16	0.72	0.12	0.75	1.11	0.30	0.02	0.74
ElcEq	0.06	0.42	1.15	0.75	0.05	0.34	1.15	− 0.00	0.02	0.74
Boxes	0.13	0.78	1.03	0.65	0.09	0.51	0.99	0.17	0.02	0.66
BldMt	− 0.01	− 0.09	1.13	0.83	− 0.06	− 0.55	1.11	0.15	0.05	0.84
Insur	0.08	0.39	1.01	0.58	0.03	0.14	1.00	0.09	0.06	0.58
Gold	0.33	0.78	0.78	0.15	0.21	0.50	0.71	0.40	0.08	0.16
Misc	− 0.28	− 1.00	1.26	0.50	− 0.54	− 2.31	1.03	1.19	0.08	0.67
Trans	− 0.07	− 0.43	1.21	0.75	− 0.71	− 1.09	1.16	0.30	0.09	0.77
Rubbr	0.05	0.37	1.21	0.78	− 0.08	− 0.61	1.12	0.49	0.09	0.83
FabPr	− 0.13	− 0.55	1.31	0.63	− 0.37	− 2.16	1.11	1.10	0.09	0.80
Clths	0.08	0.39	1.24	0.66	− 0.13	− 0.78	1.09	0.83	0.11	0.78
Chem	− 0.02	− 0.17	1.09	0.81	− 0.10	− 0.85	1.13	− 0.03	0.17	0.81
Toys	− 0.01	− 0.04	1.34	0.54	− 0.28	− 1.11	1.17	0.97	0.17	0.65
Ships	0.17	0.61	1.19	0.50	− 0.05	− 0.18	1.09	0.66	0.17	0.56
Soda	0.30	1.32	1.24	0.60	0.13	0.55	1.19	0.44	0.18	0.63

Table 2 (continued)

	CAPM				Three-factor					
Industry	a	$t(a)$	b	R^2	a	$t(a)$	b	s	h	R^2
Enrgy	0.13	0.71	0.85	0.50	0.08	0.45	0.96	− 0.35	0.21	0.54
Mines	0.30	1.24	0.98	0.45	0.08	0.34	0.91	0.53	0.23	0.50
Smoke	0.40	1.82	0.80	0.40	0.28	1.24	0.86	− 0.04	0.24	0.41
Paper	− 0.05	− 0.32	1.11	0.75	− 0.22	− 1.54	1.14	0.16	0.27	0.77
Txtls	0.05	0.27	1.12	0.65	− 0.24	− 1.50	1.03	0.71	0.30	0.76
Banks	− 0.04	− 0.26	1.09	0.76	− 0.25	− 1.84	1.13	0.13	0.35	0.79
Telcm	0.13	0.92	0.66	0.52	− 0.02	− 0.11	0.79	− 0.23	0.35	0.59
Util	− 0.00	− 0.02	0.66	0.55	− 0.17	− 1.33	0.79	− 0.20	0.38	0.62
RlEst	− 0.58	− 2.32	1.17	0.53	− 1.01	− 5.45	1.01	1.18	0.40	0.75
Steel	− 0.22	− 1.06	1.16	0.61	− 0.53	− 2.64	1.17	0.40	0.43	0.67
Autos	− 0.04	− 0.21	1.01	0.56	− 0.40	− 2.09	1.10	0.17	0.60	0.63
Mean	0.05	0.25	1.11	0.63	− 0.03	− 0.21	1.04	0.39	0.02	0.68

are 0.05, 0.07, and 0.07. These small standard errors are misleading, however, because they assume the true slopes are constant. Industry risk loadings wander through time, and estimates of period-by-period loadings are much less precise.

3.1. *The implied volatility of true risk loadings*

One way to document the temporal variation in risk loadings is with rolling CAPM and three-factor regressions (estimated monthly using five years of past returns). The idea is that, if the true CAPM and three-factor slopes for industries vary through time, the time-series variation of the rolling-regression slopes should exceed that implied by estimation error. Specifically, under the standard assumption that the sampling error of a slope is uncorrelated with the true value of the slope, the time-series variance of a rolling-regression slope is just the sum of the variance of the true slope and the variance of the estimation error,

$$\sigma^2(Time\ Series) = \sigma^2(True) + \sigma^2(Estimation\ Error)\,. \tag{5}$$

Table 3 reports estimates of $\sigma(True)$ for the market, SMB, and HML slopes in five-year rolling CAPM and three-factor regressions. The estimates document substantial temporal variation in the CAPM betas of industries. All but five of the implied standard deviations of the true CAPM market slopes are greater than zero, 28 are greater than 0.10, and nine are greater than 0.20. The average is 0.12. Thus, if the typical industry has a long-term average beta of 1.0, the traditional two-standard-deviation rule of thumb suggests that its current true beta might be anywhere between 0.76 and 1.24. If we use the average market premium during our sample period, 5.16% per year, as the expected premium,

Table 3
Implied standard deviations of true market, *SMB*, and *HML* slopes in five-year rolling CAPM and three-factor regressions

$R_i - R_f = a_i + b_i[R_M - R_f] + e_i, \qquad R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$

The industries are defined in Appendix A. $R_M - R_f$, *SMB*, and *HML* are defined in Table 1. CAPM and three-factor regressions are estimated each month of the 6/68 to 12/94 period, using a rolling window of 60 prior monthly returns. The implied standard deviation of an industry's true market, *SMB*, or *HML* slope, $\hat{\sigma}(True)$, is the square root of the difference between the time-series variance of the industry's five-year slope estimates and the average of the estimation-error variances (squared standard errors) of its five-year slope estimates,

$$\hat{\sigma}(True) = [\hat{\sigma}^2(Time\ Series) - \hat{\sigma}^2(Estimation\ Error)]^{1/2}.$$

If the average estimation-error variance exceeds the time-series variance, $\hat{\sigma}(True)$ is set to zero. Mean is the average of $\hat{\sigma}(True)$ across the 48 industries.

	CAPM	Three-factor		
Industry	*b*	*b*	*s*	*h*
Drugs	0.088	0.101	0.141	0.262
MedEq	0.079	0.116	0.000	0.000
Hlth	0.251	0.148	0.000	0.181
Comps	0.000	0.000	0.038	0.277
Chips	0.025	0.051	0.030	0.314
BusSv	0.114	0.067	0.155	0.255
LabEq	0.043	0.063	0.000	0.169
Hshld	0.092	0.082	0.084	0.209
Meals	0.227	0.142	0.176	0.331
Beer	0.218	0.226	0.142	0.201
PerSv	0.120	0.000	0.382	0.104
Cnstr	0.098	0.031	0.332	0.293
Rtail	0.116	0.083	0.113	0.158
Fun	0.163	0.000	0.000	0.181
Food	0.104	0.042	0.226	0.245
Agric	0.248	0.133	0.038	0.000
Mach	0.000	0.000	0.201	0.155
Books	0.149	0.136	0.187	0.184
Aero	0.168	0.096	0.161	0.229
Coal	0.172	0.140	0.373	0.000
Guns	0.131	0.069	0.255	0.325
Whlsl	0.113	0.011	0.173	0.053
Fin	0.106	0.169	0.040	0.052
ElcEq	0.071	0.108	0.000	0.213
Boxes	0.084	0.069	0.077	0.190
BldMt	0.000	0.000	0.086	0.071
Insur	0.074	0.000	0.086	0.233
Gold	0.415	0.425	0.090	0.000
Misc	0.250	0.120	0.084	0.152
Trans	0.078	0.023	0.148	0.118
Rubbr	0.080	0.042	0.144	0.102

Table 3 (continued)

	CAPM	Three-factor		
Industry	*b*	*b*	*s*	*h*
FabPr	0.253	0.124	0.179	0.211
Clths	0.144	0.131	0.135	0.290
Chem	0.041	0.000	0.000	0.154
Toys	0.082	0.079	0.321	0.144
Ships	0.114	0.000	0.000	0.313
Soda	0.215	0.186	0.272	0.000
Enrgy	0.180	0.156	0.171	0.365
Mines	0.170	0.129	0.211	0.000
Smoke	0.118	0.056	0.179	0.365
Paper	0.000	0.063	0.000	0.148
Txtls	0.000	0.076	0.088	0.137
Banks	0.121	0.093	0.126	0.126
Telcm	0.138	0.162	0.197	0.000
Util	0.037	0.000	0.107	0.000
RlEst	0.274	0.091	0.136	0.206
Steel	0.021	0.000	0.201	0.148
Autos	0.106	0.135	0.196	0.314
Mean	0.123	0.087	0.135	0.170

the industry's current cost of equity (in excess of the risk-free rate) might be anywhere between 3.92% and 6.40% per year.

The industries' true sensitivities to the market, size, and distress risks of the three-factor model are also volatile. The average of the implied standard deviations of the true *SMB* slopes is 0.14. Forty of 48 are positive, 29 are greater than 0.10, and ten are greater than 0.20. Thus, many industries' value-weight returns behave like small-stock returns during some periods and like big-stock returns in others. Similarly, 40 of the standard deviations of the true *HML* slope are positive, 37 are greater than 0.10, and 20 are greater than 0.20. The average is 0.17. In comparison, the standard deviation of the cross-section of the 48 full-period *HML* slopes in Table 2 is 0.27. Thus, the variation through time in the true *HML* slopes of many industries is almost as large as the cross-sectional standard deviation of the long-term average *HML* slopes of the 48 industries.

Table 3 suggests that the true market betas of the CAPM are more variable than the true market slopes of the three-factor model. For 33 of 48 industries, the implied standard deviation of the true CAPM market beta is higher than that of the true three-factor market slope. The average $\hat{\sigma}(True)$ for beta falls from 0.12 in the CAPM regressions to 0.09 in the three-factor regressions. This is consistent with the evidence that the SMB and *HML* slopes in three-factor regressions typically reduce the cross-sectional variation in market slopes. For example, the standard deviation of the 48 market slopes in Table 1 is 0.19 in the CAPM regressions versus 0.13 in the three-factor regressions.

A note of caution. The population time-series variances of the rolling-regression slopes are well-defined if the true slopes are stationary (mean-reverting). Permanent changes in the supply and demand conditions facing an industry may, however, produce permanent changes in its risk loadings. If the true slopes are not stationary, the implied standard deviations in Table 3 are still descriptive evidence that the true slopes change through time. But comparisons of the estimates across industries, and comparisons of the estimates for different risk factors, may not be meaningful.

3.2. *Conditional regressions*

An alternative to the rolling regressions, both for documenting temporal variation in risk loadings and for estimating an industry's cost of equity at a specific time, is to use instruments to track the wandering risks. Though size is surely not a perfect proxy for sensitivity to *SMB*, we expect that an industry's *SMB* loading will increase if firms in the industry become smaller. We also expect that if an industry becomes distressed, its book-to-market ratio and its *HML* loading will increase. Thus, we try to track time-varying sensitivities to *SMB* and *HML* with conditional regressions in which an industry's *SMB* and *HML* slopes vary with the average size and book-to-market-equity of firms in the industry,[1]

$$R_i - R_f = a_i + b_i[R_M - R_f] + [s_{i1} + s_{i2}\ \ln(ME)_i]SMB + [h_{i1} + h_{i2}\ \ln(BE/ME)_i]HML + e_i\,. \tag{6}$$

The estimates of (6) in Table 4 confirm that the loadings of industries on *SMB* and *HML* wander through time. As predicted, *SMB* loadings fall when the average size of firms in an industry increases; the $\ln(ME)_i SMB$ slope, s_{i2}, is negative for all but seven of the 48 industries, and 20 of the s_{i2} are more than two standard errors below zero. As predicted, *HML* loadings are positively related to the measure of relative distress, $\ln(BE/ME)_i$; all but one of the 48 $\ln(BE/ME)_i HML$ slopes are positive, and 31 are more than two standard errors above zero.

Table 4 also reports the time-series standard deviations of the monthly conditional loadings on *SMB* and *HML*. These standard deviations, estimated as the absolute value of the conditional slope (s_{i2} or h_{i2}) multiplied by the time-series standard deviation of the conditioning variable [$\ln(ME)_i$ or $\ln(BE/ME)_i$], are similar to the implied standard deviations of the true *SMB* and

[1]We thank Jay Shanken for suggesting this approach, which is like that in Shanken (1990).

Table 4
Conditional industry regressions for 7/65–12/94

$$R_i - R_f = a_i + b_i[R_M - R_f] + [s_{i1} + s_{i2}\ln(ME)_i]\,SMB + [h_{i1} + h_{i2}\ln(BE/ME)_i]\,HML + e_i$$

The industries are defined in Appendix A. R_f, R_M, SMB, and HML are defined in Table 1. $\ln(ME)$ is the value-weight average of the natural log of market equity for all firms in an industry, measured at the end of the month preceding the dependent and explanatory returns. $\ln(BE/ME)$ is the value-weight average of the natural log of BE/ME for industry firms that have Compustat data for BE. BE/ME is measured once each calendar year (as described in Table 1), and it is used to explain 12 monthly returns starting in July of the following year. To control for marketwide variation, $\ln(ME)$ and $\ln(BE/ME)$ are measured net of their average values (across industries) each month. In some industries we do not have accounting data for any firms before 1964. Thus the start date for the regressions is 7/65. The regression R^2 are adjusted for degrees of freedom. Std. dev. is the standard deviation of the monthly conditional loading on SMB or HML, calculated as the absolute value of the conditional slope (s_{i2} or h_{i2}) times the time-series standard deviation of the conditioning variables $[\ln(ME)_i$ or $\ln(BE/ME)_i]$.

	Coefficients						t-statistics						Std. dev.	
Industry	a	b	s_1	s_2	h_1	h_2	$t(a)$	$t(s_1)$	$t(s_2)$	$t(h_1)$	$t(h_2)$	R^2	SMB	HML
Drugs	0.58	0.86	0.40	−0.39	0.40	1.09	3.64	1.72	−2.72	2.04	5.38	0.72	0.12	0.26
MedEq	0.40	1.01	0.20	−0.26	−0.20	0.67	2.24	2.61	−1.49	−1.06	2.28	0.74	0.09	0.15
Hlth	0.47	1.20	0.41	−0.39	−0.59	0.21	1.68	1.70	−2.22	−4.44	1.00	0.69	0.24	0.10
Comps	0.13	0.90	0.67	−0.17	−0.39	0.18	0.65	2.86	−2.20	−2.94	1.01	0.65	0.16	0.08
Chips	0.20	1.15	0.67	−0.22	−0.02	0.95	1.03	8.93	−0.71	−0.15	4.17	0.78	0.05	0.28
BusSv	0.13	1.11	0.30	−0.37	−0.08	0.59	1.19	2.62	−3.62	−0.97	3.17	0.91	0.15	0.14
LabEq	−0.09	1.12	0.48	−0.24	−0.22	0.23	−0.59	8.58	−1.15	−1.95	0.70	0.83	0.05	0.04
Hshld	0.13	0.93	0.02	−0.00	0.00	0.51	0.91	0.11	−0.06	0.06	4.60	0.75	0.00	0.23
Meals	0.26	1.12	0.60	−0.30	0.10	0.84	1.33	7.14	−2.39	0.83	3.67	0.76	0.14	0.24
Beer	0.46	0.92	0.10	−0.15	0.27	0.73	2.55	0.51	−1.19	2.00	4.34	0.62	0.08	0.25
PerSv	−0.21	0.99	0.18	−0.44	−0.21	0.09	−1.04	0.77	−3.70	−1.99	0.50	0.75	0.24	0.04
Cnstr	−0.17	1.23	0.20	−0.50	0.02	0.65	−0.90	2.88	−4.77	0.20	3.75	0.74	0.33	0.23
Rtail	0.08	1.05	0.24	0.05	0.21	1.18	0.50	1.96	0.36	2.50	4.83	0.76	0.02	0.25
Fun	0.13	1.17	0.79	−0.14	−0.02	0.24	0.60	9.78	−1.10	−0.26	0.67	0.73	0.07	0.05
Food	0.37	0.87	0.21	−0.38	0.13	1.30	2.70	2.57	−3.79	2.19	6.24	0.72	0.17	0.30
Agric	−0.22	0.84	0.21	−0.43	−0.05	0.11	−0.90	0.76	−1.83	−0.44	0.70	0.56	0.13	0.07
Mach	−0.17	1.12	0.29	−0.41	−0.08	0.91	−1.37	6.27	−2.44	−1.40	3.47	0.84	0.11	0.14

Aero	−0.03	1.15	0.65	−0.51	−0.31	0.93	−0.17	7.51	−3.46	−2.86	3.81	0.74	0.23	0.23
Books	0.04	1.06	0.30	−0.58	0.40	1.31	0.22	4.69	−4.12	3.07	3.89	0.78	0.22	0.24
Coal	−0.05	0.87	0.26	−0.19	−0.10	0.35	−0.15	1.05	−1.02	−0.50	0.94	0.39	0.12	0.12
Guns	0.20	0.93	0.45	−0.61	−0.56	1.41	0.95	5.69	−3.18	−4.13	5.10	0.63	0.23	0.36
Whlsl	−0.16	0.99	−0.29	−0.80	−0.04	0.37	−2.03	−1.64	−5.74	−1.08	2.14	0.94	0.13	0.06
ElcEq	0.05	1.16	0.00	−0.05	0.05	0.07	0.33	0.25	−0.30	0.48	0.22	0.75	0.04	0.02
Fin	0.20	1.10	0.29	−0.10	0.00	0.12	1.19	4.85	−0.82	0.02	0.35	0.75	0.02	0.01
Boxes	0.12	1.00	0.19	−0.15	−0.04	0.27	0.69	2.73	−0.80	−0.42	0.92	0.66	0.05	0.06
BldMt	−0.03	1.12	0.28	−0.19	0.15	0.43	−0.23	2.70	−1.40	2.30	2.14	0.84	0.05	0.08
Insur	0.12	0.99	0.21	−0.69	−0.09	0.57	0.57	2.16	−1.97	−0.98	3.02	0.59	0.13	0.23
Gold	0.22	0.68	0.63	0.64	0.26	0.36	0.49	2.74	1.23	0.82	0.76	0.16	0.17	0.14
Misc	−0.60	1.03	1.48	0.14	0.04	0.30	−2.42	4.46	0.94	0.37	1.62	0.68	0.09	0.16
Rubbr	−0.18	1.15	−0.04	−0.67	0.06	1.20	−1.38	−0.35	−4.50	1.06	3.25	0.85	0.08	0.14
Trans	−0.16	1.16	0.32	−0.38	−0.31	0.88	−0.96	5.56	−1.46	−1.74	2.31	0.78	0.24	0.15
FabPr	−0.40	1.09	0.67	−0.22	−0.02	1.15	−2.22	2.22	−1.38	−0.29	2.85	0.81	0.08	0.18
Clths	−0.11	1.07	0.27	−0.37	−0.21	1.17	−0.69	1.26	−2.36	−2.65	6.97	0.81	0.11	0.36
Chem	−0.11	1.13	−0.14	0.11	0.15	0.15	−0.87	−0.70	0.58	2.71	0.69	0.81	0.02	0.03
Toys	−0.22	1.16	0.73	−0.25	0.25	0.80	−0.86	4.56	−1.26	2.29	3.05	0.67	0.11	0.26
Ships	−0.03	1.03	0.47	−0.26	−0.43	1.30	−0.11	3.03	−1.56	−2.58	4.56	0.58	0.14	0.41
Soda	0.08	1.18	0.22	−0.32	0.12	0.46	0.33	1.68	−2.32	1.31	2.16	0.64	0.20	0.17
Enrgy	0.03	0.94	−1.57	0.65	−0.35	1.90	0.16	2.21	1.88	−3.30	7.28	0.60	0.12	0.43
Mines	0.00	0.91	0.51	−0.21	0.19	0.36	0.03	5.06	−1.05	1.71	0.88	0.51	0.08	0.08
Smoke	0.28	0.83	0.19	−0.51	−0.00	0.86	1.19	1.53	−2.35	−0.01	3.68	0.43	0.18	0.30
Paper	−0.19	1.14	0.13	0.09	0.32	−0.18	−1.23	2.16	0.29	2.55	−0.48	0.77	0.01	0.03
Txtls	−0.28	1.02	0.14	−0.49	−0.16	0.74	−1.71	0.73	−3.12	−0.86	2.57	0.78	0.15	0.14
Banks	−0.18	1.15	0.17	−0.21	0.09	0.86	−1.27	3.10	−1.28	0.87	3.12	0.80	0.06	0.14
Telcm	−0.06	0.79	−0.66	0.16	0.13	0.52	−0.42	−2.91	1.96	1.04	2.12	0.60	0.10	0.11
Util	−0.09	0.78	0.01	−0.82	0.10	0.53	−0.64	0.13	−2.75	0.59	1.65	0.63	0.12	0.10
RlEst	−1.02	1.00	0.36	−0.38	0.38	0.21	−5.22	0.84	−1.93	4.80	0.83	0.76	0.13	0.07
Steel	−0.55	1.16	0.34	−0.40	−0.49	1.42	−2.64	3.92	−1.56	−1.73	3.43	0.68	0.12	0.25
Autos	−0.40	1.12	0.64	−0.23	0.20	0.88	−2.06	2.77	−2.13	1.46	3.65	0.65	0.13	0.30

HML slopes in Table 3. The correlation between the two estimates of the volatility of an industry's sensitivity is 0.51 for the *SMB* slopes and 0.63 for the *HML* slopes. Moreover, the averages of the standard deviations of the conditional loadings in Table 4 (0.13 for *SMB* and 0.17 for *HML*) are almost identical to the averages of the implied standard deviations in Table 3 (0.14 and 0.17). Thus, the conditional regressions track meaningful variation in industry loadings on *SMB* and *HML*, and the magnitude of this variation is similar to that inferred from the rolling regressions.

4. Estimating CAPM and three-factor risk loadings for industries

Tables 3 and 4 say that, for many industries, true sensitivities to CAPM and three-factor risks are quite volatile. Moreover, the variation in true risk loadings, and the implied variation in the cost of equity, are surely larger for individual firms. Appendix B explores the effects of time-varying risk loadings on tests of asset pricing models. Here we ask how a manager who is trying to measure the cost of equity should estimate wandering loadings.

For near-term cash flows, the manager wants a current *CE* and thus current true risk loadings. Conditional or rolling regressions, designed to track wandering risk loadings, are likely candidates. The answer for more distant cash flows depends on the behavior of the true risk loadings. If the true loadings are mean-reverting, full-period constant-slope regressions like those in Table 2 are probably best. At the other extreme, if the true risk loadings follow a random walk, current loadings are the best forecasts of all future loadings, and conditional or rolling regressions may be better than full-period constant-slope regressions.

We compare three approaches to estimating risk loadings for near-term and long-term *CE*'s: (i) full-period estimates of the CAPM and three-factor regressions (2) and (4); (ii) three-, four-, and five-year rolling estimates of (2) and (4); and (iii) full-period estimates of the conditional regression (6). We evaluate the precision of the competing risk loadings, for the purpose of estimating near-term and long-term *CE*'s, by examining their ability to explain industry returns next month and at more distant horizons. The idea is that more precise loadings will produce less disperse forecast errors (Gonedes, 1973).

4.1. One-month forecasts

Part A of Table 5 compares the in-sample fits of the full-period, constant-slope, and conditional regressions for July 1968 to December 1994. The results confirm that the conditioning variables improve the fit of the three-factor regressions. Adding ln(*ME*)*SMB* and ln(*BE*/*ME*)*HML* to the full-period constant-slope regressions raises the average R^2 (across industries) from 0.70 to 0.71. The average mean absolute unexplained return, *MA*, falls from 2.72% in the

Table 5
Comparisons of techniques for estimating risk loadings

Part A. $R_M - R_f$, SMB, and HML are defined in Table 1; $\ln(ME)$ and $\ln(BE/ME)$ are defined in Table 4. MA is the mean absolute value of the sum of the intercept and the residuals from an industry regression; $\hat{\sigma}(e)$ is the standard error of the residuals. R^2, MA, and $\hat{\sigma}(e)$ are adjusted for degrees of freedom. The t-statistics are ratios of coefficients to their standard errors, except for the market slope b where the test is that the true slope is one. The statistics shown are averages across industries.

Part B. The one-factor and three-factor regressions are estimated for each industry for each month beginning in 6/68, using a rolling window of three, four, or five years of past monthly returns. The in-sample regression coefficients, and the values of the explanatory variables for the month following the in-sample period, are used to make conditional out-of-sample forecasts of industry returns. The table shows averages, across industries, of the mean (M), mean absolute (MA), and the standard deviation ($\hat{\sigma}(e)$) of the out-of-sample forecast errors for different methods of estimating the in-sample regressions. In the first three columns (OLS, intercept), the forecasts use simple OLS regression coefficients. In the second three columns (OLS, no intercept), the OLS intercept is dropped in the forecasts. In the next three columns (shrunk, no intercept), the forecasts use regression slopes that are shrunk to correct for sampling error. The Bayes shrinkage method is described in Appendix C.

Part A: Full-period constant-slope and conditional regressions: Coefficients, t-statistics (in parentheses), and summary statistics, averaged across 48 industries, 7/68–12/94

$$R_i - R_f = a_i + b_i[R_M - R_f] + [s_{i1} + s_{i2}\ln(ME)_i]\, SMB + [h_{i1} + h_{i2}\ln(BE/ME)_i]\, HML + e_i$$

b	s_1	s_2	h_1	h_2	R^2	a	MA	$\hat{\sigma}(e)$
1.11					0.64	– 0.02	2.96	3.83
(2.35)						(– 0.07)		
1.04	0.38		0.01		0.70	– 0.04	2.72	3.50
(0.92)	(5.35)		(0.15)			(– 0.24)		
1.03	0.21	– 0.25	– 0.03	0.68	0.71	– 0.04	2.68	3.43
(0.81)	(2.25)	(– 1.59)	(– 0.08)	(2.56)		(– 0.21)		

Part B: One-month-ahead forecast errors from rolling regressions, averaged across 48 industries, 7/68–12/94

	OLS						Shrunk, no intercept		
	Intercept			No intercept					
	M	MA	$\hat{\sigma}(e)$	M	MA	$\hat{\sigma}(e)$	M	MA	$\hat{\sigma}(e)$
$R_i - R_f = a_i + b_i[R_M - R_f] + \varepsilon_i$									
3-year rolling	– 0.02	3.00	3.94	0.02	2.97	3.87	0.02	2.95	3.84
4-year rolling	– 0.05	2.99	3.92	0.00	2.97	3.87	0.00	2.95	3.85
5-year rolling	– 0.05	2.98	3.90	0.00	2.96	3.86	0.00	2.96	3.85
$R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + \varepsilon_i$									
3-year rolling	– 0.00	2.81	3.67	– 0.04	2.78	3.62	– 0.04	2.72	3.52
4-year rolling	– 0.00	2.79	3.63	– 0.03	2.77	3.59	– 0.04	2.72	3.52
5-year rolling	0.00	2.76	3.60	– 0.03	2.75	3.57	– 0.03	2.72	3.52

constant-slope regressions to 2.68% in the conditional regressions. The average residual standard deviation, $\hat{\sigma}(e)$, drops from 3.50% to 3.43%. These improvements are small, but they are consistent. The conditional MA is lower than the constant-slope MA for 35 of 48 industries; the conditional $\hat{\sigma}(e)$ is lower than the constant-slope $\hat{\sigma}(e)$ for 39 industries.

In-sample regression fits (not shown) suggest that rolling-regression estimates of risk loadings are a bit better than full-period or conditional estimates. For the 1968–1994 period, the average of the adjusted R^2 for rolling CAPM regressions estimated monthly with five years of returns is 0.65 versus 0.64 for full-period estimates. Similarly, the average R^2 for rolling five-year three-factor regressions, 0.72, is slightly higher than the averages for the full-period, constant-slope, or conditional regressions, 0.70 and 0.71. Because the true CAPM and three-factor slopes vary through time, however, in-sample fits probably exaggerate the precision of the rolling regressions for our problem – estimating risk loadings for future *CE*'s. For this purpose, out-of-sample forecast errors give better perspective on the precision of rolling-regression slopes.

We start with one-month forecasts. To construct them, we estimate CAPM and three-factor regressions each month for each industry using rolling windows of three, four, and five years of past returns. We then use the in-sample regression coefficients and next month's (out-of-sample) explanatory returns to generate out-of-sample forecasts. Because the slope estimates from the rolling regressions are so imprecise, we add a Bayesian wrinkle. More extreme estimates are likely to have more error, so in principle we can improve the rolling-regression slopes by shrinking them toward a grand mean. We use the Bayes shrinkage method of Blattberg and George (1991). The details are in Appendix C.

We consider several versions of the rolling regressions to judge (i) whether out-of-sample forecasts improve when estimation-period intercepts are dropped, (ii) whether Bayes shrinkage of the slopes helps, (iii) whether three-factor regressions forecast better than one-factor regressions, and (iv) whether longer estimation periods improve the out-of-sample forecasts. On the first three questions, the results in part B of Table 5 are clear, but not always overwhelming. (i) In every case, and for both the one-factor and three-factor regressions, suppressing estimation-period intercepts (and so imposing CAPM or three-factor asset pricing) produces forecast errors with less dispersion. The improvements, however, are small (1%–2%). (ii) If we suppress the intercepts, the least disperse forecast errors are obtained when the regression slopes are shrunk to correct for estimation error. But again, the improvements are small. (iii) In every comparison, three-factor regressions produce less disperse forecast errors than one-factor regressions. Here the improvements are larger; the averages of the mean absolute and standard deviations of the one-factor forecast errors are about 10% greater than those of the three-factor regressions.

The one-month forecasts are clean evidence that the three-factor rolling regressions capture return variation missed by the one-factor regressions. The asset pricing evidence from the rolling regressions is, however, weak. In particular, the fact that out-of-sample forecast errors are less disperse when the regression intercepts (one-factor or three-factor) are dropped is not much evidence that the true intercepts are zero. The average standard errors of the intercepts in the in-sample regressions are large (for example, 0.46 for the five-year three-factor regressions). If the true intercepts are small relative to their estimation errors, suppressing the intercepts is likely to improve the out-of-sample forecasts.

The most important result from the rolling regressions is that, for both the CAPM and the three-factor model, forecast quality is insensitive to the length of the regression estimation period. Focusing on the shrunk-no-intercept regressions, which produce the best forecasts, the averages of the mean absolute and standard deviations of the forecast errors are remarkably similar for three-, four-, and five-year estimation periods. Six- to ten-year estimation periods (not shown) produce forecast errors like those of three- to five-year estimation periods. In fact, Table 5 suggests that the forecast power of the regressions does not change if we lengthen the estimation period to the full sample. The averages of MA and $\hat{\sigma}(e)$ for the rolling three-factor regressions, 2.72 and 3.52, are almost identical to those for the full-period constant-slope regressions, 2.72 and 3.50. Similarly, the average MA for the full-period CAPM regressions (2.96) basically matches the rolling-regression estimates (2.95 and 2.96), while the average $\hat{\sigma}(e)$ for the full-period regressions (3.83) is slightly lower than the rolling-regression estimates (3.84 and 3.85).

The bottom line for the CAPM is that, on average, full-period estimates of current industry betas are no better or worse than estimates from three-, four-, and five-year rolling regressions. The insensitivity of forecast quality to the regression estimation period says that noise in the forecasts, caused by increased smoothing of variation in the true betas, just about offsets the increase in precision obtained by extending the estimation period. These results for industries are like those in Gonedes (1973) for individual firms.

The implications of Table 5 for estimates of current three-factor risk loadings are similar. For the typical industry, estimates of three-factor loadings from full-period constant-slope regressions produce forecasts of returns one month ahead that are as accurate as those from rolling regressions, and only slightly less accurate than the forecasts from conditional regressions. The next section asks which approach is best for estimating risk loadings for longer horizons.

4.2. Forecasts for distant horizons

Table 6 examines forecasts of monthly returns up to five years ahead. For the CAPM, the table shows that rolling-regression market slopes are about as good as full-period slopes for forecasts one month ahead, but the full-period slopes dominate at longer forecast horizons. This suggests that the typical industry's

CAPM beta is mean-reverting. The rolling regressions track risk loadings that wander through time. If an industry's true beta is mean-reverting, deviations from the long-term mean are temporary, and estimates from the full-period constant-slope regressions provide better estimates of distant betas. Since, on average, the full-period estimates are as good as the rolling-regression estimates at short horizons, the prescription for the CAPM is simple. Full-period market slopes are typically good choices for estimating CAPM betas and *CE*'s for all future periods.

Table 6
Summary statistics for forecast errors from conditional and rolling regressions and for residuals from full-period constant-slope regressions

$R_M - R_f$, SMB, and HML are defined in Table 1; $\ln(ME)$ and $\ln(BE/ME)$ are defined in Table 4. The conditional regression forecasts for month $t + i$ ($i = 1$, 12, 24, 36, 48, and 60) combine slopes (b, s_1, s_2, h_1, and h_2) estimated from 7/68 to 12/94 with values of $\ln(ME)$ and $\ln(BE/ME)$ for month t, and explanatory returns ($R_M - R_f$, SMB, and HML) for month $t + i$. The rolling-regression forecasts for month $t + i$ use the slopes for months $t - n$ ($n = 36$, 48, and 60) to t and market, SMB, and HML returns for month $t + i$. The slopes in the rolling regressions are shrunk using the Bayes shrinkage method in Appendix C. The one-month-ahead results for the conditional and rolling regressions summarize monthly forecast errors for 7/68 to 12/94. The one-year-ahead results summarize monthly forecast errors for 6/69 to 12/94, and the five-year-ahead results are for 6/73 to 12/94. The full-period constant-slope regression results summarize residuals from regressions estimated over the same periods as the conditional and rolling-regression forecast errors. For example, the summary statistics in the one-year column describe the residuals from constant-slope regressions estimated using monthly observations for 6/69 to 12/94. Since they summarize regression residuals, we adjust for degrees of freedom when calculating the mean absolute and standard deviation measures for the constant-slope regressions and for the one-month-ahead conditional regressions. The results are averages across the 48 industries.

One-factor regressions: $R_i - R_f = a_i + b_i[R_M - R_f] + e_i$

	Forecast horizon					
	1 month	1 year	2 years	3 years	4 years	5 years
Average mean absolute forecast error (or residual plus intercept)						
3-year rolling	2.95	2.99	2.99	2.99	3.02	3.02
4-year rolling	2.95	2.98	2.98	2.99	3.01	3.02
5-year rolling	2.96	2.98	2.99	2.99	3.01	3.02
Full period	2.96	2.97	2.96	2.95	2.97	2.97
Average standard deviation of forecast errors (or residuals)						
3-year rolling	3.84	3.89	3.88	3.89	3.92	3.93
4-year rolling	3.85	3.87	3.88	3.89	3.92	3.93
5-year rolling	3.85	3.88	3.89	3.88	3.91	3.93
Full period	3.83	3.84	3.83	3.82	3.84	3.84

Table 6 (continued)

Three-factor regressions

Rolling and full-period constant-slope: $R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$

Conditional: $R_i - R_f = a_i + b_i[R_M - R_f] + [s_{i1} + s_{i2}\ln(ME)_i]SMB$
$+ [h_{i1} + h_{i2}\ln(BE/ME)_i]HML + e_i$

	Forecast horizon					
	1 month	1 year	2 years	3 years	4 years	5 years
Average mean absolute forecast error (or residual plus intercept)						
Conditional	2.68	2.67	2.71	2.72	2.74	2.77
3-year rolling	2.72	2.78	2.80	2.84	2.86	2.89
4-year rolling	2.72	2.77	2.80	2.83	2.85	2.89
5-year rolling	2.72	2.77	2.80	2.82	2.85	2.88
Full period	2.72	2.73	2.74	2.74	2.75	2.77
Average standard deviation of forecast error (or residual)						
Conditional	3.43	3.45	3.49	3.50	3.53	3.58
3-year rolling	3.52	3.60	3.64	3.68	3.72	3.75
4-year rolling	3.52	3.59	3.64	3.67	3.70	3.74
5-year rolling	3.52	3.59	3.63	3.66	3.69	3.73
Full period	3.50	3.50	3.50	3.51	3.52	3.54

The three-factor regression results in Table 6 also suggest some mean reversion in industry loadings on $R_M - R_f$, SMB, and HML. The performance of the conditional and rolling three-factor regressions deteriorates for forecasts further into the future. Since the quality of the full-period constant-slope forecasts also falls a bit, part of the deterioration of the conditional- and rolling-regression forecasts occurs simply because the sample months differ across forecast horizons. But the full-period constant-slope forecasts do not deteriorate as much as the conditional- and rolling-regression forecasts, which suggests some mean reversion in risk loadings. Consistent with this conclusion, beyond two years the forecasts from the full-period constant-slope regressions are about as good as (but no better than) those from the conditional regressions (which are always a bit better than the forecasts from the rolling regressions).

Table 6 also suggests, however, that reversion to constant means is not a universal property of industry three-factor risk loadings. With true mean reversion, the constant-slope regressions should provide better forecasts than the conditional regressions at distant horizons. At least for horizons out to five years, they do not. A likely explanation is that the conditional three-factor regressions capture some permanent changes in risk loadings that are missed by the full-period constant-slope regressions.

4.3. Complications

The message from Tables 5 and 6 about the choice of betas to be used in estimates of CAPM costs of equity (*CE*'s) is relatively simple. For the typical industry, the full-period market slope is a good choice for estimating both near-term and distant betas. (We leave open, of course, the possibility that for some industries shifting demand and supply conditions produce nonstationarity in true betas that would favor the rolling regressions for estimates of both near-term and distant *CE*'s.)

The implications of Tables 5 and 6 for estimating three-factor *CE*'s are more complicated. The tables suggest that for the typical industry the time-varying slopes from the conditional three-factor regression (6) should be used to estimate three-factor *CE*'s for near horizons (up to two years). At longer horizons, estimates from the constant-slope regression (4) are as precise as those from the conditional regression. Statistical or economic evidence of mean reversion in an industry's three-factor slopes would push the choice for longer horizons toward constant-slope estimates. Evidence of permanent shifts in demand or supply conditions that produce nonstationarity in true three-factor slopes would favor the conditional (or rolling) regressions for estimates of both near-term and distant *CE*'s.

Even for near horizons other considerations might make three-factor *CE*'s from full-period constant-slope regressions better than conditional estimates. Table 6 says that, for forecasts one month ahead, the full-period constant-slope regressions are only a bit worse than the conditional regressions. This suggests that using full-period constant-slope *CE*'s to value near-term cash flows will not produce substantially less precise estimates of value than conditional-regression *CE*'s. Moreover, spurious variability in conditional *CE*'s can create startup and shutdown costs that are avoided with estimates from full-period constant-slope regressions. Such costs favor full-period constant-slope *CE*'s over conditional *CE*'s.

The conditional regressions have another weakness if used at the firm level. Managers have at least partial control of a firm's size (*ME*) and book-to-market-equity (*BE*/*ME*). If a firm uses a conditional regression to track its wandering risk loadings, management could change the estimated cost of equity by changing the firm's *ME* or *BE*/*ME*. Such gaming of the conditional regression would create more noise in *CE* estimates and bias the projects that are accepted. To avoid such problems, firms might be better off using full-period constant-slope *CE*'s for capital budgeting.

5. Industry costs of equity

Tables 5 and 6 do not identify clear winners among alternative slope estimates for CAPM and three-factor *CE*'s. For long horizons, CAPM betas from full-period regressions produce return forecasts that are a bit more accurate than those from rolling regressions, but for all horizons the advantages of one approach over the other are small. Similarly, for near horizons, three-factor conditional regressions produce slightly more accurate return forecasts than full-period constant-slope regressions, but the differences between the two approaches, and their advantages over rolling regressions, are always small. Although the statistical evidence from the forecasts does not clearly identify the best approach to estimating risk loadings, we show next that the choice is of some consequence. Competing approaches often produce much different *CE*'s, especially for the three-factor model.

5.1. Comparisons of alternative CAPM and three-factor CE's

Table 7 shows two estimates of the risk premiums (expected returns in excess of the risk-free rate) in CAPM *CE*'s and three estimates of the risk premiums in three-factor *CE*'s for each of the 48 industries. Two estimates use the slopes from the full-period constant-slope CAPM and three-factor regressions, (2) and (4). Two *CE*'s use shrunk CAPM and three-factor slopes estimated on the five years of monthly returns ending in December 1994. The fifth estimate combines slopes from the conditional regression (6) with values of the conditioning variables, $\ln(ME)$ and $\ln(BE/ME)$, for December 1994.

For the CAPM, most of the differences between the *CE*'s from the full-period constant-slope regressions and the end-of-period rolling regressions are modest. The two CAPM *CE*'s differ by more than 1% per year for only 11 of 48 industries; the two *CE*'s never differ by more than 2%. Differences among the alternative three-factor *CE*'s tend to be larger. The full-period estimate from the constant-slope regression (4) and the end-of-period estimate from the conditional regression (6) differ by more than 1% per year for 25 of 48 industries and by more than 2% for eight industries. Thus, for many industries, the essentially arbitrary choice between constant-slope and conditional-regression three-factor *CE*'s can lead to substantially different valuations of investment projects.

The differences in three-factor *CE*'s are driven by differences in the estimates of *SMB* and *HML* slopes. Health Care, Personal Services, and Gold are examples. Their end-of-sample values of $\ln(ME)$ are below their full-period averages. As a result, their conditional *SMB* slopes for December 1994 are above the estimates from full-period constant-slope regressions, and their conditional *CE*'s are above their constant-slope *CE*'s. Computers, Machinery, and Coal illustrate the opposite case. Firms in these industries are relatively large in December 1994, their conditional *SMB* slopes are below their full-period slopes, and their conditional three-factor *CE*'s are below their full-period *CE*'s.

For many industries, the conditional *SMB* and *HML* slopes for December 1994 both differ a lot from their full-period counterparts. Business Services and

Table 7

Regression slopes and risk premiums in CAPM and three-factor costs of equity

The industries are defined in Appendix A. The risk premiums (*CE*'s) in the cost of equity are obtained by substituting the regression slopes in the table and the average monthly $R_M - R_f$, *SMB*, and *HML* returns for 7/63 to 12/94 (Table 1) into (2) and (4) and then multiplying by 12. The full-period *CE*'s use the slopes from (2) and (4) for 7/63 to 12/94 in Table 2. The five-year *CE*'s use shrunk CAPM and three-factor slopes (see Appendix C) estimated on the five years of monthly returns ending in 12/94. The conditional *CE*'s use the slopes from (6) for 7/65 to 12/94. For these estimates, $s = s_1 + s_2 \ln(ME)$ and $h = h_1 + h_2 \ln(BE/ME)$, where s_1, s_2, h_1, and h_2 are slopes from Table 4, and $\ln(ME)$ and $\ln(BE/ME)$ are for 12/94.

	CAPM				Three-factor								
	Full-period		Five-year		Full-period				Conditional				Five-year
Industry	*CE*	*b*	*CE*	*b*	*CE*	*b*	*s*	*h*	*CE*	*b*	*s*	*h*	*CE*
Drugs	4.71	0.92	5.35	1.05	0.09	0.84	−0.25	−0.63	2.60	0.86	−0.26	−0.18	−0.46
MedEq	5.99	1.17	6.09	1.19	2.64	0.99	0.26	−0.60	4.73	1.01	0.41	−0.32	1.25
Hlth	7.95	1.56	6.77	1.33	6.14	1.24	0.93	−0.59	4.97	1.20	0.62	−0.59	4.29
Comps	5.29	1.04	5.47	1.07	2.49	0.90	0.17	−0.49	4.34	0.90	0.54	−0.37	5.66
Chips	7.04	1.38	6.14	1.20	6.01	1.15	0.69	−0.39	7.07	1.15	0.56	−0.11	9.23
BusSv	6.83	1.34	6.27	1.23	6.51	1.13	0.72	−0.29	4.21	1.11	0.26	−0.43	4.99
LabEq	6.59	1.29	5.92	1.16	5.80	1.13	0.49	−0.29	6.31	1.12	0.55	−0.22	6.56
Hshld	4.96	0.97	5.24	1.03	3.19	0.91	0.00	−0.27	3.97	0.93	0.01	−0.15	5.12
Meals	6.75	1.32	6.73	1.32	6.81	1.12	0.74	−0.24	7.23	1.12	0.56	−0.05	8.24
Beer	4.69	0.92	5.16	1.01	2.99	0.90	−0.13	−0.22	1.78	0.92	−0.30	−0.36	1.98
PerSv	6.40	1.25	5.20	1.02	7.26	1.00	1.00	−0.20	5.92	0.99	0.66	−0.23	5.10
Cnstr	6.52	1.28	6.42	1.26	6.42	1.21	0.21	−0.09	9.69	1.23	0.77	0.17	8.68
Rtail	5.68	1.11	5.96	1.17	5.88	1.04	0.27	−0.06	5.65	1.05	0.28	−0.12	4.51
Fun	6.91	1.35	6.04	1.18	8.43	1.17	0.83	−0.04	7.68	1.17	0.73	−0.12	9.32
Food	4.44	0.87	4.97	0.97	4.09	0.88	−0.07	−0.03	2.48	0.87	−0.30	−0.18	0.90
Agric	5.11	1.00	4.98	0.97	6.51	0.85	0.71	−0.02	6.03	0.84	0.60	−0.04	5.65
Mach	5.93	1.16	5.49	1.08	6.46	1.11	0.25	−0.00	7.54	1.12	0.45	0.07	9.09
Books	5.98	1.17	5.59	1.10	6.96	1.08	0.45	0.00	7.08	1.06	0.23	0.17	7.23
Aero	6.43	1.26	4.98	0.97	7.54	1.15	0.51	0.00	7.57	1.15	0.20	0.20	5.25

Coal	4.90	0.96	4.41	0.86	5.97	0.86	0.46	0.01	7.42	0.87	0.71	0.13	5.39
Guns	5.29	1.04	4.01	0.79	6.25	0.95	0.41	0.01	6.43	0.93	0.21	0.19	4.24
Whlsl	5.90	1.15	5.33	1.04	7.52	1.01	0.71	0.01	7.03	0.99	0.69	−0.04	5.42
Fin	5.95	1.16	6.99	1.37	6.72	1.11	0.30	0.02	6.95	1.10	0.35	0.03	7.58
ElcEq	5.86	1.15	5.91	1.16	5.98	1.15	−0.00	0.02	6.05	1.16	−0.04	0.05	6.43
Boxes	5.24	1.03	3.94	0.77	5.77	0.99	0.17	0.02	5.70	1.00	0.17	0.01	4.14
BldMt	5.76	1.13	5.19	1.02	6.40	1.11	0.15	0.05	6.74	1.12	0.16	0.10	5.93
Insur	5.14	1.01	5.97	1.17	5.72	1.00	0.09	0.06	6.23	0.99	0.08	0.17	6.44
Gold	3.98	0.78	3.33	0.65	5.35	0.71	0.40	0.08	4.29	0.68	0.25	0.00	6.13
Misc	6.43	1.26	5.81	1.14	9.56	1.03	1.19	0.08	8.13	1.03	1.26	−0.22	8.92
Trans	6.17	1.21	5.92	1.16	7.39	1.16	0.30	0.09	7.30	1.16	0.38	0.03	7.78
Rubbr	6.16	1.21	6.37	1.25	7.78	1.12	0.49	0.09	6.73	1.15	0.37	−0.06	7.11
FabPr	6.71	1.31	5.81	1.14	9.69	1.11	1.10	0.09	8.82	1.09	0.92	0.05	5.24
Clths	6.33	1.24	6.80	1.33	8.85	1.09	0.83	0.11	6.37	1.07	0.68	−0.24	6.28
Chem	5.57	1.09	5.44	1.06	6.58	1.13	−0.03	0.17	6.60	1.13	−0.05	0.18	6.13
Toys	6.83	1.34	5.11	1.00	10.01	1.17	0.97	0.17	7.75	1.16	0.77	−0.12	5.43
Ships	6.07	1.19	4.86	0.95	8.63	1.09	0.66	0.17	5.85	1.03	0.69	−0.31	8.99
Soda	6.35	1.24	6.04	1.18	8.46	1.19	0.44	0.18	7.15	1.18	0.34	0.00	7.04
Enrgy	4.32	0.85	3.22	0.63	4.93	0.96	−0.35	0.21	6.22	0.94	−0.49	0.55	4.80
Mines	4.99	0.98	3.38	0.66	7.65	0.91	0.53	0.23	6.96	0.91	0.66	0.03	7.85
Smoke	4.08	0.80	5.01	0.98	5.56	0.86	−0.04	0.24	4.72	0.83	−0.27	0.25	2.02
Paper	5.68	1.11	5.22	1.02	7.78	1.14	0.16	0.27	7.42	1.14	0.12	0.22	6.67
Txtls	5.71	1.12	6.00	1.17	9.18	1.03	0.71	0.30	7.60	1.02	0.79	−0.03	9.12
Banks	5.55	1.09	6.53	1.28	8.08	1.13	0.13	0.35	9.19	1.15	0.12	0.54	9.88
Telcm	3.39	0.66	4.49	0.88	5.17	0.79	−0.23	0.35	3.74	0.79	−0.38	0.17	5.34
Util	3.39	0.66	3.25	0.64	5.41	0.79	−0.20	0.38	6.74	0.78	−0.06	0.54	3.79
RlEst	5.99	1.17	5.19	1.02	11.16	1.01	1.18	0.40	11.55	1.00	1.27	0.43	9.00
Steel	5.94	1.16	5.43	1.06	9.61	1.17	0.40	0.43	9.12	1.16	0.57	0.25	9.13
Autos	5.13	1.01	5.24	1.03	9.39	1.10	0.17	0.60	5.12	1.12	0.37	−0.33	11.74

Construction are extreme examples. The December 1994 slopes on *SMB* and *HML* from the conditional regression for Business Services (0.26 and − 0.43) are much lower than the full-period slopes (0.72 and − 0.29), so the conditional three-factor *CE* (4.21%) is much lower than the constant-slope *CE* (6.51%). Similarly, the December 1994 conditional *SMB* and *HML* slopes for Construction (0.77 and 0.17) are much higher than the full-period slopes (0.21 and − 0.09), so the December 1994 conditional *CE* (9.69%) is much higher than the full-period *CE* (6.42%).

Finally, there are also large differences between the three-factor *CE*'s for December 1994 from the conditional and five-year rolling regressions. The estimates differ by more than 1% per year for 27 industries and by more than 2% for 13 industries. For Drugs, Medical Equipment, Fabricated Products, Shipping, and Autos, the conditional and rolling-regression *CE*'s for December 1994 differ by more than 3%. The forecast tests in Tables 5 and 6 suggest that the conditional regressions provide slightly more precise estimates of near-term *CE*'s than the rolling regressions, but there is much uncertainty about which is better. Unfortunately, Table 7 says the choice can have large consequences.

5.2. CAPM and three-factor CE's

As one might expect, there are also large differences between CAPM and three-factor *CE*'s. The full-period CAPM and three-factor *CE*'s differ by more than 2% for 17 industries and by more than 3% for eight industries. The five-year CAPM and three-factor *CE*'s differ by more than 2% for 19 industries and by more than 3% for 15 industries. For many industries, the choice of a CAPM or three-factor cost of equity will have a large impact on the valuation of investments.

The differences between the three-factor and CAPM *CE*'s are largely determined by the *SMB* and *HML* slopes in the three-factor regressions. Some industries have *SMB* and *HML* slopes close to zero, so their CAPM and three-factor *CE*'s are similar. Focusing on the full-period constant-slope regressions, this group includes Food, Machinery, Electrical Equipment, Boxes, Building Materials, and Insurance. Other industries have similar full-period CAPM and three-factor *CE*'s because their *SMB* and *HML* slopes offset. This group includes Business Services, Meals (Restaurant Services), Construction, and Retailers.

More numerous and interesting are the industries for which three-factor and CAPM *CE*'s differ a lot. For example, the health industries (Health Services, Medical Equipment, and Drugs) and the high-tech industries (Computers, Chips, and Laboratory Equipment) have lower full-period three-factor *CE*'s, largely due to strong negative loadings on *HML*. The three-factor model identifies these as industries with strong growth prospects during the sample period and rewards them with three-factor costs of equity that are lower than their CAPM *CE*'s. On the other hand, many industries have full-period three-factor *CE*'s that are at least 2% higher than their CAPM *CE*'s. Mining, Textiles, Banking, Real Estate, Steel, and Autos are examples. The three-factor model assigns high costs of equity to these industries because their returns covary with the returns on small stocks (they have large positive slopes on *SMB*) and because they behave like distressed stocks (they have large positive slopes on *HML*).

Finally, there is more cross-industry variation in three-factor *CE*'s than in CAPM *CE*'s. For example, the range of the full-period three-factor estimates, 0.09% to 11.16%, dwarfs that of the full-period CAPM estimates, 3.39% to 7.95%. Part of the dispersion of the three-factor *CE*'s is caused by estimation error in *SMB* and *HML* slopes. For the purpose of estimating an industry's average *CE* over the sample period, however, the full-period *SMB* and *HML* slopes are rather precise; their average standard errors are 0.07. Thus, much of the higher dispersion of the three-factor *CE*'s reflects true differences in the risk loadings of the two asset pricing models.

6. Estimating factor risk premiums

Imprecise risk loadings imply economically important uncertainty about *CE*'s. But the risk loadings are in fact a small part of the *CE* estimation problem. Uncertainty about the market, *SMB*, and *HML* premiums in the CAPM and the three-factor model is more important.

The *CE*'s in Table 7 estimate the annual factor risk premiums by annualizing the average monthly premiums for July 1963 to December 1994 in Table 1. The annualized standard errors (12 times the monthly standard errors) of the market, *SMB*, and *HML* premiums are 2.71%, 1.77%, and 1.58%. These large standard errors are, of course, examples of the general imprecision of estimates of expected stock returns (Merton, 1980). They imply that, even if we knew true risk loadings, estimates of CAPM and three-factor *CE*'s would be unavoidably imprecise.

For example, the annualized average market premium for 1963–1994 is 5.16% per year. The standard error of the premium, 2.71%, implies that the one-standard-error bounds on the CAPM *CE* of a project known to have a true beta equal to 1.0 are 2.45% to 7.87% per year. The two-standard-error bounds are −0.26% to 10.58%. These estimates clearly imply extreme imprecision in the values assigned to investment projects.

At the risk of beating a horse already dead, there is another problem in estimates of factor risk premiums. There is evidence that the expected market premium, $E(R_M) - R_f$, varies through time. (See Fama and French, 1989, and the references therein.) Predictable variation in $E(R_M) - R_f$ and in the expected

SMB and *HML* returns[2] should in principle be incorporated in *CE* estimates (Brennan, 1995). There is, however, much controversy about the extent of the variation in the expected market premium, due (once again) to the imprecision of the relevant parameter estimates. As a result, the evidence is consistent with a wide range of estimates of the time variation in the expected premium. Again, different estimates can produce big differences in estimated *CE*'s and in the values assigned to investment projects.

7. Standard errors for *CE* estimates

Though the preceding discussion gives strong clues, it is interesting to examine more formally how uncertainty about risk loadings combines with uncertainty about factor risk premiums to determine the overall imprecision of *CE* estimates.

The error in the estimate of an industry's CAPM *CE* is

$$\begin{aligned} e(\text{CAPM}\, CE) &= \hat{b}\, \overline{R_{\mathrm{M}} - R_{\mathrm{f}}} - b\mathrm{E}(R_{\mathrm{M}} - R_{\mathrm{f}}) \\ &= (b + u_b)\,[\mathrm{E}(R_{\mathrm{M}} - R_{\mathrm{f}}) + u_{\mathrm{M}}] - b\mathrm{E}(R_{\mathrm{M}} - R_{\mathrm{f}}) \\ &= u_b\,\mathrm{E}(R_{\mathrm{M}} - R_{\mathrm{f}}) + u_{\mathrm{M}} b + u_b u_{\mathrm{M}}\,, \end{aligned}$$

where $\overline{R_{\mathrm{M}} - R_{\mathrm{f}}}$ is the estimated market premium, u_{M} is the error in this estimate, $\hat{b}$ is the estimated market slope, and u_b is the error in the slope. If the joint distribution of security returns is multivariate normal, u_{M} and u_b are uncorrelated, and the standard error of the *CE* is

$$\begin{aligned} se(\text{CAPM}\, CE) = [&\mathrm{E}(R_{\mathrm{M}} - R_{\mathrm{f}})^2 \mathrm{var}(u_b) + b^2 \mathrm{var}(u_{\mathrm{M}}) \\ &+ \mathrm{var}(u_b)\,\mathrm{var}(u_{\mathrm{M}})]^{1/2}\,. \end{aligned} \tag{7}$$

Similarly, the standard error of a three-factor *CE* depends on the covariance matrix of the estimation errors of the factor loadings and the covariance matrix of the factor risk premiums. (See Table 8.)

Table 8 reports averages (across industries) of the standard errors of CAPM and three-factor *CE*'s under a variety of assumptions about the precision of estimates of factor risk loadings and risk premiums. At one extreme, the table shows that if there is no uncertainty about the market premium, and if the CAPM betas of industries are constant, then estimates of CAPM *CE*'s are precise. In particular, using the full-period CAPM betas and ignoring uncertainty about the market premium, the average standard error of CAPM industry

[2]Without showing the details, we can report that *SMB* and especially *HML* seem less predictable than the market premium, at least with dividend yields and the common interest rate variables that seem to forecast the market premium.

Table 8
Averages across industries of standard errors of CAPM and three-factor *CE*'s

The standard error for an industry's CAPM *CE* is

$$se(CAPM\ CE) = [(\overline{R_M - R_f})^2 \operatorname{var}(u_b) + \hat{b}^2 \operatorname{var}(u_M) + \operatorname{var}(u_b)\operatorname{var}(u_M)]^{1/2},$$

where $\overline{R_M - R_f}$ is the annualized average market premium for 7/63 to 12/94, $\operatorname{var}(u_M)$ is the annualized variance of the average market premium, $\hat{b}$ is the market slope from the industry's full-period CAPM regression, and $\operatorname{var}(u_b)$ is the variance of the error of the slope. The standard error for a three-factor *CE* is

$$se(\text{3-factor } CE) = [Prem' \operatorname{var}(u_\gamma)\, Prem + \gamma' \operatorname{var}(u_{Prem})\, \gamma + \boldsymbol{l}' [\operatorname{var}(u_{Prem}) \square \operatorname{var}(u_\gamma)] \boldsymbol{l}]^{1/2},$$

where $Prem = [\overline{R_M - R_F}\ \overline{SMB}\ \overline{HML}]'$ is a vector of the annualized average market, *SMB*, and *HML* premiums for 7/63 to 12/94, $\operatorname{var}(u_{Prem})$ is the annualized covariance matrix of the premiums, γ is the vector of the market, *SMB*, and *HML* slopes from the industry's full-period regression, $\operatorname{var}(u_\gamma)$ is the covariance matrix of the sampling errors in the slopes, $\boldsymbol{l}$ is a vector of *l*'s, and $a \square b$ means each element of *a* is multiplied by the corresponding element of *b*.

We consider two measures of $\operatorname{var}(u_M)$ or $\operatorname{var}(u_{Prem})$. The first (rows 1 and 2) assumes the expected premiums are measured perfectly, so $\operatorname{var}(u_M)$ and $\operatorname{var}(u_{Prem})$ are zero. The second (rows 3–5) uses the variance or the covariance matrix of the historical average premiums. We also consider three estimators of $\operatorname{var}(u_b)$ or $\operatorname{var}(u_\gamma)$ for each industry. The first (row 3) assumes the slopes are measured perfectly, so $\operatorname{var}(u_b)$ and $\operatorname{var}(u_\gamma)$ are zero. The second (rows 1 and 4) uses the variance of beta, or the covariance matrix of the slopes, from full-period regressions. The third (rows 2 and 5) uses the average variance of beta, or the average covariance matrix of the slopes, from each industry's three-year rolling CAPM or three-factor regressions.

	CAPM	Three-factor
No error in risk premiums		
Covariance matrix of slopes from:		
(1) Full-period regressions	0.23	0.54
(2) Rolling 3-year regressions	0.78	1.99
Risk premiums estimated with error		
(3) No error in slopes	3.01	3.17
Covariance matrix of slopes from:		
(4) Full-period regressions	3.03	3.23
(5) Rolling 3-year regressions	3.15	3.85

CE's is only 0.23% per year. Still ignoring uncertainty about the market premium, but using three-year rolling regressions to allow for time-varying true betas, the average standard error of CAPM *CE*'s rises from 0.23% to 0.78% per year. Even if the market premium is known, wandering betas in themselves produce substantial uncertainty about *CE*'s, and thus about estimates of project values.

Uncertainty about CAPM *CE*'s due to imprecise beta estimates is, however, small relative to the problem caused by the imprecision of the market risk premium. Table 8 shows that if we treat industry betas as known constants, the estimation error of the market premium in itself produces standard errors of CAPM *CE*'s that average a whopping 3.01% per year. [The average industry beta in (7) is greater than one.] Moreover, given the uncertainty about the market premium, the marginal effect of beta uncertainty is small. Using the three-year rolling regressions to allow for uncertainty about beta due to estimation error and time-varying true betas only raises the average standard error of the CAPM *CE*'s from 3.01% to 3.15%.

Since the imprecision of CAPM *CE*'s is largely due to uncertainty about the market premium, all the industry *CE*'s have large standard errors. When the full-period regressions are used to measure beta uncertainty, the standard errors of the CAPM *CE*'s for 29 of 48 industries (not shown) are above 3.0%. When the rolling three-year regressions are used, 31 industries have CAPM standard errors above 3.0% per year.

Table 8 shows that uncertainty about risk loadings is somewhat more important in the imprecision of three-factor *CE*'s. Again, however, uncertainty about factor risk premiums in itself creates massive uncertainty about three-factor *CE*'s, and thus about project values. When we only allow for the imprecision of the premiums, the average standard error of the three-factor industry *CE*'s is huge, 3.17% per year. When we use the three-year rolling-regression slopes to also allow for uncertainty about risk loadings, the average standard error of the three-factor *CE*'s rises to 3.85% per year. Thus, given the uncertainty about factor risk premiums, the marginal effect of uncertainty about risk loadings is again relatively small.

8. Conclusions

Estimates of the cost of equity are distressingly imprecise. Standard errors of more than 3.0% per year are typical when we use the CAPM or the three-factor model to estimate industry *CE*'s. These large standard errors are driven primarily by uncertainty about true factor risk premiums, with some help from imprecise estimates of period-by-period risk loadings. Since the risk loadings for individual firms or projects are less precise than those of industries, the standard errors of *CE*'s for firms or projects are even larger.

Uncertainty about the true asset pricing model adds further to the uncertainty about project values. For example, though they share the same estimate of the market risk premium, the CAPM and three-factor *CE*'s of many industries differ by more than 2.0% per year. And denominator uncertainty is, of course, only half of the project valuation problem. Uncertainty about the cashflow estimates in the numerator also creates first-order imprecision in estimates of project values.

Project valuation is central to the success of any firm. Our message is that the task is beset with massive uncertainty. The question then is whether there is an approach that values projects with less error than its competitors. Is the net-present-value approach, advocated with zeal by textbooks, typically more accurate than a less complicated approach, like payback? And how would one tell? Our guess is that whatever the formal approach two of the ubiquitous tools in capital budgeting are a wing and a prayer, and serendipity is an important force in outcomes.

Appendix A

We use four-digit SIC codes to assign firms to 48 industries. The industries (short name, long name, and SIC codes) are:

Agric	Agriculture	0100–0799, 2048–2048
Food	Food Products	2000–2046, 2050–2063, 2070–2079, 2090–2095, 2098–2099
Soda	Candy and Soda	2064–2068, 2086–2087, 2096–2097
Beer	Alcoholic Beverages	2080–2085
Smoke	Tobacco Products	2100–2199
Toys	Recreational Products	0900–0999, 3650–3652, 3732–3732, 3930–3949
Fun	Entertainment	7800–7841, 7900–7999
Books	Printing and Publishing	2700–2749, 2770–2799
Hshld	Consumer Goods	2047–2047, 2391–2392, 2510–2519, 2590–2599, 2840–2844, 3160–3199, 3229–3231, 3260–3260, 3262–3263, 3269–3269, 3630–3639, 3750–3751, 3800–3800, 3860–3879, 3910–3919, 3960–3961, 3991–3991, 3995–3995
Clths	Apparel	2300–2390, 3020–3021, 3100–3111, 3130–3159, 3965–3965
Hlth	Healthcare	8000–8099
MedEq	Medical Equipment	3693–3693, 3840–3851
Drugs	Pharmaceutical Products	2830–2836
Chems	Chemicals	2800–2829, 2850–2899
Rubbr	Rubber and Plastic Products	3000–3000, 3050–3099
Txtls	Textiles	2200–2295, 2297–2299, 2393–2395, 2397–2399
BldMt	Construction Materials	0800–0899, 2400–2439, 2450–2459, 2490–2499, 2950–2952, 3200–3219, 3240–3259, 3261–3261, 3264–3264,

		3270–3299, 3420–3442, 3446–3452, 3490–3499, 3996–3996
Cnstr	Construction	1500–1549, 1600–1699, 1700–1799
Steel	Steel Works, Etc.	3300–3369, 3390–3399
FabPr	Fabricated Products	3400–3400, 3443–3444, 3460–3479
Mach	Machinery	3510–3536, 3540–3569, 3580–3599
ElcEq	Electrical Equipment	3600–3621, 3623–3629, 3640–3646, 3648–3649, 3660–3660, 3691–3692, 3699–3699
Misc	Miscellaneous	3900–3900, 3990–3990, 3999–3999, 9900–9999
Autos	Automobiles and Trucks	2296–2296, 2396–2396, 3010–3011, 3537–3537, 3647–3647, 3694–3694, 3700–3716, 3790–3792, 3799–3799
Aero	Aircraft	3720–3729
Ships	Shipbuilding, Railroad Eq	3730–3731, 3740–3743
Guns	Defense	3480–3489, 3760–3769, 3795–3795
Gold	Precious Metals	1040–1049
Mines	Nonmetallic Mining	1000–1039, 1060–1099, 1400–1499
Coal	Coal	1200–1299
Enrgy	Petroleum and Natural Gas	1310–1389, 2900–2911, 2990–2999
Util	Utilities	4900–4999
Telcm	Telecommunications	4800–4899
PerSv	Personal Services	7020–7021, 7030–7039, 7200–7212, 7215–7299, 7395–7395, 7500–7500, 7520–7549, 7600–7699, 8100–8199, 8200–8299, 8300–8399, 8400–8499, 8600–8699, 8800–8899
BusSv	Business Services	2750–2759, 3993–3993, 7300–7372, 7374–7394, 7397–7397, 7399–7399, 7510–7519, 8700–8748, 8900–8999
Comps	Computers	3570–3579, 3680–3689, 3695–3695, 7373–7373
Chips	Electronic Equipment	3622–3622, 3661–3679, 3810–3810, 3812–3812
LabEq	Measuring and Control Equip	3811–3811, 3820–3830
Paper	Business Supplies	2520–2549, 2600–2639, 2670–2699, 2760–2761, 3950–3955
Boxes	Shipping Containers	2440–2449, 2640–2659, 3210–3221, 3410–3412
Trans	Transportation	4000–4099, 4100–4199, 4200–4299, 4400–4499, 4500–4599, 4600–4699, 4700–4799

Whlsl	Wholesale	5000–5099, 5100–5199
Rtail	Retail	5200–5299, 5300–5399, 5400–5499, 5500–5599, 5600–5699, 5700–5736, 5900–5999
Meals	Restaurants, Hotel, Motel	5800–5813, 5890–5890, 7000–7019, 7040–7049, 7213–7213
Banks	Banking	6000–6099, 6100–6199
Insur	Insurance	6300–6399, 6400–6411
RlEst	Real Estate	6500–6553
Fin	Trading	6200–6299, 6700–6799

Appendix B

Temporal variation in true risk loadings complicates tests of asset pricing models. This appendix explores this problem in the context of tests of the three-factor model on industries.

B.1. The negative correlation between intercepts and slopes

The full-period regressions in Table 2 reject the three-factor model. The F-test of Gibbons, Ross, and Shanken (1989) rejects the hypothesis that the intercepts in (4) are zero for all industries at the 0.0003 level.

The rejection of the three-factor model seems to be driven by the strong negative correlation between the three-factor intercepts, a_i, and the HML slopes, h_i. The observed correlation, -0.65, is much stronger than the correlation, -0.22, implied by the sample covariance matrix of the explanatory variables under the hypothesis that the regression coefficients are constant through time and the same for all industries. To highlight the correlation between h_i and a_i, Table 2 sorts industries on their HML slopes. All positive three-factor intercepts more than two standard errors from zero are associated with negative HML slopes; all negative intercepts more than two standard errors from zero are associated with positive HML slopes. Real Estate produces the most extreme negative intercept, -1.01% per month ($t = -5.45$), and the third largest HML slope, 0.40. The drug industry produces the largest positive intercept, 0.61% per month ($t = 3.88$), and the lowest HML slope, -0.63.

Negative correlation between abnormal returns and slopes is not special to the HML slopes in Table 2. The correlation between the intercepts and market slopes in the CAPM regressions, -0.26, is more negative than the estimated correlation of their sampling errors, -0.10. Similarly, the correlations between the intercepts and the $R_M - R_f$ and SMB slopes in the three-factor regressions,

-0.27 and -0.44, are also more negative than the estimated correlations of their sampling errors, -0.14 and -0.06.

There are at least two interpretations of these negative correlations. First, perhaps the risk premiums in the CAPM and the three-factor model are overstated. For example, if the three-factor model overstates the risk premium associated with distress, it will overpredict the returns on industries with high *HML* loadings and underpredict the returns on industries with low *HML* loadings.

The alternative interpretation is that the negative correlations between intercepts and slopes are driven by time-varying risk loadings. Specifically, we argue that the negative relation between abnormal returns and *HML* loadings is a natural consequence of the dynamics of growth and distress. Consider an industry that becomes distressed. In the three-factor model, one result of distress is an increase in h_i, the industry's loading on *HML*. If the industry's bad times are unexpected, the increase in h_i is probably accompanied by negative abnormal returns in (4). Conversely, the surprise onset of good times likely implies a decline in an industry's *HML* loading and positive abnormal returns. Extending the argument, industries that on balance have more surprise bad times than good times during our sample period are more likely to have positive *HML* slopes and negative intercepts in estimates of (4). Industries whose cumulative shocks are positive probably have negative *HML* slopes and positive intercepts.

This argument is not limited to the *HML* slopes. The negative correlations between the intercepts and the market and *SMB* slopes are consistent with the hypothesis that bad news about future cash flows also tends to raise an industry's risk loadings on these factors. In addition, increases in risk loadings raise discount rates and lower current prices. Both effects create negative correlation between abnormal returns and factor risks. Chan (1988) and Ball and Kothari (1989) make a similar point about CAPM market betas.

In sum, we hypothesize that in three-factor regressions like those in Table 2, industries with large positive *HML* slopes are more likely to have experienced surprise distress and negative abnormal average returns during the regression estimation period. Conversely, industries with large negative *HML* slopes are more likely to have experienced surprise good times and positive abnormal average returns. The result is a negative correlation between intercepts and *HML* slopes in the three-factor model. The alternative to this dynamics-of-distress story is the bad-model hypothesis that the three-factor model exaggerates the premium for distress. It overestimates expected returns on industries with high *HML* slopes and underestimates expected returns on industries with low *HML* slopes. The next two sections try to distinguish between these two hypotheses by looking at portfolios with roughly constant risk loadings.

B.2. Tests using deciles formed on past industry HML slopes

Suppose we allocate industries to deciles based on past *HML* slopes. Both the bad-model hypothesis and the dynamics-of-distress hypothesis predict negative correlation between intercepts and *HML* slopes during the portfolio-formation period. But they make different predictions about the post-formation returns on the deciles. The bad-model hypothesis says that the negative relation between intercepts and *HML* slopes is a model specification problem (an exaggerated premium for distress) that will persist in post-formation returns. In contrast, the dynamics-of-distress story predicts that the three-factor model will look better in post-formation returns. Specifically, if we re-form the deciles frequently based on past *HML* slopes, there should be little unexpected drift in their post-formation *HML* slopes. Thus, if the expected-return Eq. (3) holds, the intercepts in three-factor regressions on post-formation returns should be close to zero and largely uncorrelated with post-formation *HML* slopes.

To test these predictions, we sort industries into two sets of deciles, using three- and five-year past *HML* slopes. We re-form the portfolios monthly and weight industries equally in the deciles. Table A.1 shows average values of the formation-period three-factor regression coefficients for the deciles. The predicted negative relation between intercepts and *HML* slopes is clear. Growth portfolios (strong negative formation-period *HML* slopes) have strong positive formation-period abnormal average returns. Distress portfolios (strong positive *HML* slopes) have strong negative formation-period abnormal returns.

The formation-period regressions are important because they show that allocating industries to portfolios based on their *HML* slopes emphasizes (rather than diversifies away) the negative formation-period relation between three-factor regression intercepts and *HML* slopes. Thus, if the negative formation-period relation between intercepts and *HML* slopes is a bad-model problem (an exaggerated premium for distress), it should reappear in the post-formation returns on the portfolios. Table A.2 shows that this does not happen. Instead, as predicted by the dynamics-of-distress story, the three-factor intercepts for post-formation returns are close to zero and largely unrelated to the post-formation *HML* slopes. The Gibbons, Ross, and Shanken (GRS) tests in Table A.2 confirm that the post-formation intercepts are consistent with the three-factor model.

The success of the three-factor model in the tests on post-formation decile returns (Table A.2) is also consistent with the evidence in Tables 3 and 4 that industry slopes on *HML* wander through time. If the slopes were constant, the negative correlation between intercepts and *HML* slopes in Tables 2 and A.1 would be a bad-model problem. With constant slopes, industries would not move much across the deciles and the tests on post-formation returns (Table A.2) would tend to reproduce the strong negative correlation between intercepts and *HML* slopes observed in formation-period returns (Table A.1). Again, this does not happen.

B.3. Deciles formed on industry BE/ME

Tables A.1 and A.2 also summarize tests on deciles formed in June each year using industry book-to-market ratios (*BE/ME*) for the fiscal year ending in the preceding calendar year. We hypothesize that, like high past *HML* slopes, high *BE/ME* is likely to identify industries that on balance experienced recent surprise distress (and low stock returns), while low *BE/ME* is likely to be associated with recent surprise growth. Table A.1 confirms this prediction. There is the usual strong negative relation between intercepts and *HML* slopes in five-year regressions estimated on returns preceding formation of the *BE/ME* deciles.

Table A.1
Summary statistics for portfolios formed on *BE/ME* or on three- and five-year past *HML* slopes from three-factor regressions

$$R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$$

$R_M - R_f$, *SMB*, and *HML* are defined in Table 1. In parts A and B, industries are allocated to deciles (five industries per decile, except for the fifth and sixth, which have four) every month beginning in 6/68 based on their *HML* slopes estimated from three or five years of past monthly returns. Returns on the deciles are calculated for the following month with equal weighting of the industries in a decile. In part C, industries are allocated to *BE/ME* deciles in June of each year t from 1968 to 1994. Monthly returns on the deciles are calculated for the following year (July to June) with equal weighting of the industries in a decile. *BE* is the sum of book equity (defined in Table 1) for the firms in an industry that have positive Compustat *BE* for the fiscal year ending in calendar year $t - 1$. *ME* is the sum of *ME* at the end of December of year $t - 1$ for these firms. Thus, *BE/ME* uses only Compustat firms, but the industry returns include all NYSE, AMEX, and NASDAQ firms on CRSP. The table shows the average values of the ranking period (6/68–11/94, 318 months) three-factor regression coefficients, and means, standard deviations (Std. dev.), and t-statistics for the means [t(Mean)] of the decile returns for the post-ranking period (7/68–12/94).

Decile	1	2	3	4	5	6	7	8	9	10
Part A: Portfolios formed on three-year pre-ranking *HML* slopes										
Ranking-period regression coefficients										
Mean a	0.41	0.22	0.11	0.12	0.02	− 0.08	− 0.14	− 0.19	− 0.31	− 0.44
Mean b	1.00	1.01	1.03	1.00	1.02	1.02	1.02	1.03	1.05	1.08
Mean s	0.26	0.29	0.30	0.39	0.41	0.44	0.38	0.42	0.39	0.44
Mean h	− 0.82	− 0.48	− 0.29	− 0.14	− 0.03	0.06	0.17	0.29	0.46	0.73
Post-ranking returns										
Means	0.66	0.91	0.82	0.92	1.07	1.02	0.99	1.02	1.06	1.10
Std. dev.	6.10	5.81	5.80	5.56	5.56	5.61	5.28	5.31	5.23	5.27
t (Mean)	1.92	2.78	2.53	2.94	3.43	3.23	3.32	3.41	3.60	3.72

Table A.1 (continued)

Decile	1	2	3	4	5	6	7	8	9	10
Part B: Portfolios formed on five-year pre-ranking *HML* slopes										
Ranking-period regression coefficients										
Mean *a*	0.41	0.25	0.10	0.08	− 0.02	− 0.06	− 0.10	− 0.22	− 0.31	− 0.44
Mean *b*	1.04	1.02	1.03	1.04	1.00	1.03	1.04	1.04	1.01	1.03
Mean *s*	0.30	0.31	0.27	0.40	0.46	0.47	0.43	0.37	0.36	0.44
Mean *h*	− 0.71	− 0.42	− 0.25	− 0.11	− 0.00	0.07	0.15	0.26	0.39	0.62
Post-ranking returns										
Means	0.93	0.74	0.71	0.91	0.99	1.07	0.10	1.04	0.94	1.10
Std. dev.	6.28	5.71	5.81	5.73	5.67	5.72	5.22	5.22	5.15	5.03
t (Mean)	2.64	2.32	2.19	2.84	3.10	3.33	3.77	3.56	3.27	3.89
Part C: Portfolios formed on *BE/ME*										
Pre-ranking five-year regression coefficients										
Mean *a*	0.53	0.31	0.03	0.06	0.04	− 0.12	− 0.21	− 0.25	− 0.25	− 0.44
Mean *b*	0.93	1.03	1.05	1.10	1.03	1.03	1.03	1.04	1.04	1.00
Mean *s*	0.14	0.40	0.38	0.36	0.37	0.42	0.48	0.34	0.41	0.44
Mean *h*	− 0.49	− 0.28	− 0.15	− 0.07	− 0.02	0.06	0.07	0.16	0.33	0.32
Post-ranking returns										
Means	0.76	0.91	0.72	0.94	0.91	1.03	0.85	1.01	1.19	1.21
Std. dev.	5.52	6.01	5.84	5.56	5.55	5.51	5.43	5.29	5.25	5.47
t (Mean)	2.45	2.71	2.21	3.00	2.92	3.34	3.78	3.38	4.02	3.93

Again, however, since we re-form the *BE/ME* portfolios annually, there should be little unexpected drift in their true post-formation *HML* slopes. If the three-factor model holds, three-factor regressions on post-formation returns should produce intercepts close to zero, and the negative correlation between *HML* slopes and intercepts should largely disappear. Table A.2 confirms these predictions.

The portfolios formed on industry *BE/ME* also provide evidence on whether survivor bias drives the book-to-market effect in average returns. Kothari, Shanken, and Sloan (1995) argue that average returns on high-*BE/ME* portfolios of Compustat stocks are overstated because Compustat is more likely to include distressed firms that survive and miss distressed firms that fail. Since our industries contain all NYSE, AMEX, and NASDAQ stocks, the strong spread in post-formation average returns (0.45% per month, or about 5.5% per year) for portfolios formed on industry *BE/ME* (Table A.1) cannot be attributed to survivor bias. Our results are thus consistent with the more detailed evidence of

Chan, Jegadeesh, and Lakonishok (1995) that Compustat survivor bias cannot explain the strong positive relation between BE/ME and average return.

B.4. *The unresolved testing problem*

The portfolios formed on past HML slopes and BE/ME in Tables A.1 and A.2 refute the bad-model interpretation of the strong negative correlation between

Table A.2
Three-factor and one-factor regressions for post-formation returns on portfolios formed on industry HML slopes or industry book-to-market equity ratios: 7/68–12/94

$$R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i, \qquad R_i - R_f = a_i + b_i[R_M - R_f] + e_i$$

$R_M - R_f$, SMB, and HML are defined in Table 1. The formation of deciles on industry BE/ME or HML slopes is described in Table A.1. One- and three-factor regressions are estimated on the post-formation returns for 7/68–12/94 (318 months). The regression R^2 are adjusted for degrees of freedom. $t(a)$ is the t-statistic for an intercept. The standard errors of b_i, s_i, and h_i are about 0.03, 0.04, and 0.05. $F(a)$ is the F-statistic of Gibbons, Ross, and Shanken (1989) for tests of the hypothesis that the intercepts for all deciles are zero; $p(F)$ is its p-value (the probability of a value of F as large or larger than the sample value if the true intercepts are all zero). $Mn(a)$, $Mn(|a|)$, and $Mn(a^2)$ are the average, average absolute, and average squared values of the intercepts for a set of deciles.

	Three-factor						One-factor			
Decile	a	b	s	h	R^2	$t(a)$	a	b	R^2	$t(a)$
Regressions for portfolios formed on three-year past HML slopes										
1	−0.11	1.03	0.37	−0.45	0.89	−0.95	−0.35	1.21	0.83	−2.44
2	0.05	1.04	0.32	−0.27	0.88	0.45	−0.08	0.17	0.85	−0.64
3	−0.06	1.07	0.36	−0.23	0.92	−0.66	−0.17	1.19	0.88	−1.56
4	−0.08	1.09	0.31	0.00	0.92	−0.94	−0.07	1.15	0.90	−0.67
5	0.10	1.02	0.43	−0.02	0.88	0.85	0.10	1.11	0.84	0.81
6	−0.04	1.09	0.40	0.12	0.90	−0.45	0.04	1.14	0.87	0.34
7	−0.09	0.98	0.50	0.22	0.88	−0.89	0.05	1.03	0.80	0.35
8	−0.05	1.04	0.38	0.18	0.90	−0.56	0.06	1.07	0.86	0.55
9	−0.02	1.00	0.38	0.22	0.86	−0.15	0.12	1.03	0.81	0.93
10	−0.05	1.00	0.40	0.37	0.82	−0.37	0.18	1.00	0.75	1.19
10 − 1	0.07	−0.03	0.03	0.82	0.34	0.36	0.52	−0.21	0.06	2.49
Regressions for portfolios formed on five-year past HML slopes										
1	−0.17	1.05	0.38	−0.49	0.88	1.39	−0.09	1.24	0.82	−0.58
2	−0.09	1.03	0.32	−0.31	0.91	−0.85	−0.24	0.16	0.87	−2.10
3	−0.25	1.08	0.40	−0.09	0.90	−2.34	−0.28	1.18	0.87	−2.34
4	−0.07	1.07	0.45	−0.05	0.92	−0.73	−0.08	1.17	0.88	−0.70
5	0.02	1.09	0.34	0.00	0.90	−0.15	0.00	1.16	0.88	0.01
6	−0.00	1.08	0.45	0.13	0.88	0.00	0.09	1.13	0.83	0.68
7	0.11	0.98	0.40	0.06	0.88	1.09	0.16	1.04	0.84	1.36
8	−0.09	1.04	0.38	0.32	0.89	−0.90	0.10	1.04	0.83	0.84
9	−0.14	1.02	0.37	0.24	0.90	−1.47	0.00	1.03	0.85	0.05
10	−0.02	0.95	0.37	0.36	0.81	−0.17	0.20	0.94	0.73	1.33
10 − 1	−0.19	−0.10	−0.01	0.86	0.38	−1.05	0.28	−0.30	0.11	1.31

Table A.2 (continued)

	Three-factor						One-factor			
Decile	a	b	s	h	R^2	$t(a)$	a	b	R^2	$t(a)$
Regressions for portfolios formed on industry *BE/ME*										
1	0.09	0.95	0.07	− 0.53	0.87	0.81	− 0.20	1.09	0.82	− 1.50
2	0.10	1.02	0.46	− 0.38	0.91	1.00	− 0.09	1.20	0.84	− 0.68
3	− 0.23	1.07	0.45	− 0.11	0.92	− 2.37	− 0.27	1.19	0.87	− 2.31
4	− 0.02	1.04	0.40	− 0.06	0.90	− 0.21	− 0.04	1.13	0.87	− 0.34
5	− 0.11	1.08	0.33	0.05	0.90	− 1.04	− 0.06	1.13	0.87	− 0.58
6	0.04	1.00	0.48	0.02	0.87	0.38	0.07	1.09	0.82	0.57
7	− 0.21	1.03	0.46	0.14	0.91	− 2.18	− 0.11	1.09	0.85	− 0.96
8	− 0.08	1.04	0.35	0.21	0.89	− 0.74	0.06	1.06	0.85	0.47
9	0.08	1.04	0.40	0.27	0.90	0.78	0.24	1.05	0.84	2.04
10	− 0.06	1.09	0.46	0.55	0.89	− 0.61	0.26	1.05	0.77	1.78
10 − 1	− 0.16	0.13	0.39	1.08	0.54	− 1.02	0.46	− 0.04	− 0.00	2.09

Summary of regression intercepts (excluding 10 − 1)

Explanatory variables			$F(a)$	$p(F)$	$Mn(a)$	$Mn(\|a\|)$	$Mn(a^2)$
Regressions for portfolios formed on three-year past *HML* slopes							
$R_M - R_f$			1.350	0.203	− 0.012	0.122	0.0227
$R_M - R_f$	*SMB*	*HML*	0.637	0.782	− 0.037	0.067	0.0052
Regressions for portfolios formed on five-year past *HML* slopes							
$R_M - R_f$			2.074	0.026	− 0.014	0.124	0.0234
$R_M - R_f$	*SMB*	*HML*	1.762	0.067	− 0.038	0.095	0.0144
Regressions for portfolios formed on *BE/ME*							
$R_M - R_f$			2.384	0.010	− 0.015	0.141	0.0275
$R_M - R_f$	*SMB*	*HML*	1.513	0.134	− 0.039	0.102	0.0145

intercepts and *HML* slopes in Table 2. Although there is a large spread in the portfolios' post-formation *HML* slopes, the three-factor intercepts are close to zero, and there is little relation between the intercepts and *HML* slopes. Moreover, the portfolios in Tables A.1 and A.2 have roughly constant *HML* slopes. In contrast, the implied volatilities in Table 3 and the conditional regressions in Table 4 say that there is substantial variation in the true *HML* slopes for industries. Thus, it appears that the large negative correlation between the intercepts and *HML* slopes in Table 2 – and the strong rejection of the three-factor model – are caused by the dynamics of growth and distress.

Because the conditional regressions in Table 4 seem to capture the wandering *SMB* and *HML* slopes, one might hope that they also absorb the intercepts produced by the dynamics of growth and distress. In fact, the intercepts in these regressions are close to those of the constant-slope regressions in Table 2. A naive application of the GRS test (the explanatory variables in the conditional regressions are not the same for all industries) rejects the three-factor model as strongly in the conditional regressions as in the constant-slope regressions.

Why don't the conditional regressions absorb the regression intercepts? Even if we knew the true model for expected returns and the true risk loadings at the beginning of each month, the dynamics-of-distress story predicts a negative correlation between intercepts and unexpected drift in risk loadings. Bad news that increases risk loadings is likely to produce a negative abnormal return; good news is likely to produce lower risk loadings and a positive abnormal return. Thus, in tests of the true asset pricing model that use the true time-varying risk loadings, we can predict the abnormal average return for a test period based on the unexpected drift in the true risk loadings during the period. We do not predict that an industry's average abnormal return is zero unless, by chance, its risk loadings at the end of the test period are the same as at the beginning.

Negative correlation between abnormal returns and unexpected drift in risk loadings does not by itself imply, however, that tests of asset pricing models are biased toward rejection. If the intercepts generated by the dynamics of growth and distress are just average values of normally distributed return shocks, they satisfy the assumptions of the GRS test, and they do not bias the tests in Tables 2 and 4 toward rejection of the three-factor model. In fact, if we maintain the other assumptions of the GRS test, such as multivariate normality and a constant covariance matrix for the residuals, wandering risk loadings increase the residual variances in constant-slope regressions like those in Table 2, and so make false rejection of an asset pricing model less likely.

Then why do we reject the three-factor model in Tables 2 and 4? Perhaps the three-factor model misses important industry factors in expected returns that happen to be negatively related to *HML* slopes. For example, Real Estate produces the most extreme intercepts in Tables 2 and 4, -1.01% ($t = -5.45$) and -1.02% ($t = -5.22$) per month. Applying Bonferroni's inequality to the t-statistics of the Real Estate intercepts [multiplying their univariate p-values by 48(!)] in itself produces a comfortable rejection of the hypothesis that the three-factor regression intercepts are zero for all industries. It is then tempting to argue that Real Estate stocks are a hedge against the relative price of housing services (a potential state variable in the ICAPM), so the equilibrium expected return on Real Estate is less than predicted by the three-factor model. Unfortunately, this hedging argument also seems to predict negative intercepts for the health industries (Drugs, Medical Equipment, and Health Services), but their intercepts in Tables 2 and 4 are positive, and large. Indeed, the intercepts for

Drugs, 0.61 ($t = 3.88$) and 0.58 ($t = 3.64$), suffice to reject the hypothesis that the three-factor regression intercepts are zero for all industries.

Another possibility is that the rejection of the three-factor model in Tables 2 and 4 is due to violations of the assumptions of the GRS test. For example, the residuals from the three-factor model are not multivariate normal. In Table 2, the average kurtosis of the residuals for the 48 industries is 4.22. In simulations of the GRS test, Affleck-Graves and McDonald (1989) find that departures from normality of this magnitude can substantially increase the probability of rejecting the true asset pricing model.

Until we better understand the testing problem created by negative correlation between abnormal returns and stochastic drift in the risk loadings of industries and firms, perhaps the best solution to the problem is to test asset pricing models on portfolios formed to have constant risk loadings. This is, of course, the approach in Tables A.1 and A.2, and in most of the existing literature.

Appendix C

We can represent the one-and three-factor regressions (2) and (4) as

$$R_i - R_f = X\beta_i + \varepsilon_i,$$

where β_i (2×1 or 4×1) is the vector of true regression coefficients for industry i in (2) or (4), X is the ($N \times 2$ or $N \times 4$) matrix of explanatory returns for N months, and $R_i - R_f$ and ε_i are ($N \times 1$) vectors of excess returns and disturbances. If the joint distribution of security returns is multivariate normal (MVN) and if β_i is constant, then the ordinary least squares (OLS) estimate of β_i, B_i, is MVN with mean vector β_i and covariance matrix $\sigma^2(\varepsilon_i)(X'X)^{-1}$,

$$B_i \sim \text{MVN}[\beta_i, \sigma^2(\varepsilon_i)\,(X'X)^{-1}]\,. \tag{A.1}$$

In a Bayesian framework, β_i is a random vector. We assume a prior distribution for β_i that is MVN with mean vector β and covariance matrix $\Sigma(\beta)$ (2×2 or 4×4),

$$\beta_i \sim \text{MVN}[\beta, \Sigma(\beta)]\,. \tag{A.2}$$

With these assumptions, Blattberg and George (1991) show that the mean of the posterior distribution of β_i is

$$\text{E}(\beta_i) = D(i)^{-1}[X'X/(\sigma^2(\varepsilon_i)\,B_i) + \Sigma(\beta)^{-1}\,\beta], \tag{A.3}$$

where

$$D(i) = X'X/\sigma^2(\varepsilon_i) + \Sigma(\beta)^{-1}\,. \tag{A.4}$$

The posterior mean is a thus a weighted average of the prior mean β and the sample estimates B_i, where the weights are relative precisions. Equivalently, rearranging (A.3), the posterior mean shrinks the OLS B_i toward the prior mean β to correct the sample estimates for sampling error,

$$\mathrm{E}(\beta_i) = B_i - W(i)(B_i - \beta)\,, \tag{A.5}$$

where the shrinkage matrix $W(i)$ is

$$W(i) = D(i)^{-1}\,\Sigma(\beta)^{-1}\,. \tag{A.6}$$

To implement (A.5), we estimate β as the mean, across industries, of the B_i for an estimation period, and we estimate $\sigma^2(\varepsilon_i)$ as the variance of the OLS residuals for industry i, $\hat{\sigma}^2(e_i)$. The estimates of β and $X'X$ are specific to an estimation period, and $\hat{\sigma}^2(e_i)$ is specific to industries and estimation periods.

Invertibility problems force us to use an estimate of $\Sigma(\beta)$ for the overall sample period. Specifically, we can estimate the covariance matrix of the B_i with the sample covariance matrix (2×2 or 4×4) of the B_i for an estimation period, denoted by $C(B)$. We can then estimate $\Sigma(\beta)$ as

$$C(\beta) = C(B) - \hat{\sigma}^2(\mathrm{e})(X'X)^{-1}\,, \tag{A.7}$$

where $\hat{\sigma}^2(e)$ is the mean of $\hat{\sigma}^2(e_i)$ across industries. When we use $C(\beta)$ to estimate $\Sigma(\beta)$ for each regression estimation period, there are occasional periods when $C(\beta)$ is not invertible. Intuitively, there are periods when the dispersion of the B_i estimates across industries $[C(B)]$ is too low, relative to the average estimated covariance matrix of the sampling errors of the slopes $[C(B - \beta) = \hat{\sigma}^2(e)(X'X)^{-1}]$, to produce a meaningful covariance matrix for the true slopes. To bypass this problem, we produce one overall estimate of $\Sigma(\beta)$, using average values across estimation periods of the three components of $C(\beta)$ in (A.7).

There is one final problem in estimating $\Sigma(\beta)$. The estimate for the overall period is typically not invertible if the intercepts in (4) are included. Intuitively, the average cross-sectional variance of the estimated intercepts is not large enough, relative to the sampling-error variances of the estimates, to produce a meaningful estimate of the cross-sectional variance of the true intercepts. We interpret this as evidence that a dogmatic prior for the intercepts (zero) must be used to get Bayes estimates of the regression slopes. In other words, to get Bayes estimates of the slopes in (4) we must impose the three-factor expected-return Eq. (3). Thus, the intercepts are dropped in all the inputs in (A.5).

For perspective on the Bayes estimates, Table A.3 shows averages, over industries and estimation periods, of the key shrinkage inputs for five-year rolling estimates of the slopes in (2) and (4). Note that estimates of the standard deviation of the true market slopes in the three-factor regressions are small (around 0.16) relative to the those for the *SMB* and *HML* slopes (around 0.40 and 0.33). As a result, although the market slopes are estimated more reliably (they have smaller standard errors), the weighting matrix that produces shrunk

Table A.3
Shrinkage inputs for five-year one-factor and three-factor regression slopes

$R_i - R_f = a_i + b_i[R_M - R_f] + e_i, \qquad R_i - R_f = a_i + b_i[R_M - R_f] + s_i SMB + h_i HML + e_i$

$R_M - R_f$, SMB, and HML are defined in Table 1. One-factor and three-factor regressions are estimated for each industry for each month of the 6/68 to 11/94 period, using a rolling window of five years of past monthly returns. In the three-factor regressions, $C(B)$ is an overall estimate of the covariance matrix of the estimated regression slopes. $C(B)$ is the average, across regression estimation periods, of the (3 × 3) matrix of the covariances (across industries) of the regression slopes for an estimation period. $C(B - \beta)$ is an overall estimate of the covariance matrix of the estimation errors of the estimated slopes. $C(B - \beta)$ is the average, first across industries and then across estimation periods, of the residual variances in the three-factor regressions, times the average, over the estimation periods, of $(X'X)^{-1}$, the inverse of the covariance matrix of the explanatory variables. $C(\beta) = C(B) - C(B - \beta)$ is an overall estimate of the covariance matrix of the true regression slopes. $s(B)$, $s(B - \beta)$, and $s(\beta)$ are the square roots of the diagonal elements of $C(B)$, $C(B - \beta)$, and $C(\beta)$. The three-factor shrinkage matrix, W, uses overall averages (over industries and then regression estimation periods) of each of the terms in (A.4) and (A.6). This W matrix is illustrative, but it is not used in Tables 5 to 7. We do use the overall $C(\beta)$ shown here in Tables 5 to 7, but the other elements of (A.4) and (A.6) used to calculate shrinkage weights are specific to industries and estimation periods. $s^2(b)$, $s^2(b - \beta)$, and $s^2(\beta)$ are the one-factor analogues of $C(B)$, $C(B - \beta)$, and $C(\beta)$.

	Three-factor				One-factor	
	b	s	h			
		$C(B)$		$s(B)$	$s^2(b)$	$s(b)$
b	0.042	0.012	− 0.000	0.205	0.067	0.258
s	0.012	0.194	0.018	0.441		
h	− 0.000	0.018	0.155	0.394		
		$C(B - \beta)$		$s(B - \beta)$	$s^2(b - \beta)$	$s(b - \beta)$
b	0.015	− 0.006	0.010	0.124	0.013	0.115
s	− 0.006	0.036	0.002	0.189		
h	0.010	0.002	0.044	0.208		
		$C(\beta)$		$s(\beta)$	$s^2(\beta)$	$s(\beta)$
b	0.027	0.018	− 0.010	0.163	0.053	0.231
s	0.018	0.159	0.015	0.399		
h	− 0.010	0.015	0.111	0.334		
		W			W	
b	0.658	0.059	− 0.062		0.816	
s	0.206	0.839	0.028			
h	− 0.213	0.038	0.764			

slopes gives more weight to the sample estimates of the SMB and HML slopes than to the sample estimates of the market slopes. Roughly speaking (i.e., ignoring the off-diagonal terms in the weighting matrix) about 66% of the difference between an industry's OLS market slope and the average market slope is allocated to its shrunk market slope, whereas about 84% and

76% of the OLS estimates of the *SMB* and *HML* slopes make it into the shrunk slopes.

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The Capital Asset Pricing Model: Theory and Evidence

Eugene F. Fama and Kenneth R. French

The capital asset pricing model (CAPM) of William Sharpe (1964) and John Lintner (1965) marks the birth of asset pricing theory (resulting in a Nobel Prize for Sharpe in 1990). Four decades later, the CAPM is still widely used in applications, such as estimating the cost of capital for firms and evaluating the performance of managed portfolios. It is the centerpiece of MBA investment courses. Indeed, it is often the only asset pricing model taught in these courses.[1]

The attraction of the CAPM is that it offers powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk. Unfortunately, the empirical record of the model is poor—poor enough to invalidate the way it is used in applications. The CAPM's empirical problems may reflect theoretical failings, the result of many simplifying assumptions. But they may also be caused by difficulties in implementing valid tests of the model. For example, the CAPM says that the risk of a stock should be measured relative to a comprehensive "market portfolio" that in principle can include not just traded financial assets, but also consumer durables, real estate and human capital. Even if we take a narrow view of the model and limit its purview to traded financial assets, is it

[1] Although every asset pricing model is a capital asset pricing model, the finance profession reserves the acronym CAPM for the specific model of Sharpe (1964), Lintner (1965) and Black (1972) discussed here. Thus, throughout the paper we refer to the Sharpe-Lintner-Black model as the CAPM.

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legitimate to limit further the market portfolio to U.S. common stocks (a typical choice), or should the market be expanded to include bonds, and other financial assets, perhaps around the world? In the end, we argue that whether the model's problems reflect weaknesses in the theory or in its empirical implementation, the failure of the CAPM in empirical tests implies that most applications of the model are invalid.

We begin by outlining the logic of the CAPM, focusing on its predictions about risk and expected return. We then review the history of empirical work and what it says about shortcomings of the CAPM that pose challenges to be explained by alternative models.

The Logic of the CAPM

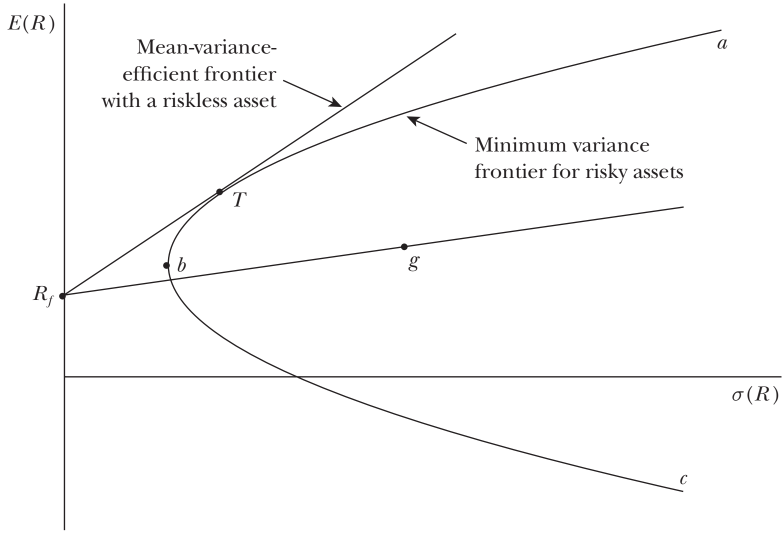
The CAPM builds on the model of portfolio choice developed by Harry Markowitz (1959). In Markowitz's model, an investor selects a portfolio at time $t - 1$ that produces a stochastic return at t. The model assumes investors are risk averse and, when choosing among portfolios, they care only about the mean and variance of their one-period investment return. As a result, investors choose "mean-variance-efficient" portfolios, in the sense that the portfolios 1) minimize the variance of portfolio return, given expected return, and 2) maximize expected return, given variance. Thus, the Markowitz approach is often called a "mean-variance model."

The portfolio model provides an algebraic condition on asset weights in mean-variance-efficient portfolios. The CAPM turns this algebraic statement into a testable prediction about the relation between risk and expected return by identifying a portfolio that must be efficient if asset prices are to clear the market of all assets.

Sharpe (1964) and Lintner (1965) add two key assumptions to the Markowitz model to identify a portfolio that must be mean-variance-efficient. The first assumption is *complete agreement*: given market clearing asset prices at $t - 1$, investors agree on the joint distribution of asset returns from $t - 1$ to t. And this distribution is the true one—that is, it is the distribution from which the returns we use to test the model are drawn. The second assumption is that there is *borrowing and lending at a risk-free rate*, which is the same for all investors and does not depend on the amount borrowed or lent.

Figure 1 describes portfolio opportunities and tells the CAPM story. The horizontal axis shows portfolio risk, measured by the standard deviation of portfolio return; the vertical axis shows expected return. The curve *abc*, which is called the minimum variance frontier, traces combinations of expected return and risk for portfolios of risky assets that minimize return variance at different levels of expected return. (These portfolios do not include risk-free borrowing and lending.) The tradeoff between risk and expected return for minimum variance portfolios is apparent. For example, an investor who wants a high expected return, perhaps at point *a*, must accept high volatility. At point *T*, the investor can have an interme-

Figure 1
Investment Opportunities



diate expected return with lower volatility. If there is no risk-free borrowing or lending, only portfolios above *b* along *abc* are mean-variance-efficient, since these portfolios also maximize expected return, given their return variances.

Adding risk-free borrowing and lending turns the efficient set into a straight line. Consider a portfolio that invests the proportion *x* of portfolio funds in a risk-free security and $1 - x$ in some portfolio *g*. If all funds are invested in the risk-free security—that is, they are loaned at the risk-free rate of interest—the result is the point R_f in Figure 1, a portfolio with zero variance and a risk-free rate of return. Combinations of risk-free lending and positive investment in *g* plot on the straight line between R_f and *g*. Points to the right of *g* on the line represent borrowing at the risk-free rate, with the proceeds from the borrowing used to increase investment in portfolio *g*. In short, portfolios that combine risk-free lending or borrowing with some risky portfolio *g* plot along a straight line from R_f through *g* in Figure 1.[2]

[2] Formally, the return, expected return and standard deviation of return on portfolios of the risk-free asset *f* and a risky portfolio *g* vary with *x*, the proportion of portfolio funds invested in *f*, as

$$R_p = xR_f + (1 - x)R_g,$$

$$E(R_p) = xR_f + (1 - x)E(R_g),$$

$$\sigma(R_p) = (1 - x)\sigma(R_g), \; x \leq 1.0,$$

which together imply that the portfolios plot along the line from R_f through *g* in Figure 1.

To obtain the mean-variance-efficient portfolios available with risk-free borrowing and lending, one swings a line from R_f in Figure 1 up and to the left as far as possible, to the tangency portfolio T. We can then see that all efficient portfolios are combinations of the risk-free asset (either risk-free borrowing or lending) and a single risky tangency portfolio, T. This key result is Tobin's (1958) "separation theorem."

The punch line of the CAPM is now straightforward. With complete agreement about distributions of returns, all investors see the same opportunity set (Figure 1), and they combine the same risky tangency portfolio T with risk-free lending or borrowing. Since all investors hold the same portfolio T of risky assets, it must be the value-weight market portfolio of risky assets. Specifically, each risky asset's weight in the tangency portfolio, which we now call M (for the "market"), must be the total market value of all outstanding units of the asset divided by the total market value of all risky assets. In addition, the risk-free rate must be set (along with the prices of risky assets) to clear the market for risk-free borrowing and lending.

In short, the CAPM assumptions imply that the market portfolio M must be on the minimum variance frontier if the asset market is to clear. This means that the algebraic relation that holds for any minimum variance portfolio must hold for the market portfolio. Specifically, if there are N risky assets,

$$\text{(Minimum Variance Condition for } M\text{)} \quad E(R_i) = E(R_{ZM}) + [E(R_M) - E(R_{ZM})]\beta_{iM}, \; i = 1, \ldots, N.$$

In this equation, $E(R_i)$ is the expected return on asset i, and β_{iM}, the market beta of asset i, is the covariance of its return with the market return divided by the variance of the market return,

$$\text{(Market Beta)} \quad \beta_{iM} = \frac{\text{cov}(R_i, R_M)}{\sigma^2(R_M)}.$$

The first term on the right-hand side of the minimum variance condition, $E(R_{ZM})$, is the expected return on assets that have market betas equal to zero, which means their returns are uncorrelated with the market return. The second term is a risk premium—the market beta of asset i, β_{iM}, times the premium per unit of beta, which is the expected market return, $E(R_M)$, minus $E(R_{ZM})$.

Since the market beta of asset i is also the slope in the regression of its return on the market return, a common (and correct) interpretation of beta is that it measures the sensitivity of the asset's return to variation in the market return. But there is another interpretation of beta more in line with the spirit of the portfolio model that underlies the CAPM. The risk of the market portfolio, as measured by the variance of its return (the denominator of β_{iM}), is a weighted average of the covariance risks of the assets in M (the numerators of β_{iM} for different assets).

Thus, β_{iM} is the covariance risk of asset i in M measured relative to the average covariance risk of assets, which is just the variance of the market return.[3] In economic terms, β_{iM} is proportional to the risk each dollar invested in asset i contributes to the market portfolio.

The last step in the development of the Sharpe-Lintner model is to use the assumption of risk-free borrowing and lending to nail down $E(R_{ZM})$, the expected return on zero-beta assets. A risky asset's return is uncorrelated with the market return—its beta is zero—when the average of the asset's covariances with the returns on other assets just offsets the variance of the asset's return. Such a risky asset is riskless in the market portfolio in the sense that it contributes nothing to the variance of the market return.

When there is risk-free borrowing and lending, the expected return on assets that are uncorrelated with the market return, $E(R_{ZM})$, must equal the risk-free rate, R_f. The relation between expected return and beta then becomes the familiar Sharpe-Lintner CAPM equation,

$$\text{(Sharpe-Lintner CAPM)} \quad E(R_i) = R_f + [E(R_M) - R_f)]\beta_{iM},\ i = 1, \ldots, N.$$

In words, the expected return on any asset i is the risk-free interest rate, R_f, plus a risk premium, which is the asset's market beta, β_{iM}, times the premium per unit of beta risk, $E(R_M) - R_f$.

Unrestricted risk-free borrowing and lending is an unrealistic assumption. Fischer Black (1972) develops a version of the CAPM without risk-free borrowing or lending. He shows that the CAPM's key result—that the market portfolio is mean-variance-efficient—can be obtained by instead allowing unrestricted short sales of risky assets. In brief, back in Figure 1, if there is no risk-free asset, investors select portfolios from along the mean-variance-efficient frontier from a to b. Market clearing prices imply that when one weights the efficient portfolios chosen by investors by their (positive) shares of aggregate invested wealth, the resulting portfolio is the market portfolio. The market portfolio is thus a portfolio of the efficient portfolios chosen by investors. With unrestricted short selling of risky assets, portfolios made up of efficient portfolios are themselves efficient. Thus, the market portfolio is efficient, which means that the minimum variance condition for M given above holds, and it is the expected return-risk relation of the Black CAPM.

The relations between expected return and market beta of the Black and Sharpe-Lintner versions of the CAPM differ only in terms of what each says about $E(R_{ZM})$, the expected return on assets uncorrelated with the market. The Black version says only that $E(R_{ZM})$ must be less than the expected market return, so the

[3] Formally, if x_{iM} is the weight of asset i in the market portfolio, then the variance of the portfolio's return is

$$\sigma^2(R_M) = Cov(R_M, R_M) = Cov\left(\sum_{i=1}^{N} x_{iM}R_i,\ R_M\right) = \sum_{i=1}^{N} x_{iM}Cov(R_i, R_M).$$

premium for beta is positive. In contrast, in the Sharpe-Lintner version of the model, $E(R_{ZM})$ must be the risk-free interest rate, R_f, and the premium per unit of beta risk is $E(R_M) - R_f$.

The assumption that short selling is unrestricted is as unrealistic as unrestricted risk-free borrowing and lending. If there is no risk-free asset and short sales of risky assets are not allowed, mean-variance investors still choose efficient portfolios—points above *b* on the *abc* curve in Figure 1. But when there is no short selling of risky assets and no risk-free asset, the algebra of portfolio efficiency says that portfolios made up of efficient portfolios are not typically efficient. This means that the market portfolio, which is a portfolio of the efficient portfolios chosen by investors, is not typically efficient. And the CAPM relation between expected return and market beta is lost. This does not rule out predictions about expected return and betas with respect to other efficient portfolios—if theory can specify portfolios that must be efficient if the market is to clear. But so far this has proven impossible.

In short, the familiar CAPM equation relating expected asset returns to their market betas is just an application to the market portfolio of the relation between expected return and portfolio beta that holds in any mean-variance-efficient portfolio. The efficiency of the market portfolio is based on many unrealistic assumptions, including complete agreement and either unrestricted risk-free borrowing and lending or unrestricted short selling of risky assets. But all interesting models involve unrealistic simplifications, which is why they must be tested against data.

Early Empirical Tests

Tests of the CAPM are based on three implications of the relation between expected return and market beta implied by the model. First, expected returns on all assets are linearly related to their betas, and no other variable has marginal explanatory power. Second, the beta premium is positive, meaning that the expected return on the market portfolio exceeds the expected return on assets whose returns are uncorrelated with the market return. Third, in the Sharpe-Lintner version of the model, assets uncorrelated with the market have expected returns equal to the risk-free interest rate, and the beta premium is the expected market return minus the risk-free rate. Most tests of these predictions use either cross-section or time-series regressions. Both approaches date to early tests of the model.

Tests on Risk Premiums

The early cross-section regression tests focus on the Sharpe-Lintner model's predictions about the intercept and slope in the relation between expected return and market beta. The approach is to regress a cross-section of average asset returns on estimates of asset betas. The model predicts that the intercept in these regressions is the risk-free interest rate, R_f, and the coefficient on beta is the expected return on the market in excess of the risk-free rate, $E(R_M) - R_f$.

Two problems in these tests quickly became apparent. First, estimates of beta for individual assets are imprecise, creating a measurement error problem when they are used to explain average returns. Second, the regression residuals have common sources of variation, such as industry effects in average returns. Positive correlation in the residuals produces downward bias in the usual ordinary least squares estimates of the standard errors of the cross-section regression slopes.

To improve the precision of estimated betas, researchers such as Blume (1970), Friend and Blume (1970) and Black, Jensen and Scholes (1972) work with portfolios, rather than individual securities. Since expected returns and market betas combine in the same way in portfolios, if the CAPM explains security returns it also explains portfolio returns.[4] Estimates of beta for diversified portfolios are more precise than estimates for individual securities. Thus, using portfolios in cross-section regressions of average returns on betas reduces the critical errors in variables problem. Grouping, however, shrinks the range of betas and reduces statistical power. To mitigate this problem, researchers sort securities on beta when forming portfolios; the first portfolio contains securities with the lowest betas, and so on, up to the last portfolio with the highest beta assets. This sorting procedure is now standard in empirical tests.

Fama and MacBeth (1973) propose a method for addressing the inference problem caused by correlation of the residuals in cross-section regressions. Instead of estimating a single cross-section regression of average monthly returns on betas, they estimate month-by-month cross-section regressions of monthly returns on betas. The times-series means of the monthly slopes and intercepts, along with the standard errors of the means, are then used to test whether the average premium for beta is positive and whether the average return on assets uncorrelated with the market is equal to the average risk-free interest rate. In this approach, the standard errors of the average intercept and slope are determined by the month-to-month variation in the regression coefficients, which fully captures the effects of residual correlation on variation in the regression coefficients, but sidesteps the problem of actually estimating the correlations. The residual correlations are, in effect, captured via repeated sampling of the regression coefficients. This approach also becomes standard in the literature.

Jensen (1968) was the first to note that the Sharpe-Lintner version of the

[4] Formally, if x_{ip}, $i = 1, \ldots, N$, are the weights for assets in some portfolio p, the expected return and market beta for the portfolio are related to the expected returns and betas of assets as

$$E(R_p) = \sum_{i=1}^{N} x_{ip}E(R_i), \text{ and } \beta_{pM} = \sum_{i=1}^{N} x_{ip}\beta_{pM}.$$

Thus, the CAPM relation between expected return and beta,

$$E(R_i) = E(R_f) + [E(R_M) - E(R_f)]\beta_{iM},$$

holds when asset i is a portfolio, as well as when i is an individual security.

relation between expected return and market beta also implies a time-series regression test. The Sharpe-Lintner CAPM says that the expected value of an asset's excess return (the asset's return minus the risk-free interest rate, $R_{it} - R_{ft}$) is completely explained by its expected CAPM risk premium (its beta times the expected value of $R_{Mt} - R_{ft}$). This implies that "Jensen's alpha," the intercept term in the time-series regression,

$$\text{(Time-Series Regression)} \quad R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \varepsilon_{it},$$

is zero for each asset.

The early tests firmly reject the Sharpe-Lintner version of the CAPM. There is a positive relation between beta and average return, but it is too "flat." Recall that, in cross-section regressions, the Sharpe-Lintner model predicts that the intercept is the risk-free rate and the coefficient on beta is the expected market return in excess of the risk-free rate, $E(R_M) - R_f$. The regressions consistently find that the intercept is greater than the average risk-free rate (typically proxied as the return on a one-month Treasury bill), and the coefficient on beta is less than the average excess market return (proxied as the average return on a portfolio of U.S. common stocks minus the Treasury bill rate). This is true in the early tests, such as Douglas (1968), Black, Jensen and Scholes (1972), Miller and Scholes (1972), Blume and Friend (1973) and Fama and MacBeth (1973), as well as in more recent cross-section regression tests, like Fama and French (1992).

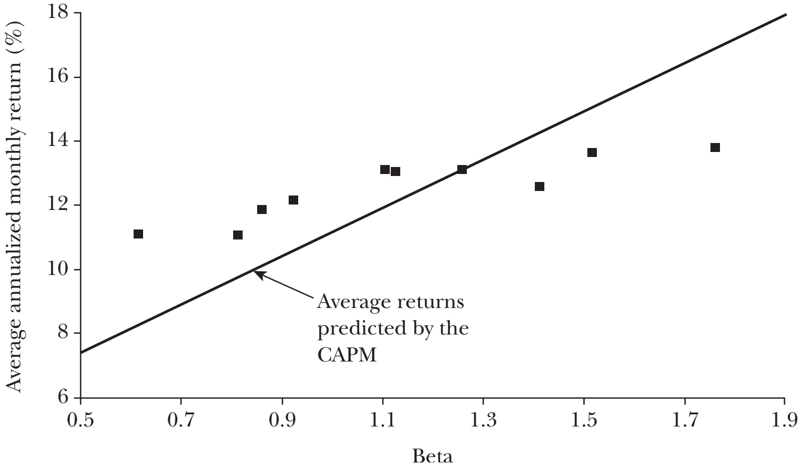
The evidence that the relation between beta and average return is too flat is confirmed in time-series tests, such as Friend and Blume (1970), Black, Jensen and Scholes (1972) and Stambaugh (1982). The intercepts in time-series regressions of excess asset returns on the excess market return are positive for assets with low betas and negative for assets with high betas.

Figure 2 provides an updated example of the evidence. In December of each year, we estimate a preranking beta for every NYSE (1928–2003), AMEX (1963–2003) and NASDAQ (1972–2003) stock in the CRSP (Center for Research in Security Prices of the University of Chicago) database, using two to five years (as available) of prior monthly returns.[5] We then form ten value-weight portfolios based on these preranking betas and compute their returns for the next twelve months. We repeat this process for each year from 1928 to 2003. The result is 912 monthly returns on ten beta-sorted portfolios. Figure 2 plots each portfolio's average return against its postranking beta, estimated by regressing its monthly returns for 1928–2003 on the return on the CRSP value-weight portfolio of U.S. common stocks.

The Sharpe-Lintner CAPM predicts that the portfolios plot along a straight

[5] To be included in the sample for year t, a security must have market equity data (price times shares outstanding) for December of $t - 1$, and CRSP must classify it as ordinary common equity. Thus, we exclude securities such as American Depository Receipts (ADRs) and Real Estate Investment Trusts (REITs).

Figure 2
Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on Prior Beta, 1928–2003



line, with an intercept equal to the risk-free rate, R_f, and a slope equal to the expected excess return on the market, $E(R_M) - R_f$. We use the average one-month Treasury bill rate and the average excess CRSP market return for 1928–2003 to estimate the predicted line in Figure 2. Confirming earlier evidence, the relation between beta and average return for the ten portfolios is much flatter than the Sharpe-Lintner CAPM predicts. The returns on the low beta portfolios are too high, and the returns on the high beta portfolios are too low. For example, the predicted return on the portfolio with the lowest beta is 8.3 percent per year; the actual return is 11.1 percent. The predicted return on the portfolio with the highest beta is 16.8 percent per year; the actual is 13.7 percent.

Although the observed premium per unit of beta is lower than the Sharpe-Lintner model predicts, the relation between average return and beta in Figure 2 is roughly linear. This is consistent with the Black version of the CAPM, which predicts only that the beta premium is positive. Even this less restrictive model, however, eventually succumbs to the data.

Testing Whether Market Betas Explain Expected Returns

The Sharpe-Lintner and Black versions of the CAPM share the prediction that the market portfolio is mean-variance-efficient. This implies that differences in expected return across securities and portfolios are entirely explained by differences in market beta; other variables should add nothing to the explanation of expected return. This prediction plays a prominent role in tests of the CAPM. In the early work, the weapon of choice is cross-section regressions.

In the framework of Fama and MacBeth (1973), one simply adds predetermined explanatory variables to the month-by-month cross-section regressions of returns on beta. If all differences in expected return are explained by beta, the average slopes on the additional variables should not be reliably different from zero. Clearly, the trick in the cross-section regression approach is to choose specific additional variables likely to expose any problems of the CAPM prediction that, because the market portfolio is efficient, market betas suffice to explain expected asset returns.

For example, in Fama and MacBeth (1973) the additional variables are squared market betas (to test the prediction that the relation between expected return and beta is linear) and residual variances from regressions of returns on the market return (to test the prediction that market beta is the only measure of risk needed to explain expected returns). These variables do not add to the explanation of average returns provided by beta. Thus, the results of Fama and MacBeth (1973) are consistent with the hypothesis that their market proxy—an equal-weight portfolio of NYSE stocks—is on the minimum variance frontier.

The hypothesis that market betas completely explain expected returns can also be tested using time-series regressions. In the time-series regression described above (the excess return on asset i regressed on the excess market return), the intercept is the difference between the asset's average excess return and the excess return predicted by the Sharpe-Lintner model, that is, beta times the average excess market return. If the model holds, there is no way to group assets into portfolios whose intercepts are reliably different from zero. For example, the intercepts for a portfolio of stocks with high ratios of earnings to price and a portfolio of stocks with low earning-price ratios should both be zero. Thus, to test the hypothesis that market betas suffice to explain expected returns, one estimates the time-series regression for a set of assets (or portfolios) and then jointly tests the vector of regression intercepts against zero. The trick in this approach is to choose the left-hand-side assets (or portfolios) in a way likely to expose any shortcoming of the CAPM prediction that market betas suffice to explain expected asset returns.

In early applications, researchers use a variety of tests to determine whether the intercepts in a set of time-series regressions are all zero. The tests have the same asymptotic properties, but there is controversy about which has the best small sample properties. Gibbons, Ross and Shanken (1989) settle the debate by providing an F-test on the intercepts that has exact small-sample properties. They also show that the test has a simple economic interpretation. In effect, the test constructs a candidate for the tangency portfolio T in Figure 1 by optimally combining the market proxy and the left-hand-side assets of the time-series regressions. The estimator then tests whether the efficient set provided by the combination of this tangency portfolio and the risk-free asset is reliably superior to the one obtained by combining the risk-free asset with the market proxy alone. In other words, the Gibbons, Ross and Shanken statistic tests whether the market proxy is the tangency portfolio in the set of portfolios that can be constructed by combining the market portfolio with the specific assets used as dependent variables in the time-series regressions.

Enlightened by this insight of Gibbons, Ross and Shanken (1989), one can see a similar interpretation of the cross-section regression test of whether market betas suffice to explain expected returns. In this case, the test is whether the additional explanatory variables in a cross-section regression identify patterns in the returns on the left-hand-side assets that are not explained by the assets' market betas. This amounts to testing whether the market proxy is on the minimum variance frontier that can be constructed using the market proxy and the left-hand-side assets included in the tests.

An important lesson from this discussion is that time-series and cross-section regressions do not, strictly speaking, test the CAPM. What is literally tested is whether a specific proxy for the market portfolio (typically a portfolio of U.S. common stocks) is efficient in the set of portfolios that can be constructed from it and the left-hand-side assets used in the test. One might conclude from this that the CAPM has never been tested, and prospects for testing it are not good because 1) the set of left-hand-side assets does not include all marketable assets, and 2) data for the true market portfolio of all assets are likely beyond reach (Roll, 1977; more on this later). But this criticism can be leveled at tests of any economic model when the tests are less than exhaustive or when they use proxies for the variables called for by the model.

The bottom line from the early cross-section regression tests of the CAPM, such as Fama and MacBeth (1973), and the early time-series regression tests, like Gibbons (1982) and Stambaugh (1982), is that standard market proxies seem to be on the minimum variance frontier. That is, the central predictions of the Black version of the CAPM, that market betas suffice to explain expected returns and that the risk premium for beta is positive, seem to hold. But the more specific prediction of the Sharpe-Lintner CAPM that the premium per unit of beta is the expected market return minus the risk-free interest rate is consistently rejected.

The success of the Black version of the CAPM in early tests produced a consensus that the model is a good description of expected returns. These early results, coupled with the model's simplicity and intuitive appeal, pushed the CAPM to the forefront of finance.

Recent Tests

Starting in the late 1970s, empirical work appears that challenges even the Black version of the CAPM. Specifically, evidence mounts that much of the variation in expected return is unrelated to market beta.

The first blow is Basu's (1977) evidence that when common stocks are sorted on earnings-price ratios, future returns on high E/P stocks are higher than predicted by the CAPM. Banz (1981) documents a size effect: when stocks are sorted on market capitalization (price times shares outstanding), average returns on small stocks are higher than predicted by the CAPM. Bhandari (1988) finds that high debt-equity ratios (book value of debt over the market value of equity, a measure of leverage) are associated with returns that are too high relative to their market betas.

Finally, Statman (1980) and Rosenberg, Reid and Lanstein (1985) document that stocks with high book-to-market equity ratios (B/M, the ratio of the book value of a common stock to its market value) have high average returns that are not captured by their betas.

There is a theme in the contradictions of the CAPM summarized above. Ratios involving stock prices have information about expected returns missed by market betas. On reflection, this is not surprising. A stock's price depends not only on the expected cash flows it will provide, but also on the expected returns that discount expected cash flows back to the present. Thus, in principle, the cross-section of prices has information about the cross-section of expected returns. (A high expected return implies a high discount rate and a low price.) The cross-section of stock prices is, however, arbitrarily affected by differences in scale (or units). But with a judicious choice of scaling variable X, the ratio X/P can reveal differences in the cross-section of expected stock returns. Such ratios are thus prime candidates to expose shortcomings of asset pricing models—in the case of the CAPM, shortcomings of the prediction that market betas suffice to explain expected returns (Ball, 1978). The contradictions of the CAPM summarized above suggest that earnings-price, debt-equity and book-to-market ratios indeed play this role.

Fama and French (1992) update and synthesize the evidence on the empirical failures of the CAPM. Using the cross-section regression approach, they confirm that size, earnings-price, debt-equity and book-to-market ratios add to the explanation of expected stock returns provided by market beta. Fama and French (1996) reach the same conclusion using the time-series regression approach applied to portfolios of stocks sorted on price ratios. They also find that different price ratios have much the same information about expected returns. This is not surprising given that price is the common driving force in the price ratios, and the numerators are just scaling variables used to extract the information in price about expected returns.

Fama and French (1992) also confirm the evidence (Reinganum, 1981; Stambaugh, 1982; Lakonishok and Shapiro, 1986) that the relation between average return and beta for common stocks is even flatter after the sample periods used in the early empirical work on the CAPM. The estimate of the beta premium is, however, clouded by statistical uncertainty (a large standard error). Kothari, Shanken and Sloan (1995) try to resuscitate the Sharpe-Lintner CAPM by arguing that the weak relation between average return and beta is just a chance result. But the strong evidence that other variables capture variation in expected return missed by beta makes this argument irrelevant. If betas do not suffice to explain expected returns, the market portfolio is not efficient, and the CAPM is dead in its tracks. Evidence on the size of the market premium can neither save the model nor further doom it.

The synthesis of the evidence on the empirical problems of the CAPM provided by Fama and French (1992) serves as a catalyst, marking the point when it is generally acknowledged that the CAPM has potentially fatal problems. Research then turns to explanations.

One possibility is that the CAPM's problems are spurious, the result of data dredging—publication-hungry researchers scouring the data and unearthing contradictions that occur in specific samples as a result of chance. A standard response to this concern is to test for similar findings in other samples. Chan, Hamao and Lakonishok (1991) find a strong relation between book-to-market equity (B/M) and average return for Japanese stocks. Capaul, Rowley and Sharpe (1993) observe a similar B/M effect in four European stock markets and in Japan. Fama and French (1998) find that the price ratios that produce problems for the CAPM in U.S. data show up in the same way in the stock returns of twelve non-U.S. major markets, and they are present in emerging market returns. This evidence suggests that the contradictions of the CAPM associated with price ratios are not sample specific.

Explanations: Irrational Pricing or Risk

Among those who conclude that the empirical failures of the CAPM are fatal, two stories emerge. On one side are the behavioralists. Their view is based on evidence that stocks with high ratios of book value to market price are typically firms that have fallen on bad times, while low B/M is associated with growth firms (Lakonishok, Shleifer and Vishny, 1994; Fama and French, 1995). The behavioralists argue that sorting firms on book-to-market ratios exposes investor overreaction to good and bad times. Investors overextrapolate past performance, resulting in stock prices that are too high for growth (low B/M) firms and too low for distressed (high B/M, so-called value) firms. When the overreaction is eventually corrected, the result is high returns for value stocks and low returns for growth stocks. Proponents of this view include DeBondt and Thaler (1987), Lakonishok, Shleifer and Vishny (1994) and Haugen (1995).

The second story for explaining the empirical contradictions of the CAPM is that they point to the need for a more complicated asset pricing model. The CAPM is based on many unrealistic assumptions. For example, the assumption that investors care only about the mean and variance of one-period portfolio returns is extreme. It is reasonable that investors also care about how their portfolio return covaries with labor income and future investment opportunities, so a portfolio's return variance misses important dimensions of risk. If so, market beta is not a complete description of an asset's risk, and we should not be surprised to find that differences in expected return are not completely explained by differences in beta. In this view, the search should turn to asset pricing models that do a better job explaining average returns.

Merton's (1973) intertemporal capital asset pricing model (ICAPM) is a natural extension of the CAPM. The ICAPM begins with a different assumption about investor objectives. In the CAPM, investors care only about the wealth their portfolio produces at the end of the current period. In the ICAPM, investors are concerned not only with their end-of-period payoff, but also with the opportunities they will have to consume or invest the payoff. Thus, when choosing a portfolio at time $t - 1$, ICAPM investors consider how their wealth at t might vary with future *state variables*, including labor income, the prices of consumption goods and the nature of portfolio opportunities at t, and expectations about the labor income, consumption and investment opportunities to be available after t.

Like CAPM investors, ICAPM investors prefer high expected return and low return variance. But ICAPM investors are also concerned with the covariances of portfolio returns with state variables. As a result, optimal portfolios are "multifactor efficient," which means they have the largest possible expected returns, given their return variances and the covariances of their returns with the relevant state variables.

Fama (1996) shows that the ICAPM generalizes the logic of the CAPM. That is, if there is risk-free borrowing and lending or if short sales of risky assets are allowed, market clearing prices imply that the market portfolio is multifactor efficient. Moreover, multifactor efficiency implies a relation between expected return and beta risks, but it requires additional betas, along with a market beta, to explain expected returns.

An ideal implementation of the ICAPM would specify the state variables that affect expected returns. Fama and French (1993) take a more indirect approach, perhaps more in the spirit of Ross's (1976) arbitrage pricing theory. They argue that though size and book-to-market equity are not themselves state variables, the higher average returns on small stocks and high book-to-market stocks reflect unidentified state variables that produce undiversifiable risks (covariances) in returns that are not captured by the market return and are priced separately from market betas. In support of this claim, they show that the returns on the stocks of small firms covary more with one another than with returns on the stocks of large firms, and returns on high book-to-market (value) stocks covary more with one another than with returns on low book-to-market (growth) stocks. Fama and French (1995) show that there are similar size and book-to-market patterns in the covariation of fundamentals like earnings and sales.

Based on this evidence, Fama and French (1993, 1996) propose a three-factor model for expected returns,

$$\text{(Three-Factor Model)} \quad E(R_{it}) - R_{ft} = \beta_{iM}[E(R_{Mt}) - R_{ft}] + \beta_{is}E(SMB_t) + \beta_{ih}E(HML_t).$$

In this equation, SMB_t (small minus big) is the difference between the returns on diversified portfolios of small and big stocks, HML_t (high minus low) is the difference between the returns on diversified portfolios of high and low B/M stocks, and the betas are slopes in the multiple regression of $R_{it} - R_{ft}$ on $R_{Mt} - R_{ft}$, SMB_t and HML_t.

For perspective, the average value of the market premium $R_{Mt} - R_{ft}$ for 1927–2003 is 8.3 percent per year, which is 3.5 standard errors from zero. The average values of SMB_t, and HML_t are 3.6 percent and 5.0 percent per year, and they are 2.1 and 3.1 standard errors from zero. All three premiums are volatile, with annual standard deviations of 21.0 percent $(R_{Mt} - R_{ft})$, 14.6 percent (SMB_t) and 14.2 percent (HML_t) per year. Although the average values of the premiums are large, high volatility implies substantial uncertainty about the true expected premiums.

One implication of the expected return equation of the three-factor model is that the intercept α_i in the time-series regression,

$$R_{it} - R_{ft} = \alpha_i + \beta_{iM}(R_{Mt} - R_{ft}) + \beta_{is}SMB_t + \beta_{ih}HML_t + \varepsilon_{it},$$

is zero for all assets *i*. Using this criterion, Fama and French (1993, 1996) find that the model captures much of the variation in average return for portfolios formed on size, book-to-market equity and other price ratios that cause problems for the CAPM. Fama and French (1998) show that an international version of the model performs better than an international CAPM in describing average returns on portfolios formed on scaled price variables for stocks in 13 major markets.

The three-factor model is now widely used in empirical research that requires a model of expected returns. Estimates of α_i from the time-series regression above are used to calibrate how rapidly stock prices respond to new information (for example, Loughran and Ritter, 1995; Mitchell and Stafford, 2000). They are also used to measure the special information of portfolio managers, for example, in Carhart's (1997) study of mutual fund performance. Among practitioners like Ibbotson Associates, the model is offered as an alternative to the CAPM for estimating the cost of equity capital.

From a theoretical perspective, the main shortcoming of the three-factor model is its empirical motivation. The small-minus-big (SMB) and high-minus-low (HML) explanatory returns are not motivated by predictions about state variables of concern to investors. Instead they are brute force constructs meant to capture the patterns uncovered by previous work on how average stock returns vary with size and the book-to-market equity ratio.

But this concern is not fatal. The ICAPM does not require that the additional portfolios used along with the market portfolio to explain expected returns "mimic" the relevant state variables. In both the ICAPM and the arbitrage pricing theory, it suffices that the additional portfolios are well diversified (in the terminology of Fama, 1996, they are multifactor minimum variance) and that they are sufficiently different from the market portfolio to capture covariation in returns and variation in expected returns missed by the market portfolio. Thus, adding diversified portfolios that capture covariation in returns and variation in average returns left unexplained by the market is in the spirit of both the ICAPM and the Ross's arbitrage pricing theory.

The behavioralists are not impressed by the evidence for a risk-based explanation of the failures of the CAPM. They typically concede that the three-factor model captures covariation in returns missed by the market return and that it picks up much of the size and value effects in average returns left unexplained by the CAPM. But their view is that the average return premium associated with the model's book-to-market factor—which does the heavy lifting in the improvements to the CAPM—is itself the result of investor overreaction that happens to be correlated across firms in a way that just looks like a risk story. In short, in the behavioral view, the market tries to set CAPM prices, and violations of the CAPM are due to mispricing.

The conflict between the behavioral irrational pricing story and the rational risk story for the empirical failures of the CAPM leaves us at a timeworn impasse. Fama (1970) emphasizes that the hypothesis that prices properly reflect available information must be tested in the context of a model of expected returns, like the CAPM. Intuitively, to test whether prices are rational, one must take a stand on what the market is trying to do in setting prices—that is, what is risk and what is the relation between expected return and risk? When tests reject the CAPM, one cannot say whether the problem is its assumption that prices are rational (the behavioral view) or violations of other assumptions that are also necessary to produce the CAPM (our position).

Fortunately, for some applications, the way one uses the three-factor model does not depend on one's view about whether its average return premiums are the rational result of underlying state variable risks, the result of irrational investor behavior or sample specific results of chance. For example, when measuring the response of stock prices to new information or when evaluating the performance of managed portfolios, one wants to account for known patterns in returns and average returns for the period examined, whatever their source. Similarly, when estimating the cost of equity capital, one might be unconcerned with whether expected return premiums are rational or irrational since they are in either case part of the opportunity cost of equity capital (Stein, 1996). But the cost of capital is forward looking, so if the premiums are sample specific they are irrelevant.

The three-factor model is hardly a panacea. Its most serious problem is the momentum effect of Jegadeesh and Titman (1993). Stocks that do well relative to the market over the last three to twelve months tend to continue to do well for the next few months, and stocks that do poorly continue to do poorly. This momentum effect is distinct from the value effect captured by book-to-market equity and other price ratios. Moreover, the momentum effect is left unexplained by the three-factor model, as well as by the CAPM. Following Carhart (1997), one response is to add a momentum factor (the difference between the returns on diversified portfolios of short-term winners and losers) to the three-factor model. This step is again legitimate in applications where the goal is to abstract from known patterns in average returns to uncover information-specific or manager-specific effects. But since the momentum effect is short-lived, it is largely irrelevant for estimates of the cost of equity capital.

Another strand of research points to problems in both the three-factor model and the CAPM. Frankel and Lee (1998), Dechow, Hutton and Sloan (1999), Piotroski (2000) and others show that in portfolios formed on price ratios like book-to-market equity, stocks with higher expected cash flows have higher average returns that are not captured by the three-factor model or the CAPM. The authors interpret their results as evidence that stock prices are irrational, in the sense that they do not reflect available information about expected profitability.

In truth, however, one can't tell whether the problem is bad pricing or a bad asset pricing model. A stock's price can always be expressed as the present value of expected future cash flows discounted at the expected return on the stock (Campbell and Shiller, 1989; Vuolteenaho, 2002). It follows that if two stocks have the same price, the one with higher expected cash flows must have a higher expected return. This holds true whether pricing is rational or irrational. Thus, when one observes a positive relation between expected cash flows and expected returns that is left unexplained by the CAPM or the three-factor model, one can't tell whether it is the result of irrational pricing or a misspecified asset pricing model.

The Market Proxy Problem

Roll (1977) argues that the CAPM has never been tested and probably never will be. The problem is that the market portfolio at the heart of the model is theoretically and empirically elusive. It is not theoretically clear which assets (for example, human capital) can legitimately be excluded from the market portfolio, and data availability substantially limits the assets that are included. As a result, tests of the CAPM are forced to use proxies for the market portfolio, in effect testing whether the proxies are on the minimum variance frontier. Roll argues that because the tests use proxies, not the true market portfolio, we learn nothing about the CAPM.

We are more pragmatic. The relation between expected return and market beta of the CAPM is just the minimum variance condition that holds in any efficient portfolio, applied to the market portfolio. Thus, if we can find a market proxy that is on the minimum variance frontier, it can be used to describe differences in expected returns, and we would be happy to use it for this purpose. The strong rejections of the CAPM described above, however, say that researchers have not uncovered a reasonable market proxy that is close to the minimum variance frontier. If researchers are constrained to reasonable proxies, we doubt they ever will.

Our pessimism is fueled by several empirical results. Stambaugh (1982) tests the CAPM using a range of market portfolios that include, in addition to U.S. common stocks, corporate and government bonds, preferred stocks, real estate and other consumer durables. He finds that tests of the CAPM are not sensitive to expanding the market proxy beyond common stocks, basically because the volatility of expanded market returns is dominated by the volatility of stock returns.

One need not be convinced by Stambaugh's (1982) results since his market proxies are limited to U.S. assets. If international capital markets are open and asset prices conform to an international version of the CAPM, the market portfolio should include international assets. Fama and French (1998) find, however, that betas for a global stock market portfolio cannot explain the high average returns observed around the world on stocks with high book-to-market or high earnings-price ratios.

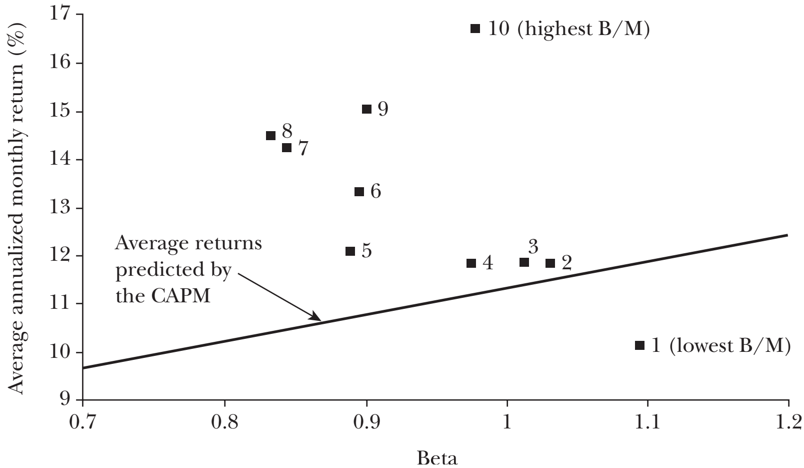
A major problem for the CAPM is that portfolios formed by sorting stocks on price ratios produce a wide range of average returns, but the average returns are not positively related to market betas (Lakonishok, Shleifer and Vishny, 1994; Fama and French, 1996, 1998). The problem is illustrated in Figure 3, which shows average returns and betas (calculated with respect to the CRSP value-weight portfolio of NYSE, AMEX and NASDAQ stocks) for July 1963 to December 2003 for ten portfolios of U.S. stocks formed annually on sorted values of the book-to-market equity ratio (B/M).[6]

Average returns on the B/M portfolios increase almost monotonically, from 10.1 percent per year for the lowest B/M group (portfolio 1) to an impressive 16.7 percent for the highest (portfolio 10). But the positive relation between beta and average return predicted by the CAPM is notably absent. For example, the portfolio with the lowest book-to-market ratio has the highest beta but the lowest average return. The estimated beta for the portfolio with the highest book-to-market ratio and the highest average return is only 0.98. With an average annualized value of the riskfree interest rate, R_f, of 5.8 percent and an average annualized market premium, $R_M - R_f$, of 11.3 percent, the Sharpe-Lintner CAPM predicts an average return of 11.8 percent for the lowest B/M portfolio and 11.2 percent for the highest, far from the observed values, 10.1 and 16.7 percent. For the Sharpe-Lintner model to "work" on these portfolios, their market betas must change dramatically, from 1.09 to 0.78 for the lowest B/M portfolio and from 0.98 to 1.98 for the highest. We judge it unlikely that alternative proxies for the market portfolio will produce betas and a market premium that can explain the average returns on these portfolios.

It is always possible that researchers will redeem the CAPM by finding a reasonable proxy for the market portfolio that is on the minimum variance frontier. We emphasize, however, that this possibility cannot be used to justify the way the CAPM is currently applied. The problem is that applications typically use the same

[6] Stock return data are from CRSP, and book equity data are from Compustat and the Moody's Industrials, Transportation, Utilities and Financials manuals. Stocks are allocated to ten portfolios at the end of June of each year t (1963 to 2003) using the ratio of book equity for the fiscal year ending in calendar year $t - 1$, divided by market equity at the end of December of $t - 1$. Book equity is the book value of stockholders' equity, plus balance sheet deferred taxes and investment tax credit (if available), minus the book value of preferred stock. Depending on availability, we use the redemption, liquidation or par value (in that order) to estimate the book value of preferred stock. Stockholders' equity is the value reported by Moody's or Compustat, if it is available. If not, we measure stockholders' equity as the book value of common equity plus the par value of preferred stock or the book value of assets minus total liabilities (in that order). The portfolios for year t include NYSE (1963–2003), AMEX (1963–2003) and NASDAQ (1972–2003) stocks with positive book equity in $t - 1$ and market equity (from CRSP) for December of $t - 1$ and June of t. The portfolios exclude securities CRSP does not classify as ordinary common equity. The breakpoints for year t use only securities that are on the NYSE in June of year t.

Figure 3
Average Annualized Monthly Return versus Beta for Value Weight Portfolios Formed on B/M, 1963–2003



market proxies, like the value-weight portfolio of U.S. stocks, that lead to rejections of the model in empirical tests. The contradictions of the CAPM observed when such proxies are used in tests of the model show up as bad estimates of expected returns in applications; for example, estimates of the cost of equity capital that are too low (relative to historical average returns) for small stocks and for stocks with high book-to-market equity ratios. In short, if a market proxy does not work in tests of the CAPM, it does not work in applications.

Conclusions

The version of the CAPM developed by Sharpe (1964) and Lintner (1965) has never been an empirical success. In the early empirical work, the Black (1972) version of the model, which can accommodate a flatter tradeoff of average return for market beta, has some success. But in the late 1970s, research begins to uncover variables like size, various price ratios and momentum that add to the explanation of average returns provided by beta. The problems are serious enough to invalidate most applications of the CAPM.

For example, finance textbooks often recommend using the Sharpe-Lintner CAPM risk-return relation to estimate the cost of equity capital. The prescription is to estimate a stock's market beta and combine it with the risk-free interest rate and the average market risk premium to produce an estimate of the cost of equity. The typical market portfolio in these exercises includes just U.S. common stocks. But empirical work, old and new, tells us that the relation between beta and average return is flatter than predicted by the Sharpe-Lintner version of the CAPM. As a result, CAPM estimates of the cost of equity for high beta stocks are too high (relative to historical average returns) and estimates for low beta stocks are too low (Friend and Blume, 1970). Similarly, if the high average returns on value stocks (with high book-to-market ratios) imply high expected returns, CAPM cost of equity estimates for such stocks are too low.[7]

The CAPM is also often used to measure the performance of mutual funds and other managed portfolios. The approach, dating to Jensen (1968), is to estimate the CAPM time-series regression for a portfolio and use the intercept (Jensen's alpha) to measure abnormal performance. The problem is that, because of the empirical failings of the CAPM, even passively managed stock portfolios produce abnormal returns if their investment strategies involve tilts toward CAPM problems (Elton, Gruber, Das and Hlavka, 1993). For example, funds that concentrate on low beta stocks, small stocks or value stocks will tend to produce positive abnormal returns relative to the predictions of the Sharpe-Lintner CAPM, even when the fund managers have no special talent for picking winners.

The CAPM, like Markowitz's (1952, 1959) portfolio model on which it is built, is nevertheless a theoretical tour de force. We continue to teach the CAPM as an introduction to the fundamental concepts of portfolio theory and asset pricing, to be built on by more complicated models like Merton's (1973) ICAPM. But we also warn students that despite its seductive simplicity, the CAPM's empirical problems probably invalidate its use in applications.

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[7] The problems are compounded by the large standard errors of estimates of the market premium and of betas for individual stocks, which probably suffice to make CAPM estimates of the cost of equity rather meaningless, even if the CAPM holds (Fama and French, 1997; Pastor and Stambaugh, 1999). For example, using the U.S. Treasury bill rate as the risk-free interest rate and the CRSP value-weight portfolio of publicly traded U.S. common stocks, the average value of the equity premium $R_{Mt} - R_{ft}$ for 1927–2003 is 8.3 percent per year, with a standard error of 2.4 percent. The two standard error range thus runs from 3.5 percent to 13.1 percent, which is sufficient to make most projects appear either profitable or unprofitable. This problem is, however, hardly special to the CAPM. For example, expected returns in all versions of Merton's (1973) ICAPM include a market beta and the expected market premium. Also, as noted earlier the expected values of the size and book-to-market premiums in the Fama-French three-factor model are also estimated with substantial error.

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model results is considerably enhanced when applying financial models to a large group of companies. Moreover, small samples are subject to measurement error, in violation of the Central Limit Theorem of statistics.[2] From a statistical standpoint, reliance on robust sample sizes mitigates the impact of possible measurement errors and vagaries in individual companies' market data. Examples of such vagaries include dividend suspension, insufficient or unrepresentative historical data due to a recent merger, impending merger or acquisition, and a new corporate identity due to restructuring activities.

The construction of reference groups inevitably involves a tradeoff between statistical adequacy and scientific accuracy. One the one hand, the screening criteria have to be stringent enough so as to capture companies whose risk is the same as the target utility, but on the other they must be flexible enough to allow enough companies to survive for the analysis to be statistically meaningful.

Formation of Comparable Groups

There are two generic approaches to forming proxy groups of companies. The first approach, referred to as the "direct" or "focused" approach, consists of selecting a group of pure-play companies that are **directly** comparable in risk to the subject utility. These companies are chosen by the application of stringent screening criteria to a universe of utility stocks in an attempt to identify companies with the same investment risk as the subject utility. There are several qualitative measures that influence investors' assessments of risk that can be employed as screening devices, for example, SIC classification code, bond ratings, beta risk measures, business risk scores, size (market capitalization), common equity ratio, percentage of revenues from regulated utility operations, geographical location, nuclear investment, etc. Provided the screening criteria are defined and applied correctly, the end result is usually a fairly small sample of companies with a risk profile similar to that of the subject utility. The second approach, referred to as the "indirect" approach, consists of selecting a large group of utilities representative of the utility

[2] The Central Limit Theorem (CLT) describes the characteristics of the distribution of values we would obtain if we were able to draw an infinite number of random samples of a given size from a given population and we calculated the mean of each sample. The CLT asserts: [1] The mean of the sampling distribution of means is equal to the mean of the population from which the samples were drawn. [2] The variance of the sampling distribution of means is equal to the variance of the population from which the samples were drawn divided by the size of the samples. [3] If the original population is distributed normally, the sampling distribution of means also will be normal. If the original population is not distributed normally, the sampling distribution of means will increasingly approximate a normal distribution as sample size increases.

industry average and then making adjustments to account for any difference in investment risk between the subject utility and the industry average.

It is a matter of judgment as to which of the two broad approaches should be employed. To illustrate, from the late 1990s to the mid 2000s, the DCF approach applied to focused groups of electric utilities produced widely scattered cost of equity estimates, with some estimates negative or barely above the cost of debt. The composition of small groups of electric utility companies was very fluid in that kind of unstable industry environment, with companies exiting the sample due to dividend suspensions or reductions, insufficient or unrepresentative historical data due to recent mergers, divestitures, impending mergers or acquisitions, and changing corporate identities due to restructuring activities. Many electric utilities became part of larger corporate entities, or divested their generation assets. Several of the utility companies' bonds were downgraded or put on credit watch or negative outlook by the bond rating agencies. Under such circumstances of instability, a superior approach was to apply cost of capital estimation techniques to a large group of electric utilities representative of the electric utility industry and then make adjustments to account for any difference in investment risk between the subject utility and the industry average.

Examples of Direct Approach

The following are examples of forming focused proxy groups. Many variations and refinements are possible, and these examples are suggestive and illustrative of the general procedure.

Example 1: The subject utility is a natural gas distribution company that is a wholly owned subsidiary of a parent company. As proxies for the subject utility's beta in a CAPM analysis, the betas of both the parent company and the betas of a sample of publicly traded natural gas distribution utilities can be examined, provided that the parent company is involved primarily in natural gas distribution activities. In order to minimize the well-known thin trading bias in measuring beta, it is reasonable to limit the sample to companies whose market capitalization exceeds a minimum capitalization threshold, say \$500 million.[2] The average beta of investment-grade electricity distribution utilities covered by Standard & Poor's provides a third proxy for the subject

[2] The thin trading bias occurs because observed returns contain stale information about past period returns rather than current period returns. Intuitively, if the stock market index surges forward but an individual company stock price remains unchanged due to lack of trading, the estimated beta is imparted a downward bias. The stock is unable to catch up to market-wide movements and appears to be a lower beta stock. Adjustment for the thin trading effect increases the beta estimate.

utility's beta.[4] This procedure is reasonable given that the natural gas distribution business possesses an investment risk profile that is similar in risk to investment-grade electricity distribution utilities. The latter possess economic characteristics similar to those of natural gas distribution utilities as they are both involved in the distribution of energy services products at regulated rates in a cyclical and weather-sensitive market. They both employ a capital-intensive network with similar physical characteristics. They are both subject to rate of return regulation. The CAPM, Risk Premium, and DCF methods are applied to the three proxies excluding inactively traded and nondividend-paying companies in the DCF analysis. The same procedure works in reverse if dealing with a subject utility involved in the distribution of electricity instead of natural gas. In other words, the proxies are interchangeable.

Example 2: The subject utility is an investment-grade vertically integrated electric utility that is a wholly owned subsidiary of a parent company, involved in both electricity and natural gas operations. In the CAPM analysis, 1) the average historical beta of the electric utility industry as represented by the electric utilities that make up Moody's Electric Utility Index and are covered by Value Line, 2) the average beta for the investment-grade parent companies of all those operating electric utilities designated as "vertically integrated" by Standard & Poor's covered by Value Line, and 3) the average beta for all investment-grade combination gas and electric utilities covered by Value Line, constitute reasonable proxies for the subject utility's business operations. The CAPM, Risk Premium, and DCF methods are applied to all three proxies, excluding inactively traded and nondividend-paying companies in the DCF analysis.

Example 3: The subject utility is the generation segment of a vertically integrated electric utility. The operating utilities designated as "diversified energy and non-energy" utilities by S&P in a 2004 comprehensive analysis of utility business risks provide a first proxy for the power generation business. This group includes the parent companies of electric utilities engaged in a diversified mix of energy utility businesses, especially power generation, with Value Line coverage and for which beta risk measures are available. A group of high-quality oil and gas producers contained in Value Line's "Petroleum

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[4] The group consists of utilities designated as "distribution" utilities by S&P in a 2004 comprehensive analysis of utility business risks. The original group includes gas, electricity, and natural gas distribution operating companies engaged in predominantly monopolistic distribution activities. Companies below investment grade, that is, companies with a bond rating below Baa3, are eliminated as well as those companies without Value Line coverage. The final sample of companies is made up of the parent company of these investment-grade operating electricity distribution companies.

Commission Decisions

In concluding this introduction section, it is instructive to consider what returns on equity have been authorized by U.S. regulatory commissions. Table 2 summarizes the annual average returns on equity authorized by regulatory commissions for each year 1981 to 2009 by Regulatory Research Associates.

TABLE 2
AUTHORIZED RETURNS ON EQUITY

	Electric Utilities		Gas Utilities	
Year	ROE %	# Cases	ROE %	# Cases
1981	15.22%	123	15.11%	60
1982	15.78%	125	15.62%	83
1983	15.36%	95	15.25%	65
1984	15.32%	75	15.31%	39
1985	15.20%	58	14.75%	34
1986	13.93%	49	13.46%	25
1987	12.99%	57	12.74%	29
1988	12.79%	33	12.85%	31
1989	12.97%	27	12.88%	31
1990	12.70%	44	12.67%	31
1991	12.55%	45	12.46%	35
1992	12.09%	48	12.01%	29
1993	11.41%	32	11.35%	45
1994	11.34%	31	11.35%	28
1995	11.55%	33	11.43%	16
1996	11.39%	22	11.19%	20
1997	11.40%	11	11.29%	13
1998	11.66%	10	11.51%	10
1999	10.77%	20	10.66%	9
2000	11.43%	12	11.39%	12
2001	11.09%	18	10.95%	7
2002	11.16%	22	11.03%	21
2003	10.97%	22	10.99%	25
2004	10.75%	19	10.59%	20
2005	10.54%	29	10.46%	26
2006	10.36%	26	10.43%	16
2007	10.36%	39	10.24%	37
2008	10.46%	37	10.37%	30
2009	10.48%	39	10.19%	29

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RRA Regulatory Focus
Major Rate Case Decisions - January - December 2020

With the U.S. economy challenged in 2020 by the fallout from the COVID-19 pandemic, the equity returns authorized electric and gas utilities nationwide fell to its worst year on record.

Based on data gathered by Regulatory Research Associates, a group within S&P Global Market Intelligence, the average return on equity authorized electric utilities was 9.44% in all rate cases decided in 2020, below the 9.66% average for cases in 2019. There were 55 electric ROE determinations in 2020, versus 47 in 2019.

The average ROE authorized gas utilities was 9.46% in cases decided in 2020 versus 9.71% in 2019. There were 34 gas cases that included an ROE determination in 2020 versus 32 in 2019.

Included in the electric ROE average is a decision by the Maine Public Utilities Commission in which the commission reduced Central Maine Power Co.'s ROE by 100 basis points to 8.25% due to imprudence associated with a new billing system. The adjustment is to be lifted when the utility meets all performance benchmarks for all service quality metrics for at least 18 consecutive months after March 1, 2020, and formally demonstrates to the commission that the problems have been resolved.

In addition, the electric ROE average in 2020 was also weighed down by an 8.20% ROE authorized Green Mountain Power, as calculated under the company's multiyear regulation plan which employs a formulaic approach tied to U.S. Treasuries.

This data includes several limited-issue rider cases. Excluding these cases, the average authorized ROE was 9.39% in electric rate cases decided in 2020, versus 9.65% observed in 2019. The difference between the ROE averages including rider cases and those excluding the rider cases is driven by ROE premiums allowed in Virginia for riders that address recovery of specific generation projects.

In 2020, the median ROE authorized in all electric utility rate cases was 9.45%, versus 9.65% in 2019; for gas utilities, the metric was 9.42% in 2020, versus 9.70% in 2019.

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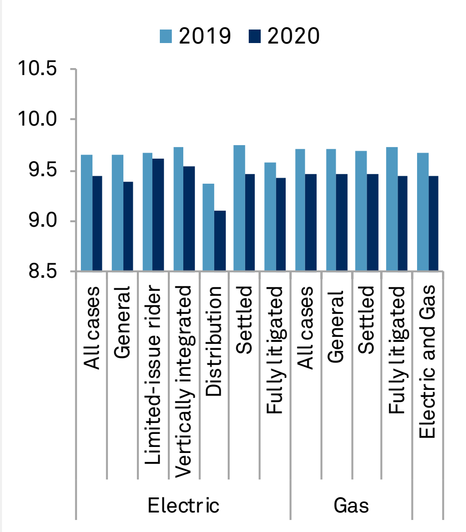
For Detailed Data

Click here to see supporting data tables.

Average authorized return on equity (%)
Dashboard



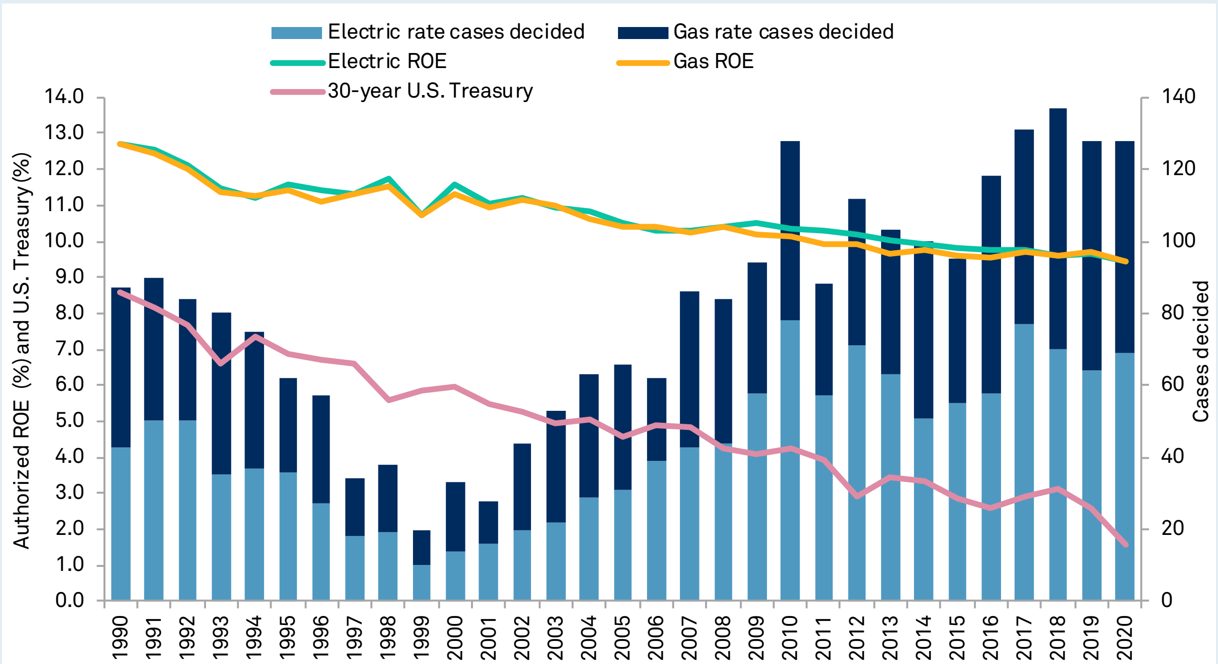
Electric average	2019	2020	
All cases	9.66	9.44	▼
General rate cases	9.65	9.39	▼
Limited-issue rider cases	9.68	9.62	▼
Vertically integrated cases	9.74	9.55	▼
Distribution cases	9.37	9.10	▼
Settled cases	9.76	9.46	▼
Fully litigated cases	9.58	9.43	▼
Gas average	**2019**	**2020**	
All cases	9.71	9.46	▼
General rate cases	9.72	9.46	▼
Settled cases	9.70	9.47	▼
Fully litigated cases	9.74	9.44	▼
Composite electric and gas averages	**2019**	**2020**	
Electric and Gas	9.68	9.45	▼
U.S. Treasury	**2019**	**2020**	
30-year bond yield	2.58	1.56	▼

Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

The averages in 2020 are at the lowest levels ever witnessed in the industry, and with the recent interest rate cuts by the U.S. Federal Reserve and current pandemic-induced recession, even lower authorized returns may be on the horizon.

From a longer-term perspective, interest rates, as measured by the 30-year U.S. Treasury bond yield, fell almost steadily from the early 1980s until 2015 or so, placing downward pressure on authorized ROEs. Even though the decline has been less dramatic in the period since 1990, average authorized ROEs fell below 10% for gas utilities in 2011 and for electric utilities in 2014.

Average electric and gas authorized ROEs and number of rate cases decided



Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

Since 2010, rate case activity has been robust, with 100 or more cases adjudicated in nine of the last 11 calendar years. This count includes electric and gas cases where no ROEs have been specified; however, withdrawn cases are not included. After reaching an almost 30-year high in 2018, when almost 140 cases were decided, rate case activity moderated somewhat in both 2019 and 2020, with about 128 electric and gas cases resolved in each year.

Absent the pandemic, increased costs associated with environmental compliance, generation and delivery infrastructure upgrades and expansion, renewable generation mandates, storm and disaster recovery, cybersecurity and employee benefits have contributed to an active rate case agenda over the last decade.

Due to COVID-19 and the challenging economic backdrop, many utilities and state commissions in 2020 found creative ways to limit the immediate impact of rate hikes by pushing rate changes into a future period or agreeing to forgo rate hikes.

Currently, there are about 75 rate cases pending. With the economy still reeling from the pandemic, we expect the pace of rate case activity to be somewhat measured in 2021.

Rising interest rates over the past several years also likely contributed to the increased rate case activity. After holding rates near zero for several years, the Federal Reserve began raising the federal funds rate in 2015. Before the pandemic hit, the Fed, after more than a decade without a cut, lowered rates three times in 2019, due to signs of a slowing economy. In addition, to stabilize the economy from the fallout from the coronavirus outbreak, the Fed cut rates twice in March 2020, resulting in a target range of 0%-0.25%. To facilitate economic recovery, Fed policymakers have indicated that it will keep rates anchored near zero through 2023.

While changes in the federal funds rate do not move in lockstep with longer-term treasuries and authorized ROEs do not move in lockstep with interest rates, the expectation is that as interest rates change, authorized ROEs would also change in a similar fashion. However, several factors impact the timing and magnitude of such a shift. Normal regulatory lag, i.e., the amount of time it takes for a utility to put together a rate case filing and tender it to the commission and then for the commission to process the case, would without any other influences delay a change in average authorized ROEs relative to interest rates.

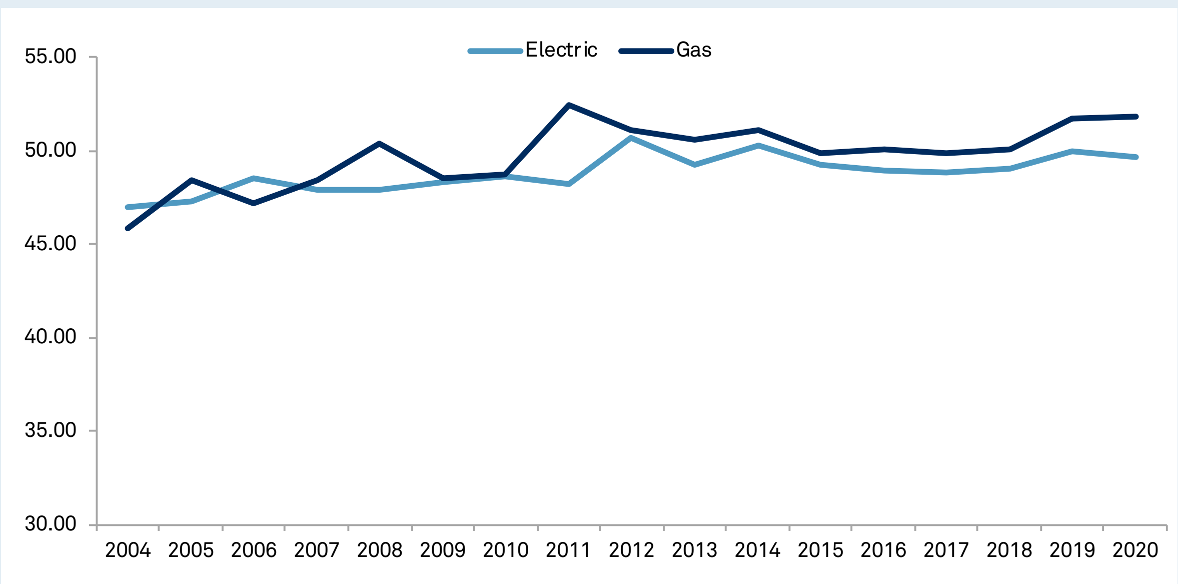
It is also worth noting that while both interest rates and authorized ROEs have generally been declining since 1990, the gap between authorized ROEs and interest rates widened somewhat over this period, largely as a result of an often-unstated understanding by regulators that the drop in interest rates caused by Federal Reserve intervention was unusual.

However, given the focus on customers' ability to pay and the need to maintain universal service as the pandemic drags on, regulators may be more apt to further lower authorized ROEs to mitigate the level of bill increases that result from recovery of pandemic-related costs. These considerations could be further complicated if the Biden administration seeks to roll-back the 2017 corporate tax reform initiatives.

Capital structure trends

To offset the negative cash flow impact of 2017 federal tax reform, many utilities sought higher common equity ratios, and the average authorized equity ratios adopted by utility commissions in 2019 were modestly higher than the levels observed in 2018 and 2017. In cases decided in 2020, the average authorized equity ratio for electric utilities was 49.69%. For 2019, 2018 and 2017, the average equity ratios authorized in electric utility cases were 49.94%, 49.02% and 48.90%, respectively. The average allowed equity ratio for gas utilities nationwide in cases decided in 2020 was 51.86%. For 2019, 2018 and 2017, the average was 51.75%, 50.12% and 49.88%, respectively.

Average authorized capital structures (%)



Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

Taking a longer-term view, equity ratios have generally increased over the last several years — the average equity ratio approved in electric rate cases decided during 2004 was 46.96%, while the average for gas utilities was 45.81%. Many commissions began approving more equity-rich capital structures in the wake of the 2008 financial crisis.

A more granular look at ROE trends

The discussion thus far has looked broadly at trends in authorized ROEs; the sections that follow provide a more granular view based upon the types of proceedings/decisions in which these ROEs were established.

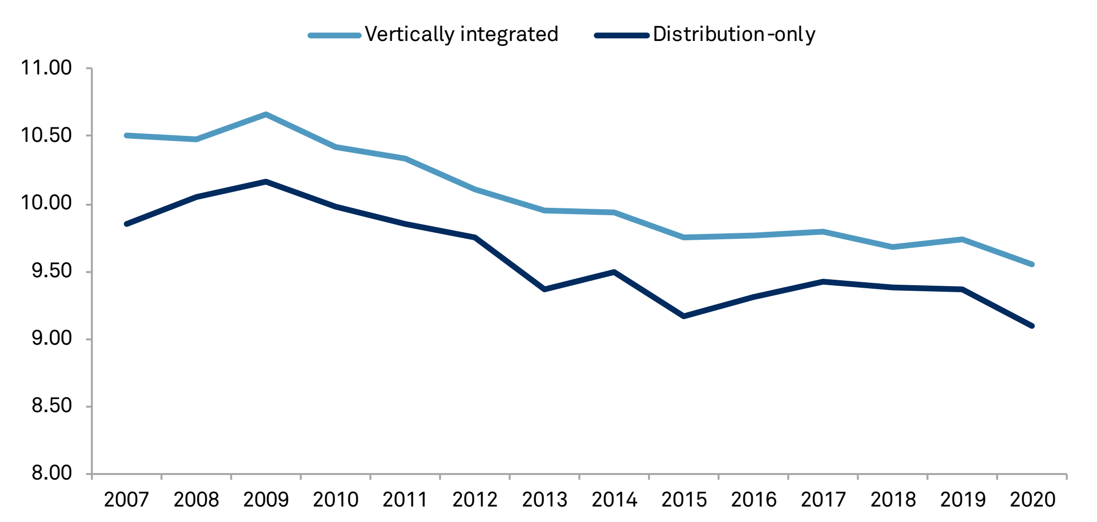
RRA has observed that there can be significant differences between the average ROEs from one subcategory of cases to another.

As a result of electric industry restructuring, certain states unbundled electric rates and implemented retail competition for generation. Commissions in those states now have jurisdiction only over the revenue requirement and return parameters for delivery operations.

Comparing electric vertically integrated cases versus delivery-only proceedings over the past several years, RRA finds that the annual average authorized ROEs in vertically integrated cases typically are about 30 to 65 basis points higher than in delivery-only cases, arguably reflecting the increased risk associated with ownership and operation of generation assets.

The industry average ROE for vertically integrated electric utilities was 9.55% in cases decided in 2020, versus the 9.74% average posted in 2019. By comparison, for electric distribution-only utilities, the industry average ROE authorized in 2020 was 9.10%, versus 9.37% in 2019.

Average authorized electric ROEs (%)

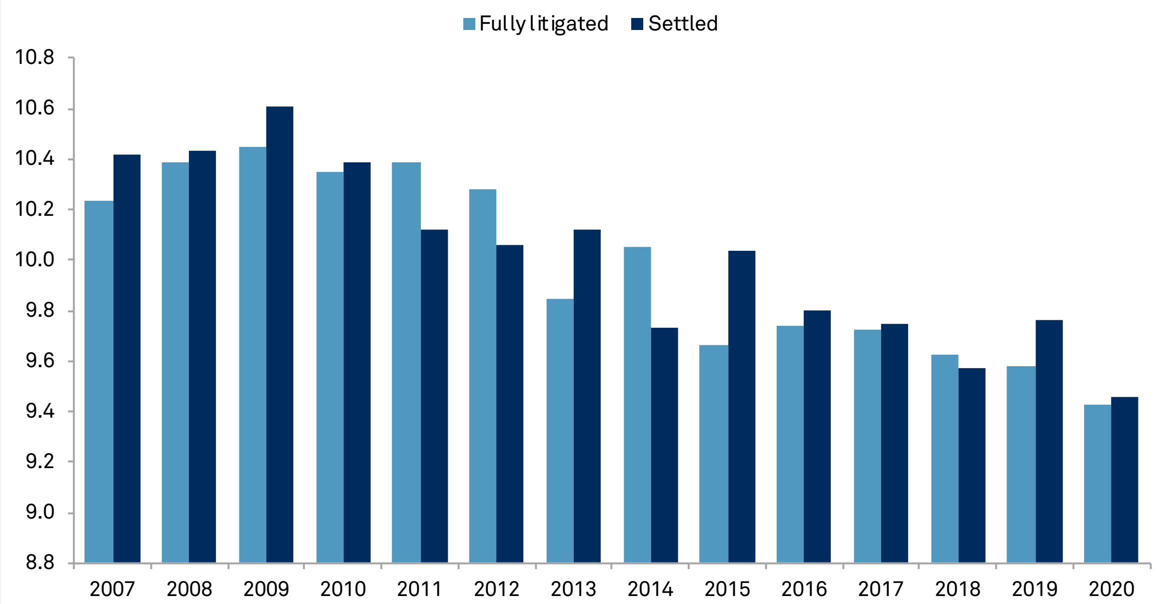


Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

Settlements have frequently been used to resolve rate cases over the last several years, and in many cases, these settlements are "black box" in nature and do not specify the ROE and other typical rate case parameters underlying the stipulated rate change. However, some states preclude this type of treatment, and settlements must specify these values, if not the specific adjustments from which these values were derived.

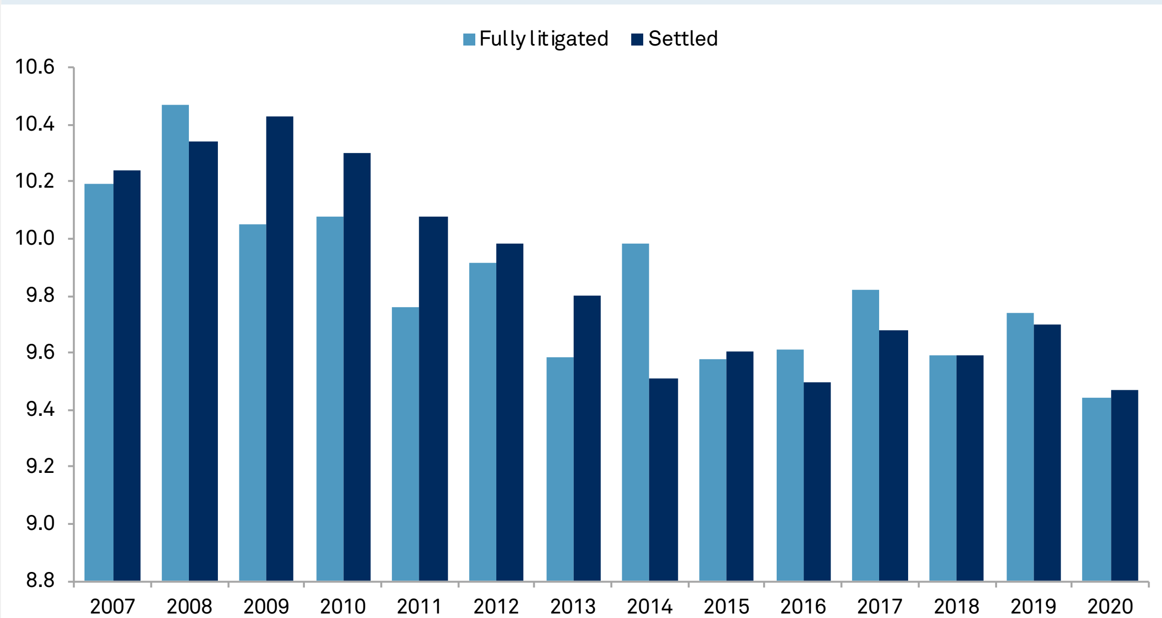
For both electric and gas cases, RRA has found no discernible pattern in the average authorized ROEs in cases that were settled versus those that were fully litigated. In some years, the average authorized ROE was higher for fully litigated cases, in others, it was higher for settled cases, and in a handful of years, the authorized ROE was similar for both fully litigated and settled cases.

Average authorized electric ROEs, settled vs. fully litigated cases (%)



Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

Average authorized gas ROEs, settled vs. fully litigated cases (%)



Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

For several years, the annual average authorized ROEs in electric cases that involve limited-issue riders were meaningfully higher than those approved in general rate cases, driven primarily by the ROE premiums authorized in generation-related limited-issue rider proceedings in Virginia. However, these premiums were approved for limited durations and have since begun to expire. As a result, the gap between the average ROE observed in the rider cases and that observed in general rate cases has narrowed. Limited-issue rider cases in which a separate ROE is determined have had limited use in the gas industry, as most of the gas riders rely on ROEs approved in a previous base rate case.

The following discussion focuses on the corresponding tables available here.

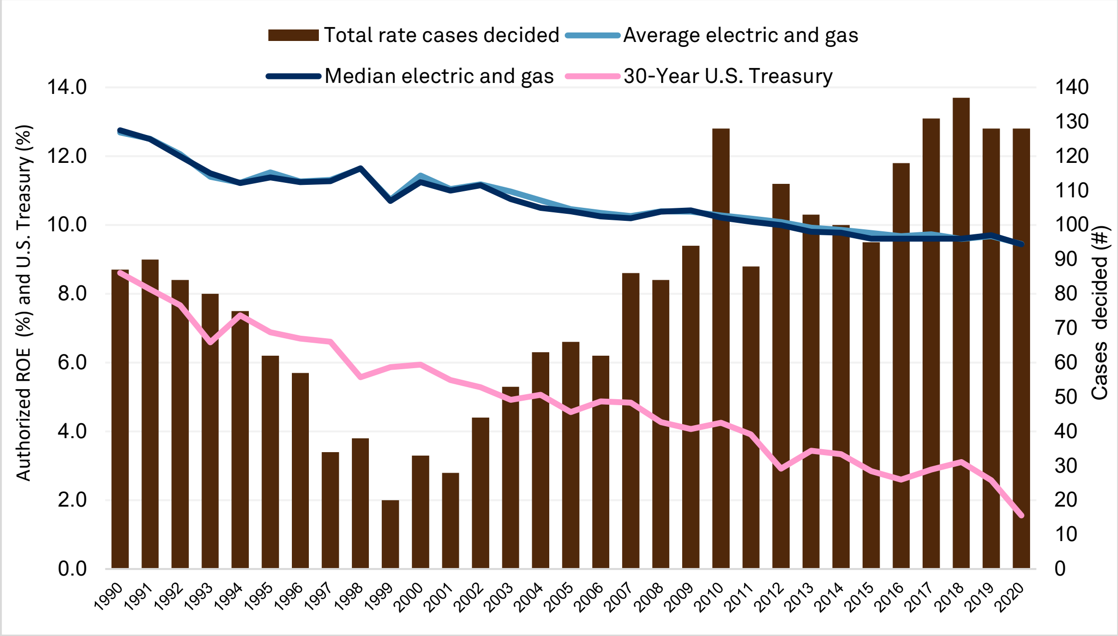
Table 1 shows the average ROE authorized in major electric and gas rate decisions annually since 1990 and by quarter since 2016, followed by the number of observations in each period. **Table 2** indicates the composite electric and gas industry data for all major cases, summarized annually since 2004 and by quarter for the past eight quarters.

Tables 3 and 4 provide comparisons since 2007 of average authorized ROEs for settled versus fully litigated cases, general rate cases versus limited-issue rider proceedings and vertically integrated cases versus delivery-only cases for electric and gas utilities, respectively.

The individual electric and gas cases decided in 2020 are listed in **Table 5**, with the decision date shown first, followed by the company name, the abbreviation for the state issuing the decision, the authorized rate of return, the ROE and the percentage of common equity in the adopted capital structure. Next, RRA indicates the month and year in which the adopted test year ended, whether the commission utilized an average or a year-end rate base and the amount of the permanent rate change authorized. The dollar amounts represent the permanent rate change ordered at the time decisions were rendered. Fuel adjustment clause rate changes are not reflected in this study.

The simple mean is utilized for the return averages. In addition, the average equity returns indicated in this report reflect the ROEs approved in cases that were decided during the specified time periods and are not necessarily representative of either the average currently authorized ROEs for utilities industrywide or the returns actually earned by the utilities.

Composite electric and gas authorized ROEs and number of rate cases



Data compiled Jan. 27, 2021.
Source: Regulatory Research Associates, a group within S&P Global Market Intelligence

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Table 6 and the graph above track the average and median equity return authorized for all electric and gas rate cases combined by year for the last 30 years. As the table indicates, since 1990, authorized ROEs have generally trended downward, reflecting the significant decline in interest rates and capital costs that has occurred over this time frame. The combined average and median equity returns authorized for electric and gas utilities in each of the years 1990 through 2019 and the number of observations for each year are presented in the accompanying chart.

Please note: In an effort to align data presented in this report with data available in S&P Global Market Intelligence's online database, earlier historical data provided in previous reports may not match historical data in this report due to certain differences in presentation, including the treatment of cases that were withdrawn or dismissed, as well as the addition of cases that were previously not part of RRA's coverage.

Bluefield Water Works v. Public Service Comm'n - 262 U.S. 679 (1923)

- Syllabus
- Case

U.S. Supreme Court

Bluefield Water Works v. Public Service Comm'n, 262 U.S. 679 (1923)

Bluefield Water Works & Improvement

Company v. Public Service Commission

No. 256

Argued January 22, 1923

Decided June 11, 1923

262 U.S. 679

ERROR TO THE SUPREME COURT OF APPEALS

OF THE STATE OF WEST VIRGINIA

Syllabus

1. A judgment of the highest court of a state which upholds an order of a state commission fixing the rates of a public utility company over the objection that the rates are confiscatory and the order hence violative of the Fourteenth Amendment is reviewable here, on the constitutional question, by writ of error. P. 262 U. S. 683.

2. In estimating the value of the property of a public utility corporation as a basis for rate regulation, evidence of present reproduction costs less depreciation must be given consideration. P. 262 U. S. 689. *Southwestern Bell Telephone Co. v. Public Service Commission, ante,* 262 U. S. 276.

3. A public utility corporation challenging as confiscatory rates imposed by a state commission is entitled, under the due process clause of the Fourteenth Amendment, to the independent judgment of the court as to both law and facts. *Id.*

4. Rates which are not sufficient to yield a reasonable return on the value of the property used at the time it is being used to render the service of the utility to the public are unjust, unreasonable, and confiscatory, and their enforcement deprives the public utility company of its property, in violation of the Fourteenth Amendment. P. 262 U. S. 690.

5. A public utility is entitled to such rates as will permit it to earn a return on the value of the property it employs for the convenience of the public equal to that generally being made at the same time and in the same region of the country on investments

Page 262 U. S. 680

in other business undertakings which are attended by corresponding risks and uncertainties, but it has no constitutional right to profits such as are realized or anticipated in highly profitable enterprises or speculative ventures. P. 262 U. S. 692.

6. The return should be reasonably sufficient to assure confidence in the financial soundness of the utility, and should be adequate, under efficient and economical management, to maintain its credit and enable it to raise the money necessary for the proper discharge of its public duties. *Id.*

7. A rate of return may be reasonable at one time, and become too high or too low by changes affecting opportunities for investment, the money market, and business conditions generally. *Id.*

8. In this case, 6% was inadequate to constitute just compensation. P. 262 U. S. 695.

89 W Va. 736 reversed.

Error to a judgment of the Supreme Court of Appeals of West Virginia sustaining an order of a state commission fixing water rates in a suit brought by the plaintiff in error to set the order aside.

Page 262 U. S. 683

MR. JUSTICE BUTLER delivered the opinion of the Court.

Plaintiff in error is a corporation furnishing water to the City of Bluefield, West Virginia, and its inhabitants. September 27, 1920, the Public Service Commission of the state, being authorized by statute to fix just and reasonable rates, made its order prescribing rates. In accordance with the laws of the state (§ 16, c. 15-O, Code of West Virginia), the company instituted proceedings in the Supreme Court of Appeals to suspend and set aside the order. The petition alleges that the order is repugnant to the Fourteenth Amendment, and deprives the company of its property without just compensation and without due process of law, and denies it equal protection of the laws. A final judgment was entered, denying the company relief and dismissing its petition. The case is here on writ of error.

1. The city moves to dismiss the writ of error for the reason, as it asserts, that there was not drawn in question the validity of a statute or an authority exercised under the state on the ground of repugnancy to the federal Constitution.

The validity of the order prescribing the rates was directly challenged on constitutional grounds, and it was held valid by the highest court of the state. The prescribing of rates is a legislative act. The commission is an instrumentality of the state, exercising delegated powers. Its order is of the same force as would be a like enactment by the legislature. If, as alleged, the prescribed rates are confiscatory, the order is void. Plaintiff in error is entitled to bring the case here on writ of error and to have that question decided by this Court. The motion to dismiss will be denied. *See Oklahoma Natural Gas Co. v.*

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Russell, 261 U. S. 290, and cases cited; also *Ohio Valley Co. v. Ben Avon Borough,* 253 U. S. 287.

2. The commission fixed $460,000 as the amount on which the company is entitled to a return. It found that, under existing rates, assuming some increase of business, gross earnings for 1921 would be $80,000 and operating expenses $53,000, leaving $27,000, the equivalent of 5.87 percent, or 3.87 percent after deducting 2 percent allowed for depreciation. It held existing rates insufficient to the extent of 10,000. Its order allowed the company to add 16 percent to all bills, excepting those for public and private fire protection. The total of the bills so to be increased amounted to $64,000 -- that is, 80

percent of the revenue was authorized to be increased 16 percent, equal to an increase of 12.8 percent on the total, amounting to $10,240.

As to value: the company claims that the value of the property is greatly in excess of $460,000. Reference to the evidence is necessary. There was submitted to the commission evidence of value which it summarized substantially as follows:

a. Estimate by company's engineer on

basis of reproduction new, less

depreciation at prewar prices . . . . . $ 624,548.00

b. Estimate by company's engineer on

basis of reproduction new, less

depreciation at 1920 prices 1,194,663.00

c. Testimony of company's engineer

fixing present fair value for rate-

making purposes 900,000.00

d. Estimate by commissioner's engineer on

basis of reproduction new, less

depreciation at 1915 prices, plus

additions since December 31, 1915, at

actual cost, excluding Bluefield

Valley waterworks, water rights,

and going value 397,964.38

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e. Report of commission's statistician

showing investment cost less

depreciation. 365,445.13

f. Commission's valuation, as fixed in

case No. 368 ($360,000), plus gross

additions to capital since made

($92,520.53). 452,520.53

It was shown that the prices prevailing in 1920 were nearly double those in 1915 and pre-war time. The company did not claim value as high as its estimate of cost of construction in 1920. Its valuation engineer testified that, in his opinion, the value of the property was $900,000 -- a figure between the cost of construction in 1920, less depreciation, and the cost of construction in 1915 and before the war, less depreciation.

The commission's application of the evidence may be stated briefly as follows:

As to "a," supra: the commission deducted $204,000 from the estimate (details printed in the margin), [Footnote 1] leaving approximately $421,000, which it contrasted with the estimate of its own engineer, $397,964.38 (*see "d," supra*). It found that there should be included $25,000 for the Bluefield Valley waterworks plant in Virginia, 10 percent for going value, and $10,000 for working capital. If these be added to $421,000, there results $500,600. This may be compared with the commission's final figure, $460,000.

Page 262 U. S. 686

As to "b" and "c," supra: these were given no weight by the commission in arriving at its final figure, $460,000. It said:

"Applicant's plant was originally constructed more than twenty years ago, and has been added to from time to time as the progress and development of the community required. For this reason, it would be unfair to its consumers to use as a basis for present fair value the abnormal prices prevailing during the recent war period; but when, as in this case, a part of the plant has been constructed or added to during that period, in fairness to the applicant, consideration must be given to the cost of such expenditures made to meet the demands of the public."

As to "d," supra: the commission, taking $400,000 (round figures), added $25,000 for Bluefield Valley waterworks plant in Virginia, 10 percent for going value, and $10,000 for working capital, making $477,500. This may be compared with its final figure, $460,000.

As to "e," supra: the commission, on the report of its statistician, found gross investment to be $500,402.53. Its engineer, applying the straight line method, found 19 percent depreciation. It applied 81 percent to gross investment and added 10 percent for going value and $10,000 for working capital, producing $455,500. [Footnote 2] This may be compared with its final figure, $460,000.

As to "f," supra: it is necessary briefly to explain how this figure, $452,520.53, was arrived at. Case No. 368 was a proceeding initiated by the application of the company for higher rates, April 24, 1915. The commission made a valuation as of January 1, 1915. There were presented two estimates of reproduction cost less depreciation, one by a valuation engineer engaged by the company,

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and the other by a valuation engineer engaged by the city, both "using the same method." An inventory made by the company's engineer was accepted as correct by the city and by the commission. The method "was that generally employed by courts and commissions in arriving at the value of public utility properties under this method," and in both estimates, "five year average unit prices" were applied. The estimate of the company's engineer was $540,000, and of the city's engineer $392,000. The principal differences as given by the commission are shown in the margin. [Footnote 3] The commission disregarded both estimates and arrived at $360,000. It held that the best basis of valuation was the net investment -- *i.e.,* the total cost of the property less depreciation. It said:

"The books of the company show a total gross investment, since its organization, of $407,882, and that there has been charged off for depreciation from year to year the total sum of $83,445, leaving a net investment of $324,427. . . . From an examination of the books . . . , it appears that the records of the company have been remarkably well kept and preserved. It therefore seems that, when a plant is developed under these conditions, the net investment, which, of course, means the total gross investment less depreciation, is the very best basis of valuation for ratemaking purposes, and that the other methods above referred to should

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be used only when it is impossible to arrive at the true investment. Therefore, after making due allowance for capital necessary for the conduct of the business and considering the plant as a going concern, it is the opinion of the commission that the fair value for the purpose of determining reasonable and just rates in this case of the property of the applicant company, used by it in the public service of supplying water to the city of Bluefield and its citizens, is the sum of $360,000, which sum is hereby fixed and determined by the commission to be the fair present value for the said purpose of determining the reasonable and just rates in this case."

In its report in No. 368, the commission did not indicate the amounts respectively allowed for going value or working capital. If 10 percent be added for the former and $10,000 for the latter (as fixed by the commission in the present case), there is produced $366,870, to be compared with $360,000, found by the commission in its valuation as of January 1, 1915. To this it added $92,520.53 expended since, producing $452,520.53. This may be compared with its final figure, $460,000.

The state Supreme Court of Appeals holds that the valuing of the property of a public utility corporation and prescribing rates are purely legislative acts, not subject to judicial review except insofar as may be necessary to determine whether such rates are void on constitutional or other grounds, and that findings of fact by the commission based on evidence to support them will not be reviewed by the court. *City of Bluefield v. Waterworks,* 81 W.Va. 201, 204; *Coal & Coke Co. v. Public Service Commission,* 84 W.Va. 662, 678; *Charleston v. Public Service Commission,* 86 W.Va. 536.

In this case, (89 W.Va. 736) it said:

"From the written opinion of the commission, we find that it ascertained the value of the petitioner's property for ratemaking [then quoting the commission] 'after

Page 262 U. S. 689

maturely and carefully considering the various methods presented for the ascertainment of fair value and giving such weight as seems proper to every element involved and all the facts and circumstances disclosed by the record.'"

The record clearly shows that the commission, in arriving at its final figure, did not accord proper, if any, weight to the greatly enhanced costs of construction in 1920 over those prevailing about 1915 and before the war, as established by uncontradicted evidence, and the company's detailed estimated cost of reproduction new, less depreciation at 1920 prices, appears to have been wholly disregarded. This was erroneous. *Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri, ante,* 262 U. S. 276. Plaintiff in error is entitled under the due process clause of the Fourteenth Amendment to the independent judgment of the court as to both law and facts. *Ohio Valley Co. v. Ben Avon Borough,* 253 U. S. 287, 253 U. S. 289, and cases cited.

We quote further from the court's opinion (pp. 739, 740):

"In our opinion, the commission was justified by the law and by the facts in finding as a basis for ratemaking the sum of $460,000.00. . . . In our case of *Coal & Coke Ry. Co. v. Conley,* 67 W.Va. 129, it is said:"

"It seems to be generally held that, in the absence of peculiar and extraordinary conditions, such as a more costly plant than the public service of the community requires, or the erection of a plant at an actual, though extravagant, cost, or the purchase of one at an exorbitant or inflated price, the actual amount of money invested is to be taken as the basis, and upon this a return must be allowed equivalent to that which is ordinarily received in the locality in which the business is done, upon capital invested in similar enterprises. In addition to this, consideration must be given to the nature of the investment, a higher rate

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being regarded as justified by the risk incident to a hazardous investment."

"That the original cost considered in connection with the history and growth of the utility and the value of the services rendered constitute the principal elements to be considered in connection with ratemaking seems to be supported by nearly all the authorities."

The question in the case is whether the rates prescribed in the commission's order are confiscatory, and therefore beyond legislative power. Rates which are not sufficient to yield a reasonable return on the value of the property used at the time it is being used to render the service are unjust, unreasonable, and confiscatory, and their enforcement deprives the public utility company of its property in violation of the Fourteenth Amendment. This is so well settled by numerous decisions of this Court that citation of the cases is scarcely necessary: "What the company is entitled to ask is a fair return upon the value of that which it employs for the public convenience." *Smyth v. Ames,* (1898) 169 U. S. 467, 169 U. S. 547.

"There must be a fair return upon the reasonable value of the property at the time it is being used for the public. . . . And we concur with the court below in holding that the value of the property is to be determined as of the time when the inquiry is made regarding the rates. If the property, which legally enters into the consideration of the question of rates, has increased in value since it was acquired, the company is entitled to the benefit of such increase."

Willcox v. Consolidated Gas Co., (1909) 212 U. S. 19, 212 U. S. 41, 212 U. S. 52.

"The ascertainment of that value is not controlled by artificial rules. It is not a matter of formulas, but there must be a reasonable judgment having its basis in a proper consideration of all relevant facts."

Minnesota Rate Cases, (1913) 230 U. S. 352, 230 U. S. 434.

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"And in order to ascertain that value, the original cost of construction, the amount expended in permanent improvements, the amount and market value of its bonds and stock, the present as compared with the original cost of construction, the probable earning capacity of the property under particular rates prescribed by statute, and the sum required to meet operating expenses, are all matters for consideration, and are to be given such weight as may be just and right in each case. We do not say that there may not be other matters to be regarded in estimating the value of the property."

Smyth v. Ames, 169 U. S. 546, 169 U. S. 547.

". . . The making of a just return for the use of the property involves the recognition of its fair value if it be more than its cost. The property is held in private ownership, and it is that property, and not the original cost of it, of which the owner may not be deprived without due process of law."

Minnesota Rate Cases, 230 U. S. 454.

In *Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri, supra,* applying the principles of the cases above cited and others, this Court said:

"Obviously, the commission undertook to value the property without according any weight to the greatly enhanced costs of material, labor, supplies, etc., over those prevailing in 1913, 1914, and 1916. As matter of common knowledge, these increases were large. Competent witnesses estimated them as 45 to 50 percentum. . . . It is impossible to ascertain what will amount to a fair return upon properties devoted to public service without giving consideration to the cost of labor, supplies, etc. at the time the investigation is made. An honest and intelligent forecast of probable future values, made upon a view of all the relevant circumstances, is essential. If the highly important element of present costs is wholly disregarded, such a forecast becomes impossible. Estimates for tomorrow cannot ignore prices of today. "

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It is clear that the court also failed to give proper consideration to the higher cost of construction in 1920 over that in 1915 and before the war, and failed to give weight to cost of reproduction less depreciation on the basis of 1920 prices, or to the testimony of the company's valuation engineer, based on present and past costs of construction, that the property in his opinion, was worth $900,000. The final figure, $460,000, was arrived at substantially on the basis of actual cost, less depreciation, plus 10 percent for going value and $10,000 for working capital. This resulted in a valuation considerably and materially less than would have been reached by a fair and just consideration of all the facts. The valuation cannot be sustained. Other objections to the valuation need not be considered.

3. *Rate of return:* the state commission found that the company's net annual income should be approximately $37,000, in order to enable it to earn 8 percent for return and depreciation upon the value of its property as fixed by it. Deducting 2 percent for depreciation, there remains 6 percent on $460,000, amounting to $27,600 for return. This was approved by the state court.

The company contends that the rate of return is too low, and confiscatory. What annual rate will constitute just compensation depends upon many circumstances, and must be determined by the exercise of a fair and enlightened judgment, having regard to all relevant facts. A public utility is entitled to such rates as will permit it to earn a return on the value of the property which it employs for the convenience of the public equal to that generally being made at the same time and in the same general part of the country on investments in other business undertakings which are attended by corresponding, risks and uncertainties, but it has no constitutional right to profits such as are realized or anticipated in

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highly profitable enterprises or speculative ventures. The return should be reasonably sufficient to assure confidence in the financial soundness of the utility, and should be adequate, under efficient and economical management, to maintain and support its credit and enable it to raise the money necessary for the proper discharge of its public duties. A rate of return may be reasonable at one time and become too high or too low by changes affecting opportunities for investment, the money market, and business conditions generally.

In 1909, this Court, in *Willcox v. Consolidated Gas Co.,* 212 U. S. 19, 212 U. S. 48-50, held that the question whether a rate yields such a return as not to be confiscatory depends upon circumstances, locality, and risk, and that no proper rate can be established for all cases, and that, under the circumstances of that case, 6 percent was a fair return on the value of the property employed in supplying gas to the City of New York, and that a rate yielding that return was not confiscatory. In that case, the investment was held to be safe, returns certain, and risk reduced almost to a minimum -- as nearly a safe and secure investment as could be imagined in regard to any private manufacturing enterprise.

In 1912, in *Cedar Rapids Gas Co. v. Cedar Rapids,* 223 U. S. 655, 223 U. S. 670, this Court declined to reverse the state court where the value of the plant considerably exceeded its cost, and the estimated return was over 6 percent

In 1915, in *Des Moines Gas Co. v. Des Moines,* 238 U. S. 153, 238 U. S. 172, this Court declined to reverse the United States district court in refusing an injunction upon the conclusion reached that a return of 6 percent per annum upon the value would not be confiscatory.

In 1919, this Court, in *Lincoln Gas Co. v. Lincoln,* 250 U. S. 256, 250 U. S. 268, declined on the facts of that case to approve a finding that no rate yielding as much as 6 percent

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on the invested capital could be regarded as confiscatory. Speaking for the Court, Mr. Justice Pitney said:

"It is a matter of common knowledge that, owing principally to the World War, the costs of labor and supplies of every kind have greatly advanced since the ordinance was adopted, and largely since this cause was last heard in the court below. And it is equally well known that annual returns upon capital and enterprise the world over have materially increased, so that what would have been a proper rate of return for capital invested in gas plants and similar public utilities a few years ago furnishes no safe criterion for the present or for the future."

In 1921, in *Brush Electric Co. v. Galveston,* the United States district court held 8 percent a fair rate of return. [Footnote 4]

In January, 1923, in *City of Minneapolis v. Rand,* the Circuit Court of Appeals of the Eighth Circuit (285 F. 818, 830) sustained, as against the attack of the city on the ground that it was excessive, 7 1/2 percent, found by a special master and approved by the district court as a fair and reasonable return on the capital investment -- the value of the property.

Investors take into account the result of past operations, especially in recent years, when determining the terms upon which they will invest in such an undertaking. Low, uncertain, or irregular income makes for low prices for the securities of the utility and higher rates of interest to be demanded by investors. The fact that the company may not insist as a matter of constitutional right that past losses be made up by rates to be applied in the present and future tends to weaken credit, and the fact that the utility is protected against being compelled to serve for confiscatory rates tends to support it. In

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this case, the record shows that the rate of return has been low through a long period up to the time of the inquiry by the commission here involved. For example, the average rate of return on the total cost of the property from 1895 to 1915, inclusive, was less than 5 percent; from 1911 to 1915, inclusive, about 4.4 percent, without allowance for depreciation. In 1919, the net operating income was approximately $24,700, leaving $15,500, approximately, or 3.4 percent on $460,000 fixed by the commission, after deducting 2 percent for depreciation. In 1920, the net operating income was approximately $25,465, leaving $16,265 for return, after allowing for depreciation. Under the facts and circumstances indicated by the record, we think that a rate of return of 6 percent upon the value of the property is substantially too low to constitute just compensation for the use of the property employed to render the service.

The judgment of the Supreme Court of Appeals of West Virginia is reversed.

MR. JUSTICE BRANDEIS concurs in the judgment of reversal for the reasons stated by him in *Missouri ex rel. Southwestern Bell Telephone Co. v. Public Service Commission of Missouri, supra.*

[Footnote 1]

Difference in depreciation allowed $49,000

Preliminary organization and development cost. . 14,500

Bluefield Valley waterworks plant. 25,000

Water rights 50,000

Excess overhead costs. 39,000

Paving over mains. 28,500

$204,000

[Footnote 2]

As to "e": $365,445.13 represents investment cost less depreciation. The gross investment was found to be $500,402.53, indicating a deduction on account of depreciation of $134,957.40, about 27 percent, as against 19 percent found by the commission's engineer.

[Footnote 3]

Company City

Engineer Engineer

1. Preliminary costs . . . . $ 14,455 $ 1,000

2. Water rights. . . . . 50,000 Nothing

3. Cutting pavements over mains. . . 27,744 233

4. Pipe lines from gravity springs . 22,072 15,442

5. Laying cast iron street mains . . 19,252 15,212

6. Reproducing Ada springs 18,558 13,027

7. Superintendence and engineering . 20,515 13,621

8. General contingent cost 16,415 5,448

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189,011 $63,983

[Footnote 4]

This case was affirmed by this Court, *ante,* 262 U. S. 443.

FPC v. Hope Nat. Gas Co. - 320 U.S. 591 (1944)

- Syllabus
- Case

U.S. Supreme Court

FPC v. Hope Nat. Gas Co., 320 U.S. 591 (1944)

Federal Power Commission v. Hope Natural Gas Co.

No. 34

Argued October 20, 21, 1943

Decided January 3, 1944*

320 U.S. 591

CERTIORARI TO THE CIRCUIT COURT OF APPEALS

FOR THE FOURTH CIRCUIT

Syllabus

1. The validity of an order of the Federal Power Commission fixing rates under the Natural Gas Act is to be determined on judicial review by whether the impact or total effect of the order is just and reasonable, rather than by the method of computing the rate base. P. 320 U. S. 602.

2. One who seeks to have set aside an order of the Federal Power Commission fixing rates under the Natural Gas Act has the burden of showing convincingly that it is unjust and unreasonable in its consequences. P. 320 U. S. 602.

3. An order of the Federal Power Commission reducing respondent's rates for sales of natural gas in interstate commerce *held* valid under the Natural Gas Act. P. 320 U. S. 603.

The rate base determined by the Commission was found by it to be the "actual legitimate cost" of the company's interstate property, less depletion and depreciation, plus allowances for unoperated acreage, working capital, and future net capital additions. "Reproduction cost new" and "trended original cost" were given no weight. Accrued depletion and depreciation and the annual allowance for depletion and depreciation were determined by application of the "economic service life" method to "actual legitimate cost."

4. Considering the amount of the annual return which the company would be permitted to earn on its property in interstate service, and the various factors which that return reflects, this Court is unable to say that the rates fixed by the Commission are not "just and reasonable" under the Act. P. 320 U. S. 604.

5. Rates which enable a natural gas company to operate successfully, to maintain its financial integrity, to attract capital, and to compensate its investors for the risks

assumed cannot be condemned as unjust and unreasonable under the Natural Gas Act, even though

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they might produce only a meager return on a rate base computed on the "present fair value" method. P. 320 U. S. 605.

6. The rationale of the decision renders it unnecessary to determine whether the Commission's exclusion from the rate base of well drilling and other costs, previously charged to operating expenses, was consistent with the "prudent investment" theory as developed and applied in particular cases. P. 320 U. S. 605.

7. *United Railway Co. v. West,* 280 U. S. 234, so far as it rejects cost as the basis of depreciation allowances, is disapproved. P. 320 U. S. 606.

8. The requirements of the Constitution in respect of rates are not more exacting than the standards of the Act, and a rate order valid under the latter is consistent with the former. P. 320 U. S. 607.

9. In fixing "just and reasonable" rates under §§ 4 and 5 of the Natural Gas Act, for natural gas sold in interstate commerce by a private operator through an established distribution system, the Commission was not required to take into consideration the indirect benefits -- affecting the economy, conservation policies, and tax revenues -- which the producing State might derive from higher valuations and rates. P. 320 U. S. 609.

10. The suggestion that the Commission did not allow for gas production a return sufficient to induce private enterprise to perform completely and efficiently its functions for the public is unsupported. P. 320 U. S. 615

11. The Commission is not empowered by the provisions of §§ 4 and 5, which authorize it to fix "just and reasonable" rates, to fix rates calculated to discourage intrastate resales for industrial use. P. 320 U. S. 616.

12. The question whether the rates charged by the company discriminate against domestic users and in favor of industrial users is not presented. P. 320 U. S. 617.

13. Findings of the Commission as to the lawfulness of past rates *held* not reviewable under §19(b) of the Act. P. 320 U. S. 618.

134 F.2d 287 reversed.

Certiorari, 319 U.S. 735, to review a decree setting aside an order of the Federal Power Commission, 44 P.U.R.(N.S.) 1, under the Natural Gas Act.

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MR. JUSTICE DOUGLAS delivered the opinion of the Court.

The primary issue in these cases concerns the validity under the Natural Gas Act of 1938, 52 Stat. 821, 15 U.S.C. § 717 *et seq.,* of a rate order issued by the Federal Power Commission reducing the rates chargeable by Hope Natural Gas Co., 44 P.U.R.,N.S., 1. On a petition for review of the order made pursuant to § 19(b) of the Act, the

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Circuit Court of Appeals set it aside, one judge dissenting. 134 F.2d 287. The cases are here on petitions for writs of certiorari which we granted because of the public importance of the questions presented. *City of Cleveland v. Hope Natural Gas Co.,* 319 U.S. 735.

Hope is a West Virginia corporation organized in 1898. It is a wholly owned subsidiary of Standard Oil Co. (N.J.). Since the date of its organization, it has been in the business of producing, purchasing and marketing natural gas in that state. [Footnote 1] It sells some of that gas to local consumers in West Virginia. But the great bulk of it goes to five customer companies which receive it at the West Virginia line and distribute it in Ohio and in Pennsylvania. [Footnote 2] In July, 1938, the cities of Cleveland and Akron filed complaints with the Commission charging that the rates collected by Hope from East Ohio Gas Co. (an affiliate of Hope which distributes gas in Ohio) were excessive and unreasonable. Later in 1938, the Commission, on its own motion, instituted an investigation to determine the reasonableness of all of Hope's interstate rates. In March,

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1939, the Public Utility Commission of Pennsylvania filed a complaint with the Commission charging that the rates collected by Hope from Peoples Natural Gas Co. (an affiliate of Hope distributing gas in Pennsylvania) and two non-affiliated companies were unreasonable. The City of Cleveland asked that the challenged rates be declared unlawful, and that just and reasonable rates be determined from June 30, 1939 to the date of the Commission's order. The latter finding was requested in aid of state regulation and to afford the Public Utilities Commission of Ohio a proper basic for disposition of a fund collected by East Ohio under bond from Ohio consumers since June 30, 1939. The cases were consolidated, and hearings were held.

On May 26, 1942, the Commission entered its order and made its findings. Its order required Hope to decrease its future interstate rates so as to reflect a reduction, on an annual basis of not less than $3,609,857 in operating revenues. And it established "just and reasonable" average rates per m.c.f. for each of the five customer companies. [Footnote 3] In response to the prayer of the City of Cleveland, the Commission also made findings as to the lawfulness of past rates, although concededly it had no authority under the Act to fix past rates or to award reparations. 44 P.U.R.(N.S.) p. 34. It found that the rates collected by Hope from East Ohio were unjust, unreasonable, excessive, and therefore unlawful, by $830,892 during 1939, $3,219,551 during 1940, and $2,815,789 on an annual basis since 1940. It further found that just, reasonable, and lawful rates for gas sold by Hope to East Ohio for resale for ultimate public consumption were those required

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to produce $11,528,608 for 1939, $11,507,185 for 1940, and $11.910,947 annually since 1940.

The Commission established an interstate rate base of $33,712,526 which, it found, represented the "actual legitimate cost" of the company's interstate property less depletion and depreciation and plus unoperated acreage, working capital and future net capital additions. The Commission, beginning with book cost, made certain adjustments not necessary to relate here, and found the "actual legitimate cost" of the plant in interstate service to be $51,957,416, as of December 31, 1940. It deducted accrued depletion and depreciation, which it found to be $22,328,016 on an "economic service life" basis. And it added $1,392,021 for future net capital additions, $566,105 for useful unoperated acreage, and $2,125,000 for working capital. It used 1940 as a test year to estimate future revenues and expenses. It allowed over $16,000,000 as annual operating expenses -- about $1,300,000 for taxes, $1,460,000 for depletion and depreciation, $600,000 for exploration and development costs, $8,500,000 for gas purchased. The Commission allowed a net increase of $421,160 over 1940 operating expenses, which amount was to take care of future increase in wages, in West Virginia property taxes, and in exploration and development costs. The total amount of deductions allowed from interstate revenues was $13,495,584.

Hope introduced evidence from which it estimated reproduction cost of the property at $97,000,000. It also presented a so-called trended "original cost" estimate which exceeded $105,000,000. The latter was designed "to indicate what the original cost of the property would have been if 1938 material and labor prices had prevailed throughout the whole period of the piecemeal construction of the company's property since 1898."

44 P.U.R.(N.S.), pp. 8, 9. Hope estimated by the "percent condition" method accrued depreciation at about 35% of

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reproduction cost new. On that basis, Hope contended for a rate base of $66,000,000. The Commission refused to place any reliance on reproduction cost new, saying that it was "not predicated upon facts," and was "too conjectural and illusory to be given any weight in these proceedings." *Id.,* 44 P.U.R.(N.S), p. 8. It likewise refused to give any "probative value" to trended "original cost," since it was "not founded in fact," but was "basically erroneous" and produced "irrational results." *Id.,* 44 P.U.R.(N.S.), p. 9. In determining the amount of accrued depletion and depreciation, the Commission, following *Lindheimer v. Illinois Bell Telephone Co.,* 292 U. S. 151, 292 U. S. 167-169; *Federal Power Commission v. Natural Gas Pipeline Co.,* 315 U. S. 575, 315 U. S. 592-593, based its computation on "actual legitimate cost." It found that Hope, during the years when its business was not under regulation, did not observe "sound depreciation and depletion practices," but "actually accumulated an excessive reserve" [Footnote 4] of about $46,000,000. *Id.,* 44 P.U.R.(N.S.), p. 18. One member of the Commission thought that the entire amount of the reserve should be deducted from "actual legitimate cost" in determining the rate base. [Footnote 5] The majority of the

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Commission concluded, however, that where, as here, a business is brought under regulation for the first time, and where incorrect depreciation and depletion practices have prevailed, the deduction of the reserve requirement (actual existing depreciation and depletion), rather than the excessive reserve, should be made so as to lay "a sound basis for future regulation and control of rates." *Id.,* 44 P.U.R.(N.S.), p. 18. As we have pointed out, it determined accrued depletion and depreciation to be $22,328,016; and it allowed approximately $1,460,000 as the annual operating expense for depletion and depreciation. [Footnote 6]

Hope's estimate of original cost was about $69,735,000 -- approximately $17,000,000 more than the amount found by the Commission. The item of $17,000,000 was made up largely of expenditures which, prior to December 31, 1938, were charged to operating expenses. Chief among those expenditures was some $12,600,000 expended

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in well drilling prior to 1923. Most of that sum was expended by Hope for labor, use of drilling rigs, hauling, and similar costs of well drilling. Prior to 1923, Hope followed the general practice of the natural gas industry and charged the cost of drilling wells to operating expenses. Hope continued that practice until the Public Service Commission of West Virginia, in 1923, required it to capitalize such expenditures, as does the Commission under its present Uniform System of Accounts. [Footnote 7] The Commission refused to add such items to the rate base, stating that

"No greater injustice to consumers could be done than to allow items as operating expenses and at a later date include them in the rate base, thereby placing multiple charges upon the consumers."

Id., 44 P.U.R.(N.S.), p. 12. For the same reason, the Commission excluded from the rate base about $1,600,000 of expenditures on properties which Hope acquired from other utilities, the latter having charged those payments to operating expenses. The Commission disallowed certain other overhead items amounting to over $3,000,000 which also had been previously charged to operating expenses. And it refused to add some $632,000 as interest during construction, since no interest was in fact paid.

Hope contended that it should be allowed a return of not less than 8%. The Commission found that an 8% return would be unreasonable, but that 6 1/2% was a fair rate of return. That rate of return, applied to the rate base of $33,712,526, would produce $2,191,314 annually, as compared with the present income of not less than $5,801,171.

The Circuit Court of Appeals set aside the order of the Commission for the following reasons. (1) It held that the rate base should reflect the "present fair value" of the

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property, that the Commission, in determining the "value," should have considered reproduction cost and trended original cost, and that "actual legitimate cost" (prudent investment) was not the proper measure of "fair value" where price levels had changed since the investment. (2) It concluded that the well drilling costs and overhead items in the amount of some $17,000,000 should have been included in the rate base. (3) It held that accrued depletion and depreciation and the annual allowance for that expense should be computed on the basis of "present fair value" of the property, not on the basis of "actual legitimate cost."

The Circuit Court of Appeals also held that the Commission had no power to make findings as to past rates in aid of state regulation. But it concluded that those findings were proper as a step in the process of fixing future rates. Viewed in that light, however, the findings were deemed to be invalidated by the same errors which vitiated the findings on which the rate order was based.

Order Reducing Rates. Congress has provided in § 4(a) of the Natural Gas Act that all natural gas rates subject to the jurisdiction of the Commission "shall be just and reasonable, and any such rate or charge that is not just and reasonable is hereby declared to be unlawful." Sec. 5(a) gives the Commission the power, after hearing, to determine the "just and reasonable rate" to be thereafter observed and to fix the rate by order. Sec. 5(a) also empowers the Commission to order a "decrease where existing rates are unjust . . . unlawful, or are not the lowest reasonable rates." And Congress has provided in § 19(b) that, on review of these rate orders, the "finding of the Commission as to the facts, if supported by substantial evidence, shall be conclusive." Congress, however, has provided no formula by which the "just and reasonable" rate is to be determined. It has not filled in the

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details of the general prescription [Footnote 8] of § 4(a) and § 5(a). It has not expressed in a specific rule the fixed principle of "just and reasonable."

When we sustained the constitutionality of the Natural Gas Act in the Natural Gas Pipeline Co. case, we stated that the

"authority of Congress to regulate the prices of commodities in interstate commerce is at least as great under the Fifth Amendment as is that of the states under the Fourteenth to regulate the prices of commodities in intrastate commerce."

315 U.S. p. 315 U. S. 582. Ratemaking is indeed but one species of price-fixing. *Munn v. Illinois,* 94 U. S. 113, 94 U. S. 134. The fixing of prices, like other applications of the police power, may reduce the value of the property which is being regulated. But the fact that the value is reduced does not mean that the regulation is invalid. *Block v. Hirsh,* 256 U. S. 135, 256 U. S. 155-157; *Nebbia v. New York,* 291 U. S. 502, 291 U. S. 523-539, and cases cited. It does, however, indicate that "fair value" is the end product of the process of ratemaking, not the starting point, as the Circuit Court of Appeals held. The heart of the matter is that rates cannot be made to depend upon "fair value" when the value of the going enterprise depends on earnings under whatever rates may be anticipated. [Footnote 9]

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We held in *Federal Power Commission v. Natural Gas Pipeline Co., supra,* that the Commission was not bound to the use of any single formula or combination of formulae in determining rates. Its ratemaking function, moreover, involves the making of "pragmatic adjustments." *Id.,* p. 315 U. S. 586. And when the Commission's order is challenged in the courts, the question is whether that order, "viewed in its entirety," meets the requirements of the Act. *Id.,* p. 315 U. S. 586. Under the statutory standard of "just and reasonable," it is the result reached, not the method employed, which is controlling. *Cf. Los Angeles Gas & Electric Corp. v. Railroad Commission,* 289 U. S. 287, 289 U. S. 304-305, 289 U. S. 314; *West Ohio Gas Co. v. Public Utilities Commission (No. 1),* 294 U. S. 63, 294 U. S. 70; *West v. Chesapeake & Potomac Tel. Co.,* 295 U. S. 662, 295 U. S. 692-693 (dissenting opinion). It is not theory, but the impact of the rate order, which counts. If the total effect of the rate order cannot be said to be unjust and unreasonable, judicial inquiry under the Act is at an end. The fact that the method employed to reach that result may contain infirmities is not then important. Moreover, the Commission's order does not become suspect by reason of the fact that it is challenged. It is the product of expert judgment which carries a presumption of validity. And he who would upset the rate order under the Act carries the heavy burden of making a convincing showing that it is invalid because it is unjust and unreasonable in its consequences. *Cf. Railroad Commission v. Cumberland Tel. & T. Co.,* 212 U. S. 414; *Lindheimer v. Illinois Bell Tel. Co., supra,* pp. 292 U. S. 164, 292 U. S. 169; *Railroad Commission v. Pacific Gas & Elec. Co.,* 302 U. S. 388, 302 U. S. 401.

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The ratemaking process under the Act, *i.e.,* the fixing of "just and reasonable" rates, involves a balancing of the investor and the consumer interests. Thus, we stated in the *Natural Gas Pipeline Co.* case that "regulation does not insure that the business shall produce net revenues." 315 U.S. p. 315 U. S. 590. But, such considerations aside, the investor interest has a legitimate concern with the financial integrity of the company whose rates are being regulated. From the investor or company point of view, it is important that there be enough revenue not only for operating expenses, but also for the capital costs of the business. These include service on the debt and dividends on the stock. *Cf. Chicago & Grand Trunk R. Co. v. Wellman,* 143 U. S. 339, 143 U. S. 345-346. By that standard, the return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit and to attract capital. *See Missouri ex rel. Southwestern Bell Tel. Co. v. Public Service Commission,* 262 U. S. 276, 262 U. S. 291 (Mr. Justice Brandeis concurring). The conditions under which more or less might be allowed are not important here. Nor is it important to this case to determine the various permissible ways in which any rate base on which the return is computed might be arrived at. For we are of the view that the end result in this case cannot be condemned under the Act as unjust and unreasonable from the investor or company viewpoint.

We have already noted that Hope is a wholly owned subsidiary of the Standard Oil Co. (N.J.). It has no securities outstanding except stock. All of that stock has been owned by Standard since 1908. The par amount presently outstanding is approximately $28,000,000, as compared with the rate base of $33,712,526 established by

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the Commission. Of the total outstanding stock, $11,000,000 was issued in stock dividends. The balance, or about $17,000,000, was issued for cash or other assets. During the four decades of its operations, Hope has paid over $97,000,000 in cash dividends. It had, moreover, accumulated by 1940 an earned surplus of about $8,000,000. It had thus earned the total investment in the company nearly seven times. Down to 1940, it earned over 20% per year on the average annual amount of its capital stock issued for cash or other assets. On an average invested capital of some $23,000,000, Hope's average earnings have been about 12% a year. And, during this period, it had accumulated in addition reserves for depletion and depreciation of about $46,000,000. Furthermore, during 1939, 1940, and 1941, Hope paid dividends of 10% on its stock. And in the year 1942, during about half of which the lower rates were in effect, it paid dividends of 7 1/2%. From 1939-1942, its earned surplus increased from $5,250,000 to about $13,700,000, *i.e.,* to almost half the par value of its outstanding stock.

As we have noted, the Commission fixed a rate of return which permits Hope to earn $2,191,314 annually. In determining that amount, it stressed the importance of maintaining the financial integrity of the company. It considered the financial history of Hope and a vast array of data bearing on the natural gas industry, related businesses, and general economic conditions. It noted that the yields on better issues of bonds of natural gas companies sold in the last few years were "close to 3 percent," 44 P.U.R. (N.S.), p. 33. It stated that the company was a "seasoned enterprise whose risks have been minimized" by adequate provisions for depletion and depreciation (past and present) with "concurrent high profits," by "protected established markets, through affiliated distribution companies, in populous and industrialized areas," and by a supply of gas locally to meet all requirements,

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"except on certain peak days in the winter, which it is feasible to supplement in the future with gas from other sources." *Id.,* 44 P.U.R.(N.S.), p. 33. The Commission concluded,

"The company's efficient management, established markets, financial record, affiliations, and its prospective business place it in a strong position to attract capital upon favorable terms when it is required."

Id., 44 P.U.R.(N.S.), p. 33.

In view of these various considerations, we cannot say that an annual return of $2,191,314 is not "just and reasonable" within the meaning of the Act. Rates which enable the company to operate successfully, to maintain its financial integrity, to attract capital, and to compensate its investors for the risks assumed certainly cannot be condemned as invalid, even though they might produce only a meager return on the so -called "fair value" rate base. In that connection, it will be recalled that Hope contended for a rate base of $66,000,000 computed on reproduction cost new. The Commission points out that, if that rate base were accepted, Hope's average rate of return for the four-year period from 1937-1940 would amount to 3.27%. During that period, Hope earned an annual average return of about 9% on the average investment. It asked for no rate increases. Its properties were well maintained and operated. As the Commission says, such a modest rate of 3.27% suggests an "inflation of the base on which the rate has been computed." *Dayton Power & Light Co. v. Public Utilities Commission,* 292 U. S. 290, 292 U. S. 312. *Cf. Lindheimer v. Illinois Bell Tel. Co., supra,* p. 292 U. S. 164. The incongruity between the actual operations and the return computed on the basis of reproduction cost suggests that the Commission was wholly justified in rejecting the latter as the measure of the rate base.

In view of this disposition of the controversy, we need not stop to inquire whether the failure of the Commission to add the $17,000,000 of well drilling and other costs to

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the rate base was consistent with the prudent investment theory as developed and applied in particular cases.

Only a word need be added respecting depletion and depreciation. We held in the *Natural Gas Pipeline Co.* case that there was no constitutional requirement "that the owner who embarks in a wasting-asset business of limited life shall receive at the end more than he has put into it." 315 U.S. p. 315 U. S. 593. The Circuit Court of Appeals did not think that that rule was applicable here, because Hope was a utility required to continue its service to the public and not scheduled to end its business on a day certain, as was stipulated to be true of the Natural Gas Pipeline Co. But that distinction is quite immaterial. The ultimate exhaustion of the supply is inevitable in the case of all natural gas companies. Moreover, this Court recognized in *Lindheimer v. Illinois Bell Tel. Co., supra,* the propriety of basing annual depreciation on cost. [Footnote 10] By such a procedure, the utility is made whole and the integrity of its investment maintained. [Footnote 11] No more is required. [Footnote 12] We cannot approve the contrary holding

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of *United Railways Co. v. West,* 280 U. S. 234, 280 U. S. 253-254. Since there are no constitutional requirements more exacting than the standards of the Act, a rate order which conforms to the latter does not run afoul of the former.

The Position of West Virginia. The State of West Virginia, as well as its Public Service Commission, intervened in the proceedings before the Commission and participated in the hearings before it. They have also filed a brief *amicus curiae* here, and have participated in the argument at the bar. Their contention is that the result achieved by the rate order "brings consequences which are unjust to West Virginia and its citizens" and which

"unfairly depress the value of gas, gas lands and gas leaseholds, unduly restrict development of their natural resources, and arbitrarily transfer their properties to the residents of other states without just compensation therefor."

West Virginia points out that the Hope Natural Gas Co. holds a large number of leases on both producing and unoperated properties. The owner or grantor receives from the operator or grantee delay rentals as compensation for postponed drilling. When a producing well is successfully brought in, the gas lease customarily continues indefinitely for the life of the field. In that case, the operator pays a stipulated gas well rental, or in some cases a gas royalty equivalent to one-eighth of the gas marketed. [Footnote 13] Both the owner and operator have valuable property interests in the gas which are separately taxable under West Virginia law. The contention is that the reversionary interests in the leaseholds should be represented in the rate proceedings, since it is their gas which is being sold in interstate

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commerce. It is argued, moreover, that the owners of the reversionary interests should have the benefit of the "discovery value" of the gas leaseholds, not the interstate consumers. Furthermore, West Virginia contends that the Commission, in fixing a rate for natural gas produced in that State, should consider the effect of the rate order on the economy of West Virginia. It is pointed out that gas is a wasting asset with a rapidly diminishing supply. As a result, West Virginia's gas deposits are becoming increasingly valuable. Nevertheless the rate fixed by the Commission reduces that value. And that reduction, it is said, has severe repercussions on the economy of the State. It is argued, in the first place, that, as a result of this rate reduction, Hope's West Virginia property taxes may be decreased in view of the relevance which earnings have under West Virginia law in the assessment of property for tax purposes. [Footnote 14] Secondly, it is pointed out that West Virginia has a production tax [Footnote 15] on the "value" of the gas exported from the State. And we are told that, for purposes of that tax, "value" becomes, under West Virginia law, "practically the substantial equivalent of market value." Thus, West Virginia argues that undervaluation of Hope's gas leaseholds will cost the State many thousands of dollars in taxes. The effect, it is urged, is to impair West Virginia's tax structure for the benefit of Ohio and Pennsylvania consumers. West Virginia emphasizes, moreover, its deep interest in the conservation of its natural resources, including its natural gas. It says that a reduction of the value of these leasehold values will jeopardize these conservation policies in three respects: (1) exploratory development of new fields will be discouraged; (2) abandonment of low-yield high-cost marginal wells will be hastened; and (3) secondary recovery of oil will be hampered.

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Furthermore, West Virginia contends that the reduced valuation will harm one of the great industries of the State, and that harm to that industry must inevitably affect the welfare of the citizens of the State. It is also pointed out that West Virginia has a large interest in coal and oil, as well as in gas, and that these forms of fuel are competitive. When the price of gas is materially cheapened, consumers turn to that fuel in preference to the others. As a result, this lowering of the price of natural gas will have the effect of depreciating the price of West Virginia coal and oil.

West Virginia insists that, in neglecting this aspect of the problem, the Commission failed to perform the function which Congress entrusted to it, and that the case should be remanded to the Commission for a modification of its order. [Footnote 16]

We have considered these contentions at length in view of the earnestness with which they have been urged upon us. We have searched the legislative history of the Natural Gas Act for any indication that Congress entrusted to the Commission the various considerations which West Virginia has advanced here. And our conclusion is that Congress did not.

We pointed out in *Illinois Natural Gas Co. v. Central Illinois Public Service Co.,* 314 U. S. 498, 314 U. S. 506, that the purpose of the Natural Gas Act was to provide,

"through the exercise of the national power over interstate commerce, an agency for regulating the wholesale distribution to public service companies of natural gas moving interstate, which this Court had declared to be interstate commerce not subject to certain types of state regulation."

As stated in the House Report, the "basic purpose" of this legislation was "to occupy" the field in which such cases as *Missouri v.*

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Kansas Natural Gas Co., 265 U. S. 298, and *Public Utilities Commission v. Attleboro Steam & Electric Co.,* 273 U. S. 83, had held the States might not act. H.Rep. No. 709, 75th Cong., 1st Sess., p. 2. In accomplishing that purpose, the bill was designed to take "no authority from State commissions," and was "so drawn as to complement, and in no manner usurp, State regulatory authority." *Id.,* p. 2. And the Federal Power Commission was given no authority over the "production or gathering of natural gas." § 1(b).

The primary aim of this legislation was to protect consumers against exploitation at the lands of natural gas companies. Due to the hiatus in regulation which resulted from the *Kansas Natural Gas Co.* case and related decisions state commissions found it difficult or impossible to discover what it cost interstate pipeline companies to deliver gas within the consuming states; and thus they were thwarted in local regulation. H.Rep., No. 709, *supra,* p. 3. Moreover, the investigations of the Federal Trade Commission had disclosed that the majority of the pipeline mileage in the country used to transport natural gas, together with an increasing percentage of the natural gas supply for pipeline transportation, had been acquired by a handful of holding companies. [Footnote 17] State commissions, independent producers, and communities having or seeking the service were growing quite helpless against these combinations. [Footnote

18] These were the types of problems with which those participating in the hearings were preoccupied. [Footnote 19] Congress addressed itself to those specific evils.

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The Federal Power Commission was given broad powers of regulation. The fixing of "just and reasonable" rates (§ 4) with the powers attendant thereto [Footnote 20] was the heart of the new regulatory system. Moreover, the Commission was given certain authority by § 7(a), on a finding that the action was necessary or desirable "in the public interest," to require natural gas companies to extend or improve their transportation facilities and to sell gas to any authorized local distributor. By § 7(b), it was given control over the abandonment of facilities or of service. And by § 7(c), as originally enacted, no natural gas company could undertake the construction or extension of any facilities for the transportation of natural gas to a market in which natural gas was already being served by another company, or sell any natural gas in such a market, without obtaining a certificate of public convenience and necessity from the Commission. In passing on such applications for certificates of convenience and necessity, the Commission was told by § 7(c), as originally enacted, that it was

"the intention of Congress that natural gas shall be sold in interstate commerce for resale for ultimate public consumption for domestic, commercial, industrial, or any other use at the lowest possible reasonable rate consistent with the maintenance of adequate service in the public interest."

The latter provision was deleted from § 7(c) when that subsection was amended by the Act of February 7, 1942, 56 Stat. 83. By that amendment, limited grandfather rights were granted companies desiring to extend their facilities and services over the routes or within the area which they were already serving. Moreover, § 7(c) was broadened so as to require certificates

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of public convenience and necessity not only where the extensions were being made to markets in which natural gas was already being sold by another company, but in other situations as well.

These provisions were plainly designed to protect the consumer interests against exploitation at the hands of private natural gas companies. When it comes to cases of abandonment or of extensions of facilities or service, we may assume that, apart from the express exemptions [Footnote 21] contained in § 7, considerations of conservation are material to the issuance of certificates of public convenience and necessity. But the Commission was not asked here for a certificate of public convenience and necessity under § 7 for any proposed construction or extension. It was faced with a determination of the amount which a private operator should be allowed to earn from the sale of natural gas across state lines through an established distribution system. Secs. 4 and 5, not § 7, provide the standards for that determination. We cannot find in the words of the Act or in its history the slightest intimation or suggestion that the exploitation of consumers by private operators through the maintenance of high rates should be allowed to continue provided the producing states obtain indirect benefits from it. That apparently was the Commission's view of the matter, for the same arguments advanced here were presented to the Commission and not adopted by it.

We do not mean to suggest that Congress was unmindful of the interests of the producing states in their natural gas supplies when it drafted the Natural Gas Act. As we have said, the Act does not intrude on the domain traditionally reserved for control by state commissions, and the Federal Power Commission was given no authority over

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"the production or gathering of natural gas." § 1(b). In addition, Congress recognized the legitimate interests of the States in the conservation of natural gas. By § 11, Congress instructed the Commission to make reports on compacts between two or more States dealing with the conservation, production and transportation of natural gas. [Footnote 22] The Commission was also directed to recommend further legislation appropriate or necessary to carry out any proposed compact and "to aid in the conservation of natural gas resources within the United States and in the orderly, equitable, and economic production, transportation, and distribution of natural gas." § 11(a). Thus, Congress was quite aware of the interests of the producing states in their natural gas supplies. [Footnote 23] But it left the protection of

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those interests to measures other than the maintenance of high rates to private companies. If the Commission is to be compelled to let the stockholders of natural gas companies have a feast so that the producing states may receive crumbs from that table, the present Act must be redesigned. Such a project raises questions of policy which go beyond our province.

It is hardly necessary to add that a limitation on the net earnings of a natural gas company from its interstate business is not a limitation on the power of the producing state either to safeguard its tax revenues from that industry [Footnote 24] or to protect the interests of those who sell their gas to the interstate operator. [Footnote 25] The return which the Commission

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allowed was the net return after all such charges.

It is suggested that the Commission has failed to perform its duty under the Act in that it has not allowed a return for gas production that will be enough to induce private enterprise to perform completely and efficiently its functions for the public. The Commission, however, was not oblivious of those matters. It considered them. It allowed, for example, delay rentals and exploration and development costs in operating expenses. [Footnote 26] No serious attempt has been made here to show that they are inadequate. We certainly cannot say that they are, unless we are to substitute our opinions for the expert judgment of the administrators to whom Congress entrusted the decision. Moreover, if, in light of experience, they turn out to be inadequate for development of new sources of supply, the doors of the Commission are open for increased allowances. This is not an order for all time. The Act contains machinery for obtaining rate adjustments. § 4.

But it is said that the Commission placed too low a rate on gas for industrial purposes as compared with gas for domestic purposes, and that industrial uses should be discouraged. It should be noted in the first place that the rates which the Commission has fixed are Hope's interstate wholesale rates to distributors not interstate rates to industrial users [Footnote 27] and domestic consumers. We hardly

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can assume, in view of the history of the Act and its provisions, that the resales intrastate by the customer companies which distribute the gas to ultimate consumers in Ohio and Pennsylvania are subject to the ratemaking powers of the Commission. [Footnote 28] But, in any event, those rates are not in issue here. Moreover, we fail to find in the power to fix "just and reasonable" rates the power to fix rates which will disallow or discourage resales for industrial use. The Committee Report stated that the Act provided "for regulation along recognized and more or less standardized lines," and that there was "nothing novel in its provisions." H.Rep.No.709, *supra,* p. 3. Yet if we are now to tell the Commission to fix the rates so as to discourage particular uses, we would indeed be injecting into a rate case a "novel" doctrine which has no express statutory sanction. The same would be true if we were to hold that the wasting-asset nature of the industry required the maintenance of the level of rates so that natural gas companies could make a greater profit on each unit of gas sold. Such theories of ratemaking for this industry may or may not be desirable. The difficulty is that § 4(a) and § 5(a) contain only the conventional standards of ratemaking for natural gas companies. [Footnote 29] The

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Act of February 7, 1942, by broadening § 7 gave the Commission some additional authority to deal with the conservation aspects of the problem. [Footnote 30] But § 4 (a) and § 5(a) were not changed. If the standard of "just and reasonable" is to sanction the maintenance of high rates by a natural gas company because they restrict the use of natural gas for certain purposes, the Act must be further amended.

It is finally suggested that the rates charged by Hope are discriminatory as against domestic users and in favor of industrial users. That charge is apparently based on § 4 (b) of the Act, which forbids natural gas companies from maintaining

"any unreasonable difference in rates, charges, service, facilities, or in any other respect, either as between localities or as between classes of service."

The power of the Commission to eliminate any such unreasonable differences or discriminations is plain. § 5(a). The Commission, however, made no findings under § 4 (b). Its failure in that regard was not challenged in the petition to review. And it has not been raised or argued here by any party. Hence, the problem of discrimination has no proper place in the present decision. It will be time enough to pass on that issue when it is presented to us. Congress has entrusted the administration of the Act to the Commission, not to the courts. Apart from the requirements of judicial review, it is not

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for us to advise the Commission how to discharge its functions.

Findings as to the Lawfulness of Past Rates. As we have noted, the Commission made certain findings as to the lawfulness of past rates which Hope had charged its interstate customers. Those findings were made on the complaint of the City of Cleveland and in aid of state regulation. It is conceded that, under the Act, the Commission has no power to make reparation orders. And its power to fix rates admittedly is limited to those "to be thereafter observed and in force." § 5(a). But the Commission maintains that it has the power to make findings as to the lawfulness of past rates even though it has no power to fix those rates. [Footnote 31] However that may be, we do not think that these findings were reviewable under § 19(b) of the Act. That section gives any party "aggrieved by an order" of the Commission a review "of such order" in the circuit court of appeals for the circuit where the natural gas company is located or has its principal place of business or in the United States Court of Appeals for the District of Columbia. We do not think that the findings in question fall within that category.

The Court recently summarized the various types of administrative action or determination reviewable as orders under the Urgent Deficiencies Act of October 22,

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1913, 28 U.S.C. §§ 45, 47a, and kindred statutory provisions. *Rochester Telephone Corp. v. United States,* 307 U. S. 125. It was there pointed out that where

"the order sought to be reviewed does not of itself adversely affect complainant, but only affects his rights adversely on the contingency of future administrative action,"

it is not reviewable. *Id.,* 307 U.S. p. 307 U. S. 130. The Court said,

"In view of traditional conceptions of federal judicial power, resort to the courts in these situations is either premature or wholly beyond their province."

Id., p. 307 U. S. 130. *And see United States v. Los Angeles & S.L. R. Co.,* 273 U. S. 299, 273 U. S. 309-310; *Shannahan v. United States,* 303 U. S. 596. These considerations are apposite here. The Commission has no authority to enforce these findings. They are "the exercise solely of the function of investigation." *United States v. Los Angeles & S.L. R. Co., supra,* p. 273 U. S. 310. They are only a preliminary, interim step towards possible future action -- action not by the Commission, but by wholly independent agencies. The outcome of those proceedings may turn on factors other than these findings. These findings may never result in the respondent feeling the pinch of administrative action.

Reversed.

MR. JUSTICE ROBERTS took no part in the consideration or decision of this case.

* Together with No. 35, *City of Cleveland v. Hope Natural Gas Co.,* also on writ of certiorari to the Circuit Court of Appeals for the Fourth Circuit.

[Footnote 1]

Hope produces about one-third of its annual gas requirements and purchases the rest under some 300 contracts.

[Footnote 2]

These five companies are the East Ohio Gas Co., the Peoples Natural Gas Co., the River Gas Co., the Fayette County Gas Co., and the Manufacturers Light & Heat Co. The first three of these companies are, like Hope, subsidiaries of Standard Oil Co. (N.J.). East Ohio and River distribute gas in Ohio, the other three in Pennsylvania. Hope's approximate sales in m.c.f. for 1940 may be classified as follows:

Local West Virginia sales . . . 11,000,000

East Ohio 40,000,000

Peoples 10,000,000

River 400,000

Fayette 860,000

Manufacturers 2,000,000

Hope's natural gas is processed by Hope Construction & Refining Co., an affiliate, for the extraction of gasoline and butane. Domestic Coke Corp., another affiliate, sells coke oven gas to Hope for boiler fuel.

[Footnote 3]

These required minimum reductions of 7□ per m.c.f. from the 36.5□ and 35.5□ rates previously charged East Ohio and Peoples, respectively, and 3□ per m.c.f. from the 31.5□ rate previously charged Fayette and Manufacturers.

[Footnote 4]

The book reserve for interstate plant amounted at the end of 1938 to about $18,000,000 more than the amount determined by the Commission as the proper reserve requirement. The Commission also noted that

"twice in the past, the company has transferred amounts aggregating $7,500,000 from the depreciation and depletion reserve to surplus. When these latter adjustments are taken into account, the excess becomes $25,500,000, which has been exacted from the ratepayers over and above the amount required to cover the consumption of property in the service rendered, and thus to keep the investment unimpaired."

44 P.U.R.(N.S.), p. 22.

[Footnote 5]

That contention was based on the fact that "every single dollar in the depreciation and depletion reserves" was taken "from gross operating revenues whose only source was the amounts charged customers in the past for natural gas. It is, therefore, a fact that the depreciation and depletion reserves have been contributed by the customers, and do not represent any investment by Hope."

Id., 44 P.U.R.(N.S.), p. 40. *And see Railroad Commission v. Cumberland Tel. & T. Co.*, 212 U. S. 414, 212 U. S. 424-425; 2 Bonbright, Valuation of Property (1937), p. 1139.

[Footnote 6]

The Commission noted that the case was

"free from the usual complexities involved in the estimate of gas reserves because the geologists for the company and the Commission presented estimates of the remaining recoverable gas reserves which were about one percent apart."

44 P.U.R.(N.S.), pp. 19, 20.

The Commission utilized the "straight-line-basis" for determining the depreciation and depletion reserve requirements. It used estimates of the average service lives of the property by classes based in part on an inspection of the physical condition of the property. And studies were made of Hope's retirement experience and maintenance policies over the years. The average service lives of the various classes of property were converted into depreciation rates and then applied to the cost of the property to ascertain the portion of the cost which had expired in rendering the service.

The record in the present case shows that Hope is on the lookout for new sources of supply of natural gas, and is contemplating an extension of its pipe line into Louisiana for that purpose. The Commission recognized in fixing the rates of depreciation that much material may be used again when various present sources of gas supply are exhausted, thus giving that property more than scrap value at the end of its present use.

[Footnote 7]

See Uniform System of Accounts prescribed for Natural Gas Companies effective January 1, 1940, Account No. 332.1.

[Footnote 8]

Sec. 6 of the Act comes the closest to supplying any definite criteria for ratemaking. It provides in subsection (a) that,

"The Commission may investigate the ascertain the actual legitimate cost of the property of every natural gas company, the depreciation therein, and, when found necessary for ratemaking purposes, other facts which bear on the determination of such cost or depreciation and the fair value of such property."

Subsection (b) provides that every natural gas company, on request, shall file with the Commission a statement of the "original cost" of its property and shall keep the Commission informed regarding the "cost" of all additions, etc.

[Footnote 9]

We recently stated that the meaning of the word "value" is to be gathered

"from the purpose for which a valuation is being made. Thus, the question in a valuation for ratemaking is how much a utility will be allowed to earn. The basic question in a valuation for reorganization purposes is how much the enterprise in all probability can earn."

Institutional Investors v. Chicago, M., St. P. & P. R. Co., 318 U. S. 523, 318 U. S. 540.

[Footnote 10]

Chief Justice Hughes said in that case (292 U.S. pp. 292 U. S. 168-169):

"If the predictions of service life were entirely accurate and retirements were made when and as these predictions were precisely fulfilled, the depreciation reserve would represent the consumption of capital, on a cost basis, according to the method which spreads that loss over the respective service periods. But if the amounts charged to operating expenses and credited to the account for depreciation reserve are excessive, to that extent, subscribers for the telephone service are required to provide, in effect, capital contributions, not to make good losses incurred by the utility in the service rendered, and thus to keep its investment unimpaired, but to secure additional plant and equipment upon which the utility expects a return."

[Footnote 11]

See Mr. Justice Brandeis (dissenting) in *United Railways & Electric Co. v. West,* 280 U. S. 234, 280 U. S. 259-288, for an extended analysis of the problem.

[Footnote 12]

It should be noted that the Act provides no specific rule governing depletion and depreciation. Sec. 9(a) merely states that the Commission

"may from time to time ascertain and determine, and by order fix, the proper and adequate rates of depreciation and amortization of the several classes of property of each natural gas company used or useful in the production, transportation, or sale of natural gas."

[Footnote 13]

See Simonton, The Nature of the Interest of the Grantee Under an Oil and Gas Lease (1918), 25 W.Va.L.Quar. 295.

[Footnote 14]

West Penn Power Co. v. Board of Review, 112 W.Va. 442, 164 S.E. 862.

[Footnote 15]

W.Va.Rev.Code of 1943, ch. 11. Art. 13, §§ 2a, 3a.

[Footnote 16]

West Virginia suggests as a possible solution (1) that a "going concern value" of the company's tangible assets be included in the rate base and (2) that the fair market value of gas delivered to customers be added to the outlay for operating expenses and taxes.

[Footnote 17]

S.Doc. 92, Pt. 84-A, ch. XII, Final Report, Federal Trade Commission to the Senate pursuant to S.Res.No. 83, 70th Cong., 1st Sess.

[Footnote 18]

S.Doc. 92, Pt. 84-A, chs. XII, XIII, *op. cit., supra,* note 17

[Footnote 19]

See Hearings on H.R. 11662, Subcommittee of House Committee on Interstate & Foreign Commerce, 74th Cong., 2d Sess.; Hearings on H.R. 4008, House Committee on Interstate & Foreign Commerce, 75th Cong., 1st Sess.

[Footnote 20]

The power to investigate and ascertain the "actual legitimate cost" of property (§ 6), the requirement as to books and records (§ 8), control over rates of depreciation (§ 9), the requirements for periodic and special reports (§ 10), the broad powers of investigation (§ 14) are among the chief powers supporting the ratemaking function.

[Footnote 21]

Apart from the grandfather clause contained in § 7(c), there is the provision of § 7(f) that a natural gas company may enlarge or extend its facilities with the "service area" determined by the Commission without any further authorization.

[Footnote 22]

See Act of July 7, 1943, 57 Stat. 383 containing an "Interstate Compact to Conserve Oil and Gas" between Oklahoma, Texas, New Mexico, Illinois, Colorado, and Kansas.

[Footnote 23]

As we have pointed out, § 7(c) was amended by the Act of February 7, 1942, 56 Stat. 83, so as to require certificates of public convenience and necessity not only where the extensions were being made to markets in which natural gas was already being sold by another company, but to other situations as well. Considerations of conservation entered into the proposal to give the Act that broader scope. H.Rep.No. 1290, 77th Cong. 1st Sess., pp. 2, 3. *And see* Annual Report, Federal Power Commission (1940) pp. 79, 80; Baum, The Federal Power Commission and State Utility Regulation (1942), p. 261.

The bill amending § 7(c) originally contained a subsection (h) reading as follows:

"Nothing contained in this section shall be construed to affect the authority of a State within which natural gas is produced to authorize or require the construction or extension of facilities for the transportation and sale of such gas within such State: Provided, however, that the Commission, after a hearing upon complaint or upon its own motion, may by order forbid any intrastate construction or extension by any natural gas company which it shall find will prevent such company from rendering adequate service to its customers in interstate or foreign commerce in territory already being served."

See Hearings on H.R. 5249, House Committee on Interstate & Foreign Commerce, 77th Cong., 1st Sess., pp. 7, 11, 21, 29, 32, 33. In explanation of its deletion, the House Committee Report stated, pp. 4, 5:

"The increasingly important problems raised by the desire of several States to regulate the use of the natural gas produced therein in the interest of consumers within such States, as against the Federal power to regulate interstate commerce in the interest of both interstate and intrastate consumers, are deemed by the committee to warrant further intensive study, and probably a more retailed and comprehensive plan for the handling thereof than that which would have been provided by the stricken subsection."

[Footnote 24]

We have noted that in the annual operating expenses of some $16,000.000 the Commission included West Virginia and federal taxes. And in the net increase of $421,160 over 1940 operating expenses allowed by the Commission was some $80,000 for increased West Virginia property taxes. The adequacy of these amounts has not been challenged here.

[Footnote 25]

The Commission included in the aggregate annual operating expenses which it allowed some $8,500,000 for gas purchased. It also allowed about $1,400,000 for natural gas production, and about $600,000 for exploration and development.

It is suggested, however, that the Commission, in ascertaining the cost of Hope's natural gas production plant, proceeded contrary to § 1(b), which provides that the Act shall not apply to "the production or gathering of natural gas." But such valuation, like the provisions for operating expenses, is essential to the ratemaking function as customarily performed in this country. *Cf.* Smith, The Control of Power Rates in the United States and England (1932), 159 The Annals 101. Indeed § 14(b) of the Act gives the Commission the power to "determine the propriety and reasonableness of the inclusion in operating expenses, capital, or surplus of all delay rentals or other forms of rental or compensation for unoperated lands and leases."

[Footnote 26]

See note 25 *supra*.

[Footnote 27]

The Commission has expressed doubts over its power to fix rates on "direct sales to industries" from interstate pipelines, as distinguished from "sales for resale to the industrial customers of distributing companies." Annual Report, Federal Power Commission (1940), p. 11.

[Footnote 28]

Sec. 1(b) of the Act provides:

"The provisions of this Act shall apply to the transportation of natural gas in interstate commerce, to the sale in interstate commerce of natural gas for resale for ultimate public consumption for domestic, commercial, industrial, or any other use, and to natural gas companies engaged in such transportation or sale, but shall not apply to any other transportation or sale of natural gas or to the local distribution of natural gas or to the facilities used for such distribution or to the production or gathering of natural gas."

And see § 2(6), defining a "natural gas company," and H.Rep.No. 709, *supra,* pp. 2, 3.

[Footnote 29]

The wasting-asset characteristic of the industry was recognized prior to the Act as requiring the inclusion of a depletion allowance among operating expenses. *See Columbus Gas & Fuel Co. v. Public Utilities Commission,* 292 U. S. 398, 292 U. S. 404-405. But no such theory of ratemaking for natural gas companies as is now suggested emerged from the cases arising during the earlier period of regulation.

[Footnote 30]

The Commission has been alert to the problems of conservation in its administration of the Act. It has indeed suggested that it might be wise to restrict the use of natural gas "by functions rather than by areas." Annual Report (1940) p. 79.

The Commission stated in that connection that natural gas was particularly adapted to certain industrial uses. But it added that the general use of such gas "under boilers for the production of steam" is, "under most circumstances, of very questionable social economy." *Ibid.*

[Footnote 31]

The argument is that § 4(a) makes "unlawful" the charging of any rate that is not just and reasonable. And § 14(a) gives the Commission power to investigate any matter "which it may find necessary or proper in order to determine whether any person has violated" any provision of the Act. Moreover, § 5(b) gives the Commission power to investigate and determine the cost of production or transportation of natural gas in cases where it has "no authority to establish a rate governing the transportation or sale of such natural gas." And § 17(c) directs the Commission to

"make available to the several State commissions such information and reports as may be of assistance in State regulation of natural gas companies."

For a discussion of these points by the Commission, *see* 44 P.U.R.(N.S.), pp. 34, 35.

Opinion of MR. JUSTICE BLACK and MR. JUSTICE MURPHY.

We agree with the Court's opinion and would add nothing to what has been said but for what is patently a wholly gratuitous assertion as to Constitutional law in the dissent of MR. JUSTICE FRANKFURTER. We refer to the statement that "Congressional acquiescence to date in the doctrine of *Chicago, M. & St. P. Ry. Co. v. Minnesota, supra,* may fairly be claimed." That was the case in which a majority of this Court was finally induced to expand the meaning

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of "due process" so as to give courts power to block efforts of the state and national governments to regulate economic affairs. The present case does not afford a proper occasion to discuss the soundness of that doctrine, because, as stated in MR. JUSTICE FRANKFURTER's dissent, "That issue is not here in controversy." The salutary practice whereby courts do not discuss issues in the abstract applies with peculiar force to Constitutional questions. Since, however, the dissent adverts to a highly controversial due process doctrine and implies its acceptance by Congress, we feel compelled to say that we do not understand that Congress voluntarily has acquiesced in a Constitutional principle of government that courts, rather than legislative bodies, possess final authority over regulation of economic affairs. Even this Court has not always fully embraced that principle, and we wish to repeat that we have never acquiesced in it, and do not now. *See Federal Power Commission v. Natural Gas Pipeline Co.,* 315 U. S. 575, 315 U. S. 599-601.

MR. JUSTICE REED, dissenting.

This case involves the problem of ratemaking under the Natural Gas Act. Added importance arises from the obvious fact that the principles stated are generally applicable to all federal agencies which are entrusted with the determination of rates for utilities. Because my views differ somewhat from those of my brethren, it may be of some value to set them out in a summary form.

The Congress may fix utility rates in situations subject to federal control without regard to any standard except the constitutional standards of due process and for taking private property for public use without just compensation. *Wilson v. New,* 243 U. S. 332, 243 U. S. 350. A Commission, however, does not have this freedom of action. Its powers are limited not only by the constitutional standards, but also by the standards of the delegation. Here, the standard added by the Natural Gas Act is that the rate be "just

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and reasonable." [Footnote 2/1] Section 6 [Footnote 2/2] throws additional light on the meaning of these words.

When the phrase was used by Congress to describe allowable rates, it had relation to something ascertainable. The rates were not left to the whim of the Commission. The rates fixed would produce an annual return, and that annual return was to be compared with a theoretical just and reasonable return, all risks considered, on the fair value of the property used and useful in the public service at the time of the determination.

Such an abstract test is not precise. The agency charged with its determination has a wide range before it could properly be said by a court that the agency had disregarded statutory standards or had confiscated the property of the utility for public use. *Cf. Chicago, M. & St. P. R. Co. v. Minnesota,* 134 U. S. 418, 134 U. S. 461-466, dissent. This is as Congress intends. Rates are left to an experienced agency particularly competent by training to appraise the amount required.

The decision as to a reasonable return had not been a source of great difficulty, for borrowers and lenders reached such agreements daily in a multitude of situations; and although the determination of fair value had been troublesome, its essentials had been worked out in fairness to investor and consumer by the time of the enactment

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of this Act. *Cf. Los Angeles Gas & Electric Corp. v. Railroad Commission,* 289 U. S. 287, 289 U. S. 304 *et seq.* The results were well known to Congress, and had that body desired to depart from the traditional concepts of fair value and earnings, it would have stated its intention plainly. *Helvering v. Griffiths,* 318 U. S. 371.

It was already clear that, when rates are in dispute, "earnings produced by rates do not afford a standard for decision." 289 U.S. at 289 U. S. 305. Historical cost, prudent investment and reproduction cost [Footnote 2/3] were all relevant factors in determining fair value. Indeed, disregarding the pioneer investor's risk, if prudent investment and reproduction cost were not distorted by changes in price levels or technology, each of them would produce the same result. The realization from the risk of an investment in a speculative field, such as natural gas utilities, should be reflected in the present fair value. [Footnote 2/4] The amount of evidence to be admitted on any point was, of course, in the agency's reasonable discretion, and it was free to give its own weight to these or other factors and to determine from all the evidence its own judgment as to the necessary rates.

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I agree with the Court in not imposing a rule of prudent investment alone in determining the rate base. This leaves the Commission free, as I understand it, to use any available evidence for its finding of fair value, including both prudent investment and the cost of installing at the present time an efficient system for furnishing the needed utility service.

My disagreement with the Court arises primarily from its view that it makes no difference how the Commission reached the rate fixed, so long as the result is fair and reasonable. For me, the statutory command to the Commission is more explicit. Entirely aside from the constitutional problem of whether the Congress could validly delegate its ratemaking power to the Commission, *in toto* and without standards, it did legislate in the light of the relation of fair and reasonable to fair value and reasonable return. The Commission must therefore make its findings in observance of that relationship.

The Federal Power Commission did not, as I construe their action, disregard its statutory duty. They heard the evidence relating to historical and reproduction cost and to the reasonable rate of return and they appraised its weight. The evidence of reproduction cost was rejected as unpersuasive, but, from the other evidence, they found a rate base, which is to me a determination of fair value. On that base, the earnings allowed seem fair and reasonable. So far as the Commission went in appraising the property employed in the service, I find nothing in the result which indicates confiscation, unfairness or unreasonableness. Good administration of ratemaking agencies under this method would avoid undue delay and render revaluations unnecessary except after violent fluctuations of price levels. Ratemaking under this method has been subjected to criticism. But until Congress changes the standards for the agencies, these ratemaking bodies should continue the conventional theory of ratemaking.

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It will probably be simpler to improve present methods than to devise new ones.

But a major error, I think was committed in the disregard by the Commission of the investment in exploratory operations and other recognized capital costs. These were not considered by the Commission, because they were charged to operating expenses by the company at a time when it was unregulated. Congress did not direct the Commission in ratemaking to deduct from the rate base capital investment which had been recovered during the unregulated period through excess earnings. In my view, this part of the investment should no more have been disregarded in the rate base than any other capital investment which previously had been recovered and paid out in dividends or placed to surplus. Even if prudent investment throughout the life of the property is accepted as the formula for figuring the rate base, it seems to me illogical to throw out the admittedly prudent cost of part of the property because the earnings in the unregulated period had been sufficient to return the prudent cost to the investors over and above a reasonable return. What would the answer be under the theory of the Commission and the Court if the only prudent investment in this utility had been the seventeen million capital charges which are now disallowed?

For the reasons heretofore stated, I should affirm the action of the Circuit Court of Appeals in returning the proceeding to the Commission for further consideration, and should direct the Commission to accept the disallowed capital investment in determining the fair value for ratemaking purposes.

[Footnote 2/1]

Natural Gas Act, § 4(a), 52 Stat. 821, 822, 15 U.S.C. § 717c(a).

[Footnote 2/2]

52 Stat. 821, 824, 15 U.S.C. § 717e:

"(a) The Commission may investigate and ascertain the actual legitimate cost of the property of every natural gas company, the depreciation therein, and, when found necessary for ratemaking purposes, other facts which bear on the determination of such cost or depreciation and the fair value of such property."

"(b) Every natural gas company upon request shall file with the Commission an inventory of all or any part of its property and a statement of the original cost thereof, and shall keep the Commission informed regarding the cost of all additions, betterments, extensions, and new construction."

[Footnote 2/3]

"Reproduction cost" has been variously defined, but, for ratemaking purposes, the most useful sense seems to be the minimum amount necessary to create at the time of the inquiry a modern plant capable of rendering equivalent service. *See* I Bonbright, Valuation of Property (1937) 152. Reproduction cost as the cost of building a replica of an obsolescent plant is not of real significance.

"Prudent investment" is not defined by the Court. It may mean the sum originally put in the enterprise, either with or without additional amounts from excess earnings reinvested in the business.

[Footnote 2/4]

It is of no more than bookkeeping significance whether the Commission allows a rate of return commensurate with the risk of the original investment or the lower rate based on current risk and a capitalization reflecting the established earning power of a successful company and the probable cost of duplicating its services. *Cf. A.T. & T. Co. v. United States,* 299 U. S. 232. But the latter is the traditional method.

MR. JUSTICE FRANKFURTER, dissenting.

My brother JACKSON has analyzed with particularity the economic and social aspects of natural gas, as well as

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the difficulties which led to the enactment of the Natural Gas Act, especially those arising out of the abortive attempts of States to regulate natural gas utilities. The Natural Gas Act of 1938 should receive application in the light of this analysis, and MR. JUSTICE JACKSON has, I believe, drawn relevant inferences regarding the duty of the Federal Power Commission in fixing natural gas rates. His exposition seems to me unanswered, and I shall say only a few words to emphasize my basic agreement with him.

For our society, the needs that are met by public utilities are as truly public services as the traditional governmental functions of police and justice. They are not less so when these services are rendered by private enterprise under governmental regulation. Who ultimately determines the ways of regulation is the decisive aspect in the public supervision of privately owned utilities. Foreshadowed nearly sixty years ago, *Railroad Commission Cases,* 116 U. S. 307, 116 U. S. 331, it was decided more than fifty years ago that the final say under the Constitution lies with the judiciary, and not the legislature. *Chicago, M. & St. P. Ry. Co. v. Minnesota,* 134 U. S. 418.

While legal issues touching the proper distribution of governmental powers under the Constitution may always be raised, Congressional acquiescence to date in the doctrine of *Chicago, M. & St. P. Ry. Co. v. Minnesota, supra,* may fairly be claimed. But, in any event, that issue is not here in controversy. As pointed out in the opinions of my brethren, Congress has given only limited authority to the Federal Power Commission, and made the exercise of that authority subject to judicial review. The Commission is authorized to fix rates chargeable for natural gas. But the rates that it can fix must be "just and reasonable." § 5 of the Natural Gas Act, 15 U.S.C. § 717d. Instead of making the Commission's rate determinations final, Congress

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specifically provided for court review of such orders. To be sure, "the finding of the Commission as to the facts, if supported by substantial evidence" was made "conclusive," § 19 of the Act, 15 U.S.C. § 717r. But obedience of the requirement of Congress that rates be "just and reasonable" is not an issue of fact of which the Commission's own determination is conclusive. Otherwise, there would be nothing for a court to review except questions of compliance with the procedural provisions of the Natural Gas Act. Congress might have seen fit so to cast its legislation. But it has not done so. It has committed to the administration of the Federal Power Commission the duty of applying standards of fair dealing and of reasonableness relevant to the purposes expressed by the Natural Gas Act. The requirement that rates must be "just and reasonable" means just and reasonable in relation to appropriate standards. Otherwise, Congress would have directed the Commission to fix such rates as in the judgment of the Commission are just and reasonable; it would not have also provided that such determinations by the Commission are subject to court review.

To what sources then are the Commission and the courts to go for ascertaining the standards relevant to the regulation of natural gas rates? It is at this point that MR. JUSTICE JACKSON's analysis seems to me pertinent. There appear to be two alternatives. Either the fixing of natural gas rates must be left to the unguided discretion of the Commission so long as the rates it fixes do not reveal a glaringly bad prophecy of the ability of a regulated utility to continue its service in the future, or the Commission's rate orders must be founded on due consideration of all the elements of the public interest which the production and distribution of natural gas involve just because it is natural gas. These elements are reflected in the Natural Gas Act, if that Act be applied as an entirety. *See, for*

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instance, §§ 4(a)(b)(c)(d), 6, and 11, 15 U.S.C. §§ 717c(a)(b)(c)(d), 717e, and 717j. Of course, the statute is not concerned with abstract theories of ratemaking. But its very foundation is the "public interest," and the public interest is a texture of multiple strands. It includes more than contemporary investors and contemporary consumers. The needs to be served are not restricted to immediacy, and social, as well as economic, costs must be counted.

It will not do to say that it must all be left to the skill of experts. Expertise is a rational process, and a rational process implies expressed reasons for judgment. It will little advance the public interest to substitute for the hodge-podge of the rule in *Smyth v. Ames,* 169 U. S. 466, an encouragement of conscious obscurity or confusion in reaching a result, on the assumption that, so long as the result appears harmless, its basis is irrelevant. That may be an appropriate attitude when state action is challenged as unconstitutional. *Cf. Driscoll v. Edison Light & Power Co.,* 307 U. S. 104. But it is not to be assumed that it was the design of Congress to make the accommodation of the conflicting interests exposed in MR. JUSTICE JACKSON's opinion the occasion for a blind clash of forces or a partial assessment of relevant factors, either before the Commission or here.

The objection to the Commission's action is not that the rates it granted were too low, but that the range of its vision was too narrow. And since the issues before the Commission involved no less than the total public interest, the proceedings before it should not be judged by narrow conceptions of common law pleading. And so I conclude that the case should be returned to the Commission. In order to enable this Court to discharge its duty of reviewing the Commission's order, the Commission should set forth with explicitness the criteria by which it is guided

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in determining that rates are "just and reasonable," and it should determine the public interest that is in its keeping in the perspective of the considerations set forth by MR. JUSTICE JACKSON.

By MR. JUSTICE JACKSON.

Certainly the theory of the court below that ties ratemaking to the "fair value reproduction cost" formula should be overruled as in conflict with *Federal Power Commission v. Natural Gas Pipeline Co.* [Footnote 3/1] But the case should, I think, be the occasion for reconsideration of our ratemaking doctrine as applied to natural gas, and should be returned to the Commission for further consideration in the light thereof.

The Commission appears to have understood the effect of the two opinions in the *Pipeline* case to be at least authority, and perhaps direction, to fix natural gas rates by exclusive application of the "prudent investment" rate base theory. This has no warrant in the opinion of THE CHIEF JUSTICE for the Court, however, which released the Commission from subservience to "any single formula or combination of formulas" provided its order, "viewed in its entirety, produces no arbitrary result." 315 U.S. at 315 U. S. 586. The minority opinion I understood to advocate the "prudent investment" theory as a sufficient guide in a natural gas case. The view was expressed in the court below that, since this opinion was not expressly controverted, it must have been approved. [Footnote 3/2] I disclaim this imputed

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approval with some particularity, because I attach importance at the very beginning of federal regulation of the natural gas industry to approaching it as the performance of economic functions, not as the performance of legalistic rituals.

I

Solutions of these cases must consider eccentricities of the industry which gives rise to them, and also to the Act of Congress by which they are governed.

The heart of this problem is the elusive, exhaustible, and irreplaceable nature of natural gas itself. Given sufficient money, we can produce any desired amount of railroad, bus, or steamship transportation, or communications facilities, or capacity for generation of electric energy, or for the manufacture of gas of a kind. In the service of such utilities, one customer has little concern with the amount taken by another, one's waste will not deprive another, a volume of service and be created equal to demand, and today's demands will not exhaust or lessen capacity to serve tomorrow. But the wealth of Midas and the wit of man cannot produce or reproduce a natural gas field. We cannot even reproduce the gas, for our manufactured product has only about half the heating value per unit of nature's own. [Footnote 3/3]

Natural gas in some quantity is produced in twenty-four states. It is consumed in only thirty-five states, and is

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available only to about 7,600,000 consumers. [Footnote 3/4] Its availability has been more localized than that of any other utility service because it has depended more on the caprice of nature.

The supply of the Hope Company is drawn from that old and rich and vanishing field that flanks the Appalachian mountains. Its center of production is Pennsylvania and West Virginia, with a fringe of lesser production in New York, Ohio, Kentucky, Tennessee, and the north end of Alabama. Oil was discovered in commercial quantities at a depth of only 69 1/2 feet near Titusville, Pennsylvania, in 1859. Its value then was about $16 per barrel. [Footnote 3/5] The oil branch of the petroleum industry went forward at once, and with unprecedented speed. The area productive of oil and gas was roughed out by the drilling of over 19,000 "wildcat" wells, estimated to have cost over $222,000,000. Of these, over 18,000 or 94.9 percent, were "dry holes." About five percent, or 990 wells, made discoveries of commercial importance, 767 of them resulting chiefly in oil and 223 in gas only. [Footnote 3/6] Prospecting for many years was a search for oil, and to strike gas was a misfortune. Waste during this period and even later is appalling. Gas was regarded as having no commercial value until about 1882, in which year the total yield was valued only at about $75,000. [Footnote 3/7] Since then, contrary to oil, which has become cheaper, gas in this field has pretty steadily advanced in price.

While for many years natural gas had been distributed on a small scale for lighting, [Footnote 3/8] its acceptance was slow,

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facilities for its utilization were primitive, and not until 1885 did it take on the appearance of a substantial industry. [Footnote 3/9] Soon, monopoly of production or markets developed. [Footnote 3/10] To get gas from the mountain country, where it was largely found, to centers of population, where it was in demand, required very large investment. By ownership of such facilities, a few corporate systems, each including several companies, controlled access to markets. Their purchases became the dominating factor in giving a market value to gas produced by many small operators. Hope is the market for over 300 such operators. By 1928, natural gas in the Appalachian field commanded an average price of 21.1 cents per m.c.f. at points of production, and was bringing 45.7 cents at points of consumption. [Footnote 3/11] The companies which controlled markets, however, did not rely on gas purchases alone. They acquired and held in fee or leasehold great acreage in territory proved by "wildcat" drilling. These large marketing system companies, as well as many small independent owners and operators, have carried on the commercial development of proved territory. The development risks appear from the estimate that, up to 1928, 312,318 proved area wells had been sunk in the Appalachian field, of which 48,962, or 15.7 percent, failed to produce oil or gas in commercial quantity. [Footnote 3/12]

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With the source of supply thus tapped to serve centers of large demand like Pittsburgh, Buffalo, Cleveland, Youngstown, Akron, and other industrial communities, the distribution of natural gas fast became big business. Its advantages as a fuel and its price commended it, and the business yielded a handsome return. All was merry, and the goose hung high for consumers and gas companies alike until about the time of the first World War. Almost unnoticed by the consuming public, the whole Appalachian field passed its peak of production and started to decline. Pennsylvania, which, to 1928, had given off about 38 percent of the natural gas from this field, had its peak in 1905; Ohio, which had produced 14 percent, had its peak in 1915; and West Virginia, greatest producer of all, with 45 percent to its credit, reached its peak in 1917. [Footnote 3/13]

Western New York and Eastern Ohio, on the fringe of the field, had some production, but relied heavily on imports from Pennsylvania and West Virginia. Pennsylvania, a producing and exporting state, was a heavy consumer, and supplemented her production with imports from West Virginia. West Virginia was a consuming state, but the lion's share of her production was exported. Thus, the interest of the states in the North Appalachian supply was in conflict.

Competition among localities to share in the failing supply and the helplessness of state and local authorities in the presence of state lines and corporate complexities is a part of the background of federal intervention in the industry. [Footnote 3/14] West Virginia took the boldest measure. It legislated a priority in its entire production in favor of its own inhabitants. That was frustrated by an injunction

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from this Court. [Footnote 3/15] Throughout the region, clashes in the courts and conflicting decisions evidenced public anxiety and confusion. It was held that the New York Public Service Commission did not have power to classify consumers and restrict their use of gas. [Footnote 3/16] That Commission held that a company could not abandon a part of its territory and still serve the rest. [Footnote 3/17] Some courts admonished the companies to take action to protect consumers. [Footnote 3/18] Several courts held that companies, regardless of failing supply, must continue to take on customers, but such compulsory additions were finally held to be within the Public Service Commission's discretion. [Footnote 3/19] There were attempts to throw up franchises and quit the service, and municipalities resorted to the courts with conflicting results. [Footnote 3/20] Public service commissions of consuming states were handicapped, for they had no control of the supply. [Footnote 3/21]

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Shortages during World War I occasioned the first intervention in the natural gas industry by the Federal Government. Under Proclamation of President Wilson, the United States Fuel Administrator took control, stopped extensions, classified consumers, and established a priority for domestic over industrial use. [Footnote 3/22] After the war, federal control was abandoned. Some cities once served with natural gas became dependent upon mixed gas of reduced heating value and relatively higher price. [Footnote 3/23]

Utilization of natural gas of highest social as well as economic return is domestic use for cooking and water

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heating, followed closely by use for space heating in homes. This is the true public utility aspect of the enterprise, and its preservation should be the first concern of regulation. Gas does the family cooking cheaper than any other fuel. [Footnote 3/24] But its advantages do not end with dollars and cents cost. It is delivered without interruption at the meter as needed, and is paid for after it is used. No money is tied up in a supply, and no space is used for storage. It requires no handling, creates no dust, and leaves no ash. It responds to thermostatic control. It ignites easily, and immediately develops its maximum heating capacity. These incidental advantages make domestic life more liveable.

Industrial use is induced less by these qualities than by low cost in competition with other fuels. Of the gas exported from West Virginia by the Hope Company, a very substantial part is used by industries. This wholesale use speeds exhaustion of supply and displaces other fuels. Coal miners and the coal industry, a large part of whose costs are wages, have complained of unfair competition from low-priced industrial gas produced with relatively little labor cost. [Footnote 3/25]

Gas rate structures generally have favored industrial users. In 1932, in Ohio, the average yield on gas for domestic consumption was 62.1 cents per m.c.f. and on industrial,

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38.7. In Pennsylvania, the figures were 62.9 against 31.7. West Virginia showed the least spread, domestic consumers paying 36.6 cents; and industrial, 27.7. [Footnote 3/26] Although this spread is less than in other parts of the United States, [Footnote 3/27] it can hardly be said to be self-justifying. It certainly is a very great factor in hastening decline of the natural gas supply.

About the time of World War I, there were occasional and short-lived efforts by some hard-pressed companies to reverse this discrimination and adopt graduated rates, giving a low rate to quantities adequate for domestic use and graduating it upward to discourage industrial use. [Footnote 3/28]

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These rates met opposition from industrial sources, of course, and since diminished revenues from industrial sources tended to increase the domestic price, they met little popular or commission favor. The fact is that neither the gas companies nor the consumers nor local regulatory bodies can be depended upon to conserve gas. Unless federal regulation will take account of conservation, its efforts seem, as in this case, actually to constitute a new threat to the life of the Appalachian supply.

II

Congress, in 1938, decided upon federal regulation of the industry. It did so after an exhaustive investigation of all aspects, including failing supply and competition for the use of natural gas intensified by growing scarcity. [Footnote 3/29] Pipelines from the Appalachian area to markets were in the control of a handful of holding company systems. [Footnote 3/30] This created a highly concentrated control of the producers' market and of the consumers' supplies. While holding companies dominated both production and distribution, they segregated those activities in separate

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subsidiaries, [Footnote 3/31] the effect of which, if not the purpose, was to isolate some end of the business from the reach of any one state commission. The cost of natural gas to consumers moved steadily upwards over the years, out of proportion to prices of oil, which, except for the element of competition, is produced under somewhat comparable conditions. The public came to feel that the companies were exploiting the growing scarcity of local gas. The problems of this region had much to do with creating the demand for federal regulation.

The Natural Gas Act declared the natural gas business to be "affected with a *public interest,*" and its regulation "necessary in the *public interest.*" [Footnote 3/32] Originally, and at the time this proceeding was commenced and tried, it also declared

"the intention of Congress that natural gas shall be sold in interstate commerce for resale for ultimate public consumption for domestic, commercial, industrial, or any other use at the lowest possible reasonable rate *consistent with the maintenance of adequate service in the public interest.* [Footnote 3/33]"

While this was later dropped, there is nothing to indicate that it was not and is not still an accurate statement of purpose of the Act. Extension or improvement of facilities may be ordered when "necessary or desirable in the public interest," abandonment of facilities may be ordered when the supply is

"depleted to the extent that the continuance of service is unwarranted, or that the *present or future public convenience or necessity*

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permit"

abandonment and certain extensions can only be made on finding of "the *present or future* public convenience and necessity." [Footnote 3/34] The Commission is required to take account of the ultimate use of the gas. Thus, it is given power to suspend new schedules as to rates, charges, and classification of services except where the schedules are for the sale of gas "for resale for industrial use only," [Footnote 3/35] which gives the companies greater freedom to increase rates on industrial gas than on domestic gas. More particularly, the Act expressly forbids any undue preference or advantage to any person or "any unreasonable difference in rates . . . either as between localities or as between classes of service." [Footnote 3/36] And the power of the Commission expressly includes that to determine the "just and reasonable rate, charge, classification, rule, regulation, practice, or contract to be thereafter observed and in force." [Footnote 3/37]

In view of the Court's opinion that the Commission, in administering the Act, may ignore discrimination, it is interesting that, in reporting this bill, both the Senate and the House Committees on Interstate Commerce pointed out that, in 1934, on a nationwide average, the price of natural gas per m.c.f. was 74.6 cents for domestic use, 49.6 cents for commercial use, and 16.9 for industrial use. [Footnote 3/38] I am not ready to think that supporters of a bill called attention to the striking fact that householders were being charged five times as much for their gas as industrial users only as a situation which the Bill would do nothing to remedy. On the other hand, the Act gave to the Commission what the Court aptly describes as "broad powers of regulation."

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III

This proceeding was initiated by the Cities of Cleveland and Akron. They alleged that the price charged by Hope for natural gas

"for resale to domestic, commercial and small industrial consumers in Cleveland and elsewhere is excessive, unjust, unreasonable, greatly in excess of the price charged by Hope to nonaffiliated companies at wholesale for resale to domestic, commercial and small industrial consumers, and *greatly in excess of the price charged by Hope to East Ohio for resale to certain favored industrial consumers in Ohio, and therefore is further unduly discriminatory between consumers and between classes of service.*"

(Italics supplied). The company answered admitting differences in prices to affiliated and nonaffiliated companies and justifying them by differences in conditions of delivery. As to the allegation that the contract price is "greatly in excess of the price charged by Hope to East Ohio for resale to certain favored industrial consumers in Ohio," Hope did not deny a price differential, but alleged that industrial gas was not sold to "favored consumers" but was sold under contract and schedules filed with and approved by the Public Utilities Commission of Ohio, and that certain conditions of delivery made it not "unduly discriminatory."

The record shows that, in 1940, Hope delivered for industrial consumption 36,523,792 m.c.f. and for domestic and commercial consumption, 50,343,652 m.c.f. I find no separate figure for domestic consumption. It served 43,767 domestic consumers directly, 511,521 through the East Ohio Gas Company, and 154,043 through the Peoples Natural Gas Company, both affiliates owned by the same parent. Its special contracts for industrial consumption, so far as appear, are confined to about a dozen big industries.

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Hope is responsible for discrimination as exists in favor of these few industrial consumers. It controls both the resale price and use of industrial gas by virtue of the very interstate sales contracts over which the Commission is exercising its jurisdiction.

Hope's contract with East Ohio Company is an example. Hope agrees to deliver, and the Ohio Company to take,

"(a) all natural gas requisite for the supply of the domestic consumers of the Ohio Company; (b) such amounts of natural gas as may be requisite to fulfill contracts made with the consent and approval of the Hope Company by the Ohio Company, or companies which it supplies with natural gas, for the sale of gas upon special terms and conditions for manufacturing purposes."

The Ohio company is required to read domestic customers' meters once a month and meters of industrial customers daily and to furnish all meter readings to Hope. The Hope Company is to have access to meters of all consumers and to all of the Ohio Company's accounts. The domestic consumers of the Ohio Company are to be fully supplied in preference to consumers purchasing for manufacturing purposes, and

"Hope Company can be required to supply gas to be used for manufacturing purposes only where the same is sold under special contracts which have first been submitted to and approved in writing by the Hope Company and which expressly provide that natural gas will be supplied thereunder only in so far as the same is not necessary to meet the requirements of domestic consumers supplied through pipelines of the Ohio Company."

This basic contract was supplemented from time to time, chiefly as to price. The last amendment was in a letter from Hope to East Ohio in 1937. It contained a special discount on industrial gas and a schedule of special industrial contracts, Hope reserving the right to make eliminations therefrom and agreeing that others might be added from time to

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time with its approval in writing. It said,

"It is believed that the price concessions contained in this letter, *while not based on our costs,* are, under certain conditions, to our mutual advantage in maintaining and building up the volumes of gas sold by us [italics supplied]. [Footnote 3/39]"

The Commission took no note of the charges of discrimination, and made no disposition of the issue tendered on this point. It ordered a flat reduction in the price per m.c.f. of all gas delivered by Hope in interstate commerce. It made no limitation, condition, or provision as to what classes of consumers should get the benefit of the reduction. While the cities have accepted and are defending the reduction, it is my view that the discrimination of which they have complained is perpetuated and increased by the order of the Commission, and that it violates the Act in so doing.

The Commission's opinion aptly characterizes its entire objective by saying that "*bona fide* investment figures now become all-important in the regulation of rates." It should be noted that the all-importance of this theory is not the result of any instruction from Congress. When the Bill to regulate gas was first before Congress it contained

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the following:

"In determining just and reasonable rates, the Commission shall fix such rate as will allow a fair return upon the actual legitimate prudent cost of the property used and useful for the service in question."

H.R. 5423, 74th Cong., 1st Sess. Title III, § 312(c). Congress rejected this language. *See* H.R. 5423, § 213 (211(c)), and H.R.Rep. No. 1318, 74th Cong., 1st Sess. 30.

The Commission contends, nevertheless, that the "all-important" formula for finding a rate base is that of prudent investment. But it excluded from the investment base an amount actually and admittedly invested of some $17,000,000. It did so because it says that the Company recouped these expenditures from customers before the days of regulation from earnings above a fair return. But it would not apply all of such "excess earnings" to reduce the rate base as one of the Commissioners suggested. The reason for applying excess earnings to reduce the investment base roughly from $69,000,000 to $52,000,000 but refusing to apply them to reduce it from that to some $18,000,000 is not found in a difference in the character of the earnings or in their reinvestment. The reason assigned is a difference in bookkeeping treatment many years before the Company was subject to regulation. The $17,000,000, reinvested chiefly in well drilling, was treated on the books as expense. (The Commission now requires that drilling costs be carried to capital account.) The allowed rate base thus actually was determined by the Company's bookkeeping, not its investment. This attributes a significance to formal classification in account keeping that seems inconsistent with rational rate regulation. [Footnote 3/40] Of

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course, the Commission would not and should not allow a rate base to be inflated by bookkeeping which had improperly capitalized expenses. I have doubts about resting public regulation upon any rule that is to be used or not depending on which side it favors.

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The Company, on the other hand, has not put its gas fields into its calculations on the present-value basis, although that, it contends, is the only lawful rule for finding a rate base. To do so would result in a rate higher than it has charged or proposes as a matter of good business to charge.

The case before us demonstrates the lack of rational relationship between conventional rate base formulas and natural gas production and the extremities to which regulating bodies are brought by the effort to rationalize them. The Commission and the Company each stands on a different theory, and neither ventures to carry its theory to logical conclusion as applied to gas fields.

IV

This order is under judicial review not because we interpose constitutional theories between a State and the business it seeks to regulate, but because Congress put upon the federal courts a duty toward administration of a new federal regulatory Act. If we are to hold that a given rate is reasonable just because the Commission has said it was reasonable, review becomes a costly, time-consuming pageant of no practical value to anyone. If, on the other hand, we are to bring judgment of our own to the task, we should for the guidance of the regulators and the regulated reveal something of the philosophy, be it legal or economic or social, which guides us. We need not be slaves to a formula, but, unless we can point out a rational way of reaching our conclusions, they can only be accepted as resting on intuition or predilection. I must admit that I possess no instinct by which to know the "reasonable" from the "unreasonable" in prices, and must seek some conscious design for decision.

The Court sustains this order as reasonable, but what makes it so, or what could possibly make it otherwise,

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I cannot learn. It holds that: "it is the result reached, not the method employed, which is controlling"; "the fact that the method employed to reach that result may contain infirmities is not then important," and it is not

"important to this case to determine the various permissible ways in which any rate base on which the return is computed might be arrived at."

The Court does lean somewhat on considerations of capitalization and dividend history and requirements for dividends on outstanding stock. But I can give no real weight to that, for it is generally, and I think deservedly, in discredit as any guide in rate cases. [Footnote 3/41]

Our books already contain so much talk of methods of rationalizing rates that we must appear ambiguous if we announce results without our working methods. We are confronted with regulation of a unique type of enterprise which I think requires considered rejection of much conventional utility doctrine and adoption of concepts of "just and reasonable" rates and practices and of the "public interest" that will take account of the peculiarities of the business.

The Court rejects the suggestions of this opinion. It says that the Committees, in reporting the bill which became the Act, said it provided "for regulation along recognized and more or less standardized lines," and that there was "nothing novel in its provisions." So saying it sustains a rate calculated on a novel variation of a rate base theory which itself had at the time of enactment of the legislation been recognized only in dissenting opinions. Our difference seems to be between unconscious innovation, [Footnote 3/42] and the purposeful and deliberate innovation I

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would make to meet the necessities of regulating the industry before us.

Hope's business has two components of quite divergent character. One, while not a conventional common carrier undertaking, is essentially a transportation enterprise consisting of conveying gas from where it is produced to point of delivery to the buyer. This is a relatively routine operation not differing substantially from many other utility operations. The service is produced by an investment in compression and transmission facilities. Its risks are those of investing in a tested means of conveying a discovered supply of gas to a known market. A rate base calculated on the prudent investment formula would seem a reasonably satisfactory measure for fixing a return from that branch of the business whose service is roughly proportionate to the capital invested. But it has other consequences which must not be overlooked. It gives marketability, and hence "value," to gas owned by the company, and gives the pipeline company a large power over the marketability, and hence "value," of the production of others.

The other part of the business -- to reduce to possession an adequate supply of natural gas -- is of opposite character, being more erratic and irregular and unpredictable in relation to investment than any phase of any other utility business. A thousand feet of gas captured and severed from real estate for delivery to consumers is recognized under our law as property of much the same nature as a ton of coal, a barrel of oil, or a yard of sand. The value to be allowed for it is the real battleground between the investor and consumer. It is from this part of the business that the chief difference between the parties as to a proper rate base arises.

It is necessary to a "reasonable" price for gas that it be anchored to a rate base of any kind? Why did courts in the first place begin valuing "rate bases" in order to "value" something else? The method came into vogue

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in fixing rates for transportation service which the public obtained from common carriers. The public received none of the carriers' physical property, but did make some use of it. The carriage was often a monopoly, so there were no open market criteria as to reasonableness. The "value" or "cost" of what was put to use in the service by the carrier was not a remote or irrelevant consideration in making such rates. Moreover, the difficulty of appraising an intangible service was thought to be simplified if it could be related to physical property which was visible and measurable and the items of which might have market value. The court hoped to reason from the known to the unknown. But gas fields turn this method topsy-turvy. Gas itself is tangible, possessible, and does have a market and a price in the field. The value of the rate base is more elusive than that of gas. It consists of intangibles -- leaseholds and freeholds -- operated and unoperated -- of little use in themselves except as rights to reach and capture gas. Their value lies almost wholly in predictions of discovery, and of price of gas when captured, and bears little relation to cost of tools and supplies and labor to develop it. Gas is what Hope sells, and it can be directly priced more reasonably and easily and accurately than the components of a rate base can be valued. Hence, the reason for resort to a roundabout way of rate base price fixing does not exist in the case of gas in the field.

But if found, and by whatever method found, a rate base is little help in determining reasonableness of the price of gas. Appraisal of present value of these intangible rights to pursue fugitive gas depends on the value assigned to the gas when captured. The "present fair value" rate base, generally in ill repute, [Footnote 3/43] is not even urged by the gas company for valuing its fields.

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The prudent investment theory has relative merits in fixing rates for a utility which creates its service merely by its investment. The amount and quality of service rendered by the usual utility will, at least roughly, be measured by the amount of capital it puts into the enterprise. But it has no rational application where there is no such relationship between investment and capacity to serve. There is no such relationship between investment and amount of gas produced. Let us assume that Doe and Roe each produces in West Virginia for delivery to Cleveland the same quantity of natural gas per day. Doe, however, through luck or foresight or whatever it takes, gets his gas from investing $50,000 in leases and drilling. Roe drilled poorer territory, got smaller wells, and has invested $250,000. Does anybody imagine that Roe can get or ought to get for his gas five times as much as Doe because he has spent five times as much? The service one renders to society in the gas business is measured by what he gets out of the ground, not by what he puts into it, and there is little more relation between the investment and the results than in a game of poker.

Two-thirds of the gas Hope handles it buys from about 340 independent producers. It is obvious that the principle of ratemaking applied to Hope's own gas cannot be applied, and has not been applied, to the bulk of the gas Hope delivers. It is not probable that the investment of any two of these producers will bear the same ratio to their investments. The gas, however, all goes to the same use, has the same utilization value and the same ultimate price.

To regulate such an enterprise by undiscriminatingly transplanting any body of rate doctrine conceived and

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adapted to the ordinary utility business can serve the "public interest" as the Natural Gas Act requires, if at all, only by accident. Mr. Justice Brandeis, the pioneer juristic advocate of the prudent investment theory for man-made utilities, never, so far as I am able to discover, proposed its application to a natural gas case. On the other hand, dissenting in *Pennsylvania v. West Virginia,* he reviewed the problems of gas supply and said,

"In no other field of public service regulation is the controlling body confronted with factors so baffling as in the natural gas industry, and in none is continuous supervision and control required in so high a degree."

262 U. S. 262 U.S. 553, 262 U. S. 621. If natural gas rates are intelligently to be regulated, we must fit our legal principles to the economy of the industry, and not try to fit the industry to our books.

As our decisions stand, the Commission was justified in believing that it was required to proceed by the rate base method even as to gas in the field. For this reason, the Court may not merely wash its hands of the method and rationale of ratemaking. The fact is that this Court, with no discussion of its fitness, simply transferred the rate base method to the natural gas industry. It happened in *Newark Natural Gas & Fuel Co. v. City of Newark, Ohio,* 242 U. S. 405 (1917), in which the company wanted 25 cents per m.c.f. and, under the Fourteenth Amendment, challenged the reduction to 18 cents by ordinance. This Court sustained the reduction because the court below "gave careful consideration to the questions of the value of the property . . . at the time of the inquiry," and whether the rate "would be sufficient to provide a fair return on the value of the property." The Court said this method was "based upon principles thoroughly established by repeated decisions of this court," citing many cases, not one of which involved natural gas or a comparable wasting natural resource. Then came issues as to state power to

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regulate as affected by the commerce clause. *Public Utilities Commission v. Landon,* 249 U. S. 236 (1919); *Pennsylvania Gas Co. v. Public Service Commission,* 252 U. S. 23 (1920). These questions settled, the Court again was called upon in natural gas cases to consider state ratemaking claimed to be invalid under the Fourteenth Amendment. *United Fuel Gas Co. v. Railroad Commission of Kentucky,* 278 U. S. 300 (1929); *United Fuel Gas Company v. Public Service Commission of West Virginia,* 278 U. S. 322 (1929). Then, as now, the differences were "due chiefly to the difference in value ascribed by each to the gas rights and leaseholds." 278 U. S. 278 U.S. 300, 278 U. S. 311. No one seems to have questioned that the rate base method must be pursued and the controversy was at what rate base must be used. Later, the "value" of gas in the field was questioned in determining the amount a regulated company should be allowed to pay an affiliate therefor -- a state determination also reviewed under the Fourteenth Amendment. *Dayton Power & Light Co. v. Public Utilities Commission of Ohio,* 292 U. S. 290 (1934); *Columbus Gas & Fuel Co. v. Public Utilities Commission of Ohio,* 292 U. S. 398 (1934). In both cases, one of which sustained and one of which struck down a fixed rate the Court assumed the rate base method, as the legal way of testing reasonableness of natural gas prices fixed by public authority, without examining its real relevancy to the inquiry.

Under the weight of such precedents, we cannot expect the Commission to initiate economically intelligent methods of fixing gas prices. But the Court now faces a new plan of federal regulation based on the power to fix the price at which gas shall be allowed to move in interstate commerce. I should now consider whether these rules devised under the Fourteenth Amendment are the exclusive tests of a just and reasonable rate under the federal statute, inviting reargument directed to that point

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if necessary. As I see it now, I would be prepared to hold that these rules do not apply to a natural gas case arising under the Natural Gas Act.

Such a holding would leave the Commission to fix the price of gas in the field as one would fix maximum prices of oil or milk or coal, or any other commodity. Such a price is not calculated to produce a fair return on the synthetic value of a rate base of any individual producer, and would not undertake to assure a fair return to any producer. The emphasis would shift from the producer to the product, which would be regulated with an eye to average or typical producing conditions in the field.

Such a price-fixing process on economic lines would offer little temptation to the judiciary to become back seat drivers of the price fixing machine. The unfortunate effect of judicial intervention in this field is to divert the attention of those engaged in the process from what is economically wise to what is legally permissible. It is probable that price reductions would reach economically unwise and self-defeating limits before they would reach constitutional ones. Any constitutional problems growing out of price-fixing are quite different than those that have heretofore been considered to inhere in ratemaking. A producer would have difficulty showing the invalidity of such a fixed price so long as he voluntarily continued to sell his product in interstate commerce. Should he withdraw and other authority be invoked to compel him to part with his property, a different problem would be presented.

Allowance in a rate to compensate for gas removed from gas lands, whether fixed as of point of production or as of point of delivery, probably best can be measured by a functional test applied to the whole industry. For good or ill, we depend upon private enterprise to exploit these natural resources for public consumption. The function which an allowance for gas in the field should perform

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for society in such circumstances is to be enough and no more than enough to induce private enterprise completely and efficiently to utilize gas resources, to acquire for public service any available gas or gas rights, and to deliver gas at a rate and for uses which will be in the future, as well as in the present, public interest.

The Court fears that,

"if we are now to tell the Commission to fix the rates so as to discourage particular uses, we would indeed be injecting into a rate case a 'novel' doctrine. . . ."

With due deference, I suggest that there is nothing novel in the idea that any change in price of a service or commodity reacts to encourage or discourage its use. The question is not whether such consequences will or will not follow; the question is whether effects must be suffered blindly or may be intelligently selected, whether price control shall have targets at which it deliberately aims or shall be handled like a gun in the hands of one who does not know it is loaded.

We should recognize "price" for what it is -- a tool, a means, an expedient. In public hands, it has much the same economic effects as in private hands. Hope knew that a concession in industrial price would tend to build up its volume of sales. It used price as an expedient to that end. The Commission makes another cut in that same price, but the Court thinks we should ignore the effect that it will have on exhaustion of supply. The fact is that, in natural gas regulation, price must be used to reconcile the private property right society has permitted to vest in an important natural resource with the claims of society upon it -- price must draw a balance between wealth and welfare.

To carry this into techniques of inquiry is the task of the Commissioner, rather than of the judge, and it certainly is no task to be solved by mere bookkeeping, but requires the best economic talent available. There would doubtless be inquiry into the price gas is bringing in the

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field, how far that price is established by arms' length bargaining, and how far it may be influenced by agreements in restraint of trade or monopolistic influences. What must Hope really pay to get and to replace gas it delivers under this order? If it should get more or less than that for its own, how much and why? How far are such prices influenced by pipeline access to markets and, if the consumers pay returns on the pipelines, how far should the increment they cause go to gas producers? East Ohio is itself a producer in Ohio. [Footnote 3/44] What do Ohio authorities require Ohio consumers to pay for gas in the field? Perhaps these are reasons why the Federal Government should put West Virginia gas at lower or at higher rates. If so, what are they? Should East Ohio be required to exploit its half million acres of unoperated reserve in Ohio before West Virginia resources shall be supplied on a devalued basis of which that State complains and for which she threatens measures of self keep? What is gas worth in terms of other fuels it displaces?

A price cannot be fixed without considering its effect on the production of gas. Is it an incentive to continue to exploit vast unoperated reserves? Is it conducive to deep drilling tests the result of which we may know only after trial? Will it induce bringing gas from afar to supplement or even to substitute for Appalachian gas? [Footnote 3/45] Can it be had from distant fields as cheap or cheaper? If so, that competitive potentiality is certainly a relevant consideration. Wise regulation must also consider, as a private buyer would, what alternatives the producer has

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if the price is not acceptable. Hope has intrastate business and domestic and industrial customers. What can it do by way of diverting its supply to intrastate sales? What can it do by way of disposing of its operated or reserve acreage to industrial concerns or other buyers? What can West Virginia do by way of conservation laws, severance or other taxation, if the regulated rate offends? It must be borne in mind that, while West Virginia was prohibited from giving her own inhabitants a priority that discriminated against interstate commerce, we have never yet held that a good faith conservation act, applicable to her own, as well as to others, is not valid. In considering alternatives, it must be noted that federal regulation is very incomplete, expressly excluding regulation of "production or gathering of natural gas," and that the only present way to get the gas seems to be to call it forth by price inducements. It is plain that there is a downward economic limit on a safe and wise price.

But there is nothing in the law which compels a commission to fix a price at that "value" which a company might give to its product by taking advantage of scarcity, or monopoly of supply. The very purpose of fixing maximum prices is to take away from the seller his opportunity to get all that otherwise the market would award him for his goods. This is a constitutional use of the power to fix maximum prices, *Block v. Hirsh,* 256 U. S. 135; *Marcus Brown Holding Co. v. Feldman,* 256 U. S. 170; *International Harvester Co. v. Kentucky,* 234 U. S. 216; *Highland v. Russell Car & Snow Plow Co.,* 279 U. S. 253, just as the fixing of minimum prices of goods in interstate commerce is constitutional although it takes away from the buyer the advantage in bargaining which market conditions would give him. *United States v. Darby,* 312 U. S. 100; *Mulford v. Smith,* 307 U. S. 38; *United States v. Rock Royal Co-operative, Inc.,* 307 U. S. 533; *Sunshine Anthracite Coal Co. v. Adkins,* 310 U. S. 381. The Commission has power to fix

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a price that will be both maximum and minimum, and it has the incidental right, and I think the duty, to choose the economic consequences it will promote or retard in production and also more importantly in consumption, to which I now turn.

If we assume that the reduction in company revenues is warranted, we then come to the question of translating the allowed return into rates for consumers or classes of consumers. Here, the Commission fixed a single rate for all gas delivered irrespective of its use despite the fact that Hope has established what amounts to two rates -- a high one for domestic use and a lower one for industrial contracts. [Footnote 3/46] The Commission can fix two prices for interstate gas as readily as one -- a price for resale to domestic users and another for resale to industrial users. This is the pattern Hope itself has established in the very contracts over which the Commission is expressly given jurisdiction. Certainly the Act is broad enough to permit two prices to be fixed instead of one, if the concept of the "public interest" is not unduly narrowed.

The Commission's concept of the public interest in natural gas cases which is carried today into the Court's opinion was first announced in the opinion of the minority in the *Pipeline* case. It enumerated only two "phases of the public interest: (1) the investor interest; (2) the consumer interest," which it emphasized to the exclusion of all others. 315 U. S. 315 U.S. 575, 315 U. S. 606. This will do well enough in dealing with railroads or utilities supplying manufactured gas, electric, power, a communications service or transportation, where utilization of facilities does not impair their future usefulness. Limitation of supply, however, brings into a natural gas case another phase of the public interest that, to my mind, overrides both the owner

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and the consumer of that interest. Both producers and industrial consumers have served their immediate private interests at the expense of the long-range public interest. The public interest, of course, requires stopping unjust enrichment of the owner. But it also requires stopping unjust impoverishment of future generations. The public interest in the use by Hope's half million domestic consumers is quite a different one from the public interest in use by a baker's dozen of industries.

Prudent price fixing, it seems to me, must at the very threshold determine whether any part of an allowed return shall be permitted to be realized from sales of gas for resale for industrial use. Such use does tend to level out daily and seasonal peaks of domestic demand, and to some extent permits a lower charge for domestic service. But is that a wise way of making gas cheaper when, in comparison with any substitute, gas is already a cheap fuel? The interstate sales contracts provide that, at times when demand is so great that there is not enough gas to go around, domestic users shall first be served. Should the operation of this preference await the day of actual shortage? Since the propriety of a preference seems conceded, should it not operate to prevent the coming of a shortage, as well as to mitigate its effects? Should industrial use jeopardize tomorrow's service to householders any more than today's? If, however, it is decided to cheapen domestic use by resort to industrial sales, should they be limited to the few uses for which gas has special values or extend also to those who use it only because it is cheaper than competitive fuels? [Footnote 3/47] And how much cheaper should industrial

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gas sell than domestic gas, and how much advantage should it have over competitive fuels? If industrial gas is to contribute at all to lowering domestic rates, should it not be made to contribute the very maximum of which it is capable, that is, should not its price be the highest at which the desired volume of sales can be realized?

If I were to answer, I should say that the household rate should be the lowest that can be fixed under commercial conditions that will conserve the supply for that use. The lowest probable rate for that purpose is not likely to speed exhaustion much, for it still will be high enough to induce economy, and use for that purpose has more nearly reached the saturation point. On the other hand, the demand for industrial gas at present rates already appears to be increasing. To lower further the industrial rate is merely further to subsidize industrial consumption and speed depletion. The impact of the flat reduction

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of rates ordered here admittedly will be to increase the industrial advantages of gas over competing fuels and to increase its use. I think this is not, and there is no finding by the Commission that it is, in the public interest.

There is no justification in this record for the present discrimination against domestic users of gas in favor of industrial users. It is one of the evils against which the Natural Gas Act was aimed by Congress, and one of the evils complained of here by Cleveland and Akron. If Hope's revenues should be cut by some $3,600,000, the whole reduction is owing to domestic users. If it be considered wise to raise part of Hope's revenues by industrial purpose sales, the utmost possible revenue should be raised from the least consumption of gas. If competitive relationships to other fuels will permit, the industrial price should be substantially advanced, not for the benefit of the Company, but the increased revenues from the advance should be applied to reduce domestic rates. For, in my opinion, the "public interest" requires that the great volume of gas now being put to uneconomic industrial use should either be saved for its more important future domestic use or the present domestic user should have the full benefit of its exchange value in reducing his present rates.

Of course, the Commission's power directly to regulate does not extend to the fixing of rates at which the local company shall sell to consumers. Nor is such power required to accomplish the purpose. As already pointed out, the very contract the Commission is altering classifies the gas according to the purposes for which it is to be resold and provides differentials between the two classifications. It would only be necessary for the Commission to order that all gas supplied under paragraph (a) of Hope's contract with the East Ohio Company shall be

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at a stated price fixed to give to domestic service the entire reduction herein and any further reductions that may prove possible by increasing industrial rates. It might further provide that gas delivered under paragraph (b) of the contract for industrial purposes to those industrial customers Hope has approved in writing shall be at such other figure as might be found consistent with the public interest as herein defined. It is too late in the day to contend that the authority of a regulatory commission does not extend to a consideration of public interests which it may not directly regulate and a conditioning of its orders for their protection. *Interstate Commerce Commission v. Railway Labor Executives Ass'n,* 315 U. S. 373; *United States v. Lowden,* 308 U. S. 225.

Whether the Commission will assert its apparently broad statutory authorization over prices and discriminations is, of course, its own affair, not ours. It is entitled to its own notion of the "public interest," and its judgment of policy must prevail. However, where there is ground for thinking that views of this Court may have constrained the Commission to accept the rate base method of decision and a particular single formula as "all important" for a rate base, it is appropriate to make clear the reasons why I, at least, would not be so understood. The Commission is free to face up realistically to the nature and peculiarity of the resources in its control, to foster their duration in fixing price, and to consider future interests in addition to those of investors and present consumers. If we return this case, it may accept or decline the proffered freedom. This problem presents the Commission an unprecedented opportunity if it will boldly make sound economic considerations, instead of legal and accounting theories, the foundation of federal policy. I would return the case to the Commission, and thereby be clearly quit of what now may appear to be some responsibility for perpetrating a shortsighted pattern of natural gas regulation.

[Footnote 3/1]

315 U. S. 315 U.S. 575.

[Footnote 3/2]

Judge Doble, dissenting below, pointed out that the majority opinion in the *Pipeline* case "contains no express discussion of the Prudent Investment Theory," and that the concurring opinion contained a clear one, and said, "It is difficult for me to believe that the majority of the Supreme Court, believing otherwise, would leave such a statement unchallenged. The fact that two other Justices had, as matter of record in our books, long opposed the reproduction cost theory of rate bases, and had commented favorably on the prudent investment theory, may have influenced that conclusion. *See* opinion of MR. JUSTICE FRANKFURTER in *Driscoll v. Edison Light & Power Co.,* 307 U. S. 104, 307 U. S. 122, and my brief as Solicitor General in that case. It should be noted, however, that these statements were made not in a natural gas case, but in an electric power case -- a very important distinction, as I shall try to make plain."

[Footnote 3/3]

Natural gas from the Appalachian field averages about 1050 to 1150 B.T.U. content, while byproduct manufactured gas is about 530 to 540. Moody's Manual of Public Utilities (1943) 1350; Youngberg, Natural Gas (1930) 7.

[Footnote 3/4]

Sen.Rep. No. 1162, 75th Cong., 1st Sess., 2.

[Footnote 3/5]

Arnold and Kemnitzer, Petroleum in the United States and Possessions (1931) 78.

[Footnote 3/6]

Id. at 62-63.

[Footnote 3/7]

Id. at 61.

[Footnote 3/8]

At Fredonia, New York, in 1821, natural gas was conveyed from a shallow well to some thirty people. The lighthouse at Barcelona Harbor, near what is now Westfield, New York, was at about that time and for many years afterward lighted by gas that issued from a crevice. Report on Utility Corporations by Federal Trade Commission, Sen.Doc. 92, Pt. 84-A, 70th Cong., 1st Sess., 8-9.

[Footnote 3/9]

In that year Pennsylvania enacted "An Act to provide for the incorporation and regulation of natural gas companies." Penn.Laws 1885, No. 32, 15 P.S. § 1981 et seq.

[Footnote 3/10]

See Steptoe and Hoffheimer's Memorandum for Governor Cornwell of West Virginia (1917), 25 West Virginia Law Quarterly 257; *see also* Report on Utility Corporations by Federal Trade Commission, Sen.Doc. No. 92, Pt. 84-A, 70th Cong., 1st Sess.

[Footnote 3/11]

Arnold and Kemnitzer, Petroleum in the United States and Possessions (1931) 73.

[Footnote 3/12]

Id. at 63.

[Footnote 3/13]

Id. at 64.

[Footnote 3/14]

See Report on Utility Corporations by Federal Trade Commission, Sen.Doc. No. 92, Pt. 84-A, 70th Cong., 1st Sess.

[Footnote 3/15]

Pennsylvania v. West Virginia, 262 U. S. 553. For conditions there which provoked this legislation, *see* 25 West Virginia Law Quarterly 257.

[Footnote 3/16]

People ex rel. Pavilion Natural Gas Co. v. Public Service Commission, 188 App.Div. 36, 176 N.Y.S. 163.

[Footnote 3/17]

Village of Falconer v. Pennsylvania Gas Company, 17 State Department Reports (N.Y.) 407.

[Footnote 3/18]

See, for example, Public Service Commission v. Iroquois Natural Gas Co., 108 Misc. 696, 178 N.Y.S. 24; *Park Abbott Realty Co. v. Iroquois Natural Gas Co.,* 102 Misc. 266, 168 N.Y.S. 673; *Public Service Commission v. Iroquois Natural Gas Co.,* 189 App.Div. 545, 179 N.Y.S. 230.

[Footnote 3/19]

People ex rel. Pennsylvania Gas Co. v. Public Service Commission, 196 App.Div. 514, 189 N.Y.S. 478.

[Footnote 3/20]

East Ohio Gas Co. v. Akron, 81 Ohio St. 33, 90 N.E. 40; *Village of Newcomerstown v. Consolidated Gas Co.,* 100 Ohio St. 494, 127 N.E. 414; *Gress v. Village of Ft. Laramie,* 100 Ohio St. 35, 125 N.E. 112; *City of Jamestown v. Pennsylvania Gas Co.,* 263 F. 437; *id.,* 264 F. 1009. *See also United Fuel Gas Co. v. Railroad Commission,* 278 U. S. 300, 278 U. S. 308.

[Footnote 3/21]

The New York Public Service Commission said:

"While the transportation of natural gas through pipe lines from one state to another state is interstate commerce . . . , Congress has not taken over the regulation of that particular industry. Indeed, it has expressly excepted it from the operation of the Interstate Commerce Commissions Law (Interstate Commerce Commissions Law, section 1). It is quite clear, therefore, that this Commission cannot require a Pennsylvania corporation producing gas in Pennsylvania to transport it and deliver it in the State of New York, and that the Interstate Commerce Commission is likewise powerless. If there exists such a power, and it seems that there does, it is a power vested in Congress, and by it not yet exercised. There is no available source of supply for the Crystal City Company at present except through purchasing from the Porter Gas Company. It is possible that this Commission might fix a price at which the Potter Gas Company should sell if it sold at all, but, as the Commission can not require it to supply gas in the State of New York, the exercise of such a power to fix the price, if such power exists, would merely say, sell at this price or keep out of the State."

Lane v. Crystal City Gas Co., 8 New York Public Service Comm.Reports, Second District, 210, 212.

[Footnote 3/22]

Proclamation by the President of September 16, 1918; Rules and Regulations of H. A. Garfield, Fuel Administrator, September 24, 1918.

[Footnote 3/23]

For example, the Iroquois Gas Corporation, which formerly served Buffalo, New York, with natural gas ranging from 1050 to 1150 b.t.u. per cu. ft., now mixes a by-product gas of between 530 and 540 b.t.u. in proportions to provide a mixed gas of about 900 b.t.u. per cu. ft. For space heating or water heating, its charges range from 65 cents for the first m.c.f. per month to 55 cents for all above 25 m.c.f. per month. Moody's Manual of Public Utilities (1943) 1350.

[Footnote 3/24]

The United States Fuel Administration made the following cooking value comparisons, based on tests made in the Department of Home Economics of Ohio State University:

Natural gas at 1.12 per M. is equivalent to coal at $6.50 per ton.

Natural gas at 2.00 per M. is equivalent to gasoline at 27□ per gal.

Natural gas at 2.20 per M. is equivalent to electricity at 3□ per k.w.h.

Natural gas at 2.40 per M. is equivalent to coal oil at 15□ per gal.

Use and Conservation of Natural Gas, issued by U.S. Fuel Administration (1918) 5.

[Footnote 3/25]

See Brief on Behalf of Legislation Imposing an Excise Tax on Natural Gas, submitted to N.R.A. by the United Mine Workers of America and the National Coal Association.

[Footnote 3/26]

Brief of National Gas Association and United Mine Workers, *supra,* note 26, pp. 35, 36, compiled from Bureau of Mines Reports.

[Footnote 3/27]

From the source quoted in the preceding note, the spread elsewhere is shown to be:

State Industrial Domestic

Illinois 29.2 1.678

Louisiana 10.4 59.7

Oklahoma 11.2 41.5

Texas 13.1 59.7

Alabama 17.8 1.227

Georgia 22.9 1.043

[Footnote 3/28]

In Corning, New York, rates were initiated by the Crystal City Gas Company as follows: 70□ for the first 5,000 cu. ft. per month; 80□ from 5,000 to 12,000; $1 for all over 12,000. The Public Service Commission rejected these rates and fixed a flat rate of 58□ per m.c.f. *Lane v. Crystal City Gas Co.,* 8 New York Public Service Comm. Reports, Second District, 210.

The Pennsylvania Gas Company (National Fuel Gas Company group) also attempted a sliding scale rate for New York consumers, net per month as follows: first 5,000 feet, 35□; second 5,000 feet, 45□; third 5,000 feet, 50□; all above 15,000, 55□. This was eventually abandoned, however. The company's present scale in Pennsylvania appears to be reversed to the following net monthly rate; first 3 m.c.f., 75□; next 4 m.c.f., 60□; next 8 m.c.f., 55□; over 15 m.c.f., 50□. Moody's Manual of Public Utilities (1943) 1350. In New York, it now serves a mixed gas.

For a study of effect of sliding scale rates in reducing consumption *see* 11 Proceedings of Natural Gas Association of America (1919) 287.

[Footnote 3/29]

See Report on Utility Corporations by Federal Trade Commission, Sen. Doc. 92, Pt. 84-A, 70th Cong., 1st Sess.

[Footnote 3/30]

Four holding company systems control over 55 percent of all natural gas transmission lines in the United States. They are Columbia Gas and Electric Corporation, Cities Service Co., Electric Bond and Share Co., and Standard Oil Co. of New Jersey. Columbia alone controls nearly 25 percent, and fifteen companies account for over 80 percent of the total. Report on Utility Corporations by Federal Trade Commission, Sen.Doc. 92, Pt. 84-A, 70th Cong., 1st Sess., 28.

In 1915, so it was reported to the Governor of West Virginia, 87 percent of the total gas production of that state was under control of eight companies. Steptoe and Hoffheimer, Legislative Regulation of Natural Gas Supply in West Virginia, 17 West Virginia Law Quarterly 257, 260. Of these, three were subsidiaries of the Columbia system and others were subsidiaries of larger systems. In view of inter-system sales and interlocking interests, it may be doubted whether there is much real competition among these companies.

[Footnote 3/31]

This pattern with its effects on local regulatory efforts will be observed in our decisions. *See United Fuel Gas Co. v. Railroad Commission,* 278 U. S. 300; *United Fuel Gas Co. v. Public Service Commission,* 278 U. S. 322; *Dayton Power & Light v. Public Utilities Commission,* 292 U. S. 290; *Columbus Gas & Fuel Co. v. Public Utilities Commission,* 292 U. S. 398, and the present case.

[Footnote 3/32]

15 U.S.C. § 717(a). (Italics supplied throughout this paragraph.)

[Footnote 3/33]

§ 7(c), 52 Stat. 825.

[Footnote 3/34]

15 U.S.C. § 717f.

[Footnote 3/35]

Id., § 717c(e).

[Footnote 3/36]

Id., § 717c(b).

[Footnote 3/37]

Id., § 717d(a).

[Footnote 3/38]

Sen.Rep. No. 1162, 75th Cong., 1st Sess. 2.

[Footnote 3/39]

The list of East Ohio Gas Company's special industrial contracts thus expressly under Hope's control and their demands are as follows:

Republic Steel Corporation . . . . . 15,000,000 cu.ft.

Otis Steel Company 10,000,000

Timken Roller Bearing Co. 7,500,000

Youngstown Sheet & Tube Co. 7,000,000

U.S. Steel Corp. -- Subsidiaries . . 6,500,000

General Electric Company 2,500,000

Pittsburgh Plate Glass Co. 2,000,000

Niles Rolling Mill Company 1,500,000

Chase Brass & Copper Company 700,000

U.S. Aluminum Company. 400,000

Mahoning Valley Steel Company. . . . 400,000

Babcock & Wilcox Company 400,000

Canton Stamping & Enameling Co. . . 350,000

[Footnote 3/40]

To make a fetish of mere accounting is to shield from examination the deeper causes, forces, movements, and conditions which should govern rates. Even as a recording of current transactions, bookkeeping is hardly an exact science. As a representation of the condition and trend of a business, it uses symbols of certainty to express values that actually are in constant flux. It may be said that, in commercial or investment banking, or any business extending credit, success depends on knowing what not to believe in accounting. Few concerns go into bankruptcy or reorganization whose books do not show them solvent, and often even profitable. If one cannot rely on accountancy accurately to disclose past or current conditions of a business, the fallacy of using it as a sole guide to future price policy ought to be apparent. However, our quest for certitude is so ardent that we pay an irrational reverence to a technique which uses symbols of certainty, even though experience again and again warns us that they are delusive. Few writers have ventured to challenge this American idolatry, *but see* Hamilton, Cost as a standard for Price, 4 Law and Contemporary Problems 321, 323-25. He observes that "As the apostle would put it, accountancy is all things to all men. . . . Its purpose determines the character of a system of accounts." He analyzes the hypothetical character of accounting and says,

"It was no eternal mold for pecuniary verities handed down from on high. It was -- like logic or algebra, or the device of analogy in the law -- an ingenious contrivance of the human mind to serve a limited and practical purpose. . . . Accountancy is far from being a pecuniary expression of all that is industrial reality. It is an instrument, highly selective in its application, in the service of the institution of moneymaking."

As to capital account, he observes,

"In an enterprise in lusty competition with others of its kind, survival is the thing and the system of accounts has its focus in solvency. . . . Accordingly, depreciation, obsolescence, and other factors which carry no immediate threat are matters of lesser concern, and the capital account is likely to be regarded as a secondary phenomenon. . . . But in an enterprise, such as a public utility, where continued survival seems assured, solvency is likely to be taken for granted. . . . A persistent and ingenious attention is likely to be directed not so much to securing the upkeep of the physical property as to making it certain that capitalization fails in not one whit to give full recognition to every item that should go into the account."

[Footnote 3/41]

See 2 Bonbright, Valuation of Property (1937) 1112.

[Footnote 3/42]

Bonbright says,

". . . the vice of traditional law lies not in its adoption of excessively rigid concepts of value and rules of valuation, but rather in its tendency to permit shifts in meaning that are inept, or else that are ill-defined because the judges that make them will not openly admit that they are doing so."

Id., 1170.

[Footnote 3/43]

"The attempt to regulate rates by reference to a periodic or occasional reappraisal of the properties has now been tested long enough to confirm the worst fears of its critics. Unless its place is taken by some more promising scheme of rate control, the days of private ownership under government regulation may be numbered."

2 Bonbright, Valuation of Property (1937) 1190.

[Footnote 3/44]

East Ohio itself owns natural gas rights in 550,600 acres, 518,526 of which are reserved and 32,074 operated, by 375 wells. Moody's Manual of Public Utilities (1943) 5.

[Footnote 3/45]

Hope has asked a certificate of convenience and necessity to lay 1140 miles of 22-inch pipeline from Hugoton gas fields in southwest Kansas to West Virginia to carry 285 million cu. ft. of natural gas per day. The cost was estimated at $51,000,000. Moody's Manual of Public Utilities (1943) 1760.

[Footnote 3/46]

I find little information as to the rates for industries in the record and none at all in such usual sources as Moody's Manual.

[Footnote 3/47]

The Federal Power Commission has touched upon the problem of conservation in connection with an application for a certificate permitting construction of a 1500-mile pipeline from southern Texas to New York City, and says:

"The Natural Gas Act, as presently drafted, does not enable the Commission to treat fully the serious implications of such a problem. The question should be raised as to whether the proposed use of natural gas would not result in displacing a less valuable fuel and create hardships in the industry already supplying the market, while at the same time rapidly depleting the country's natural gas reserves. Although, for a period of perhaps 20 years, the natural gas could be so priced as to appear to offer an apparent saving in fuel costs, this would mean simply that social costs which must eventually be paid had been ignored."

"Careful study of the entire problem may lead to the conclusion that use of natural gas should be restricted by functions, rather than by areas. Thus, it is especially adapted to space and water heating in urban homes and other buildings and to the various industrial heat processes which require concentration of heat, flexibility of control, and uniformity of results. Industrial uses to which it appears particularly adapted include the treating and annealing of metals, the operation of kilns in the ceramic, cement, and lime industries, the manufacture of glass in its various forms, and use as a raw material in the chemical industry. General use of natural gas under boilers for the production of steam is, however, under most circumstances, of very questionable social economy."

Twentieth Annual Report of the Federal Power Commission (1940) 79.

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THE COST OF CAPITAL –

A PRACTITIONER'S GUIDE

BY

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PREPARED FOR THE SOCIETY OF UTILITY AND REGULATORY FINANCIAL ANALYSTS (SURFA)

2010 EDITION

Author's Note: This manual has been prepared as an educational reference on cost of capital concepts. Its purpose is to describe a broad array of cost of capital models and techniques. No cost of equity model or other concept is recommended or emphasized, nor is any procedure for employing any model recommended. Furthermore, no opinions or preferences are expressed by either the author or the Society of Utility and Regulatory Financial Analysts.

PART 2

COST OF EQUITY ESTIMATION METHODS

One of the most controversial aspects of a public utility rate proceeding is the determination of the cost of common equity capital. This notion has been recognized by regulators. For example, the Maryland Public Service Commission made the following statement in a decision (Re: Potomac Electric Power Company, Case No. 8315, Order No. 69229, dated May 30, 1991):

> "Rate of return, particularly return on equity, is a vexatious subject. It requires us to discern the expectations of a very large number of investors. So, using the Hope and Bluefield decisions as our guides, we embark on a journey along the DCF path. That trial is strewn with judgments and assumptions, marked by forecasts writ by anonymous hands, and prone to switchbacks occasioned by the sudden appearance of precipitous events, such as war in the Persian Gulf."

In spite of this apparent cynicism, the process of cost of capital estimation remains an integral component of the regulatory process. To aid this process, numerous methods and models have been developed over time which are designed to provide an estimate of a utility's cost of common equity.

All cost of common equity models have the same basic objective – to estimate the minimum rate of return necessary to attract capital to the utility. Kolbe, Read and Hall (1986, 13) define cost of capital as "the expected rate of return prevailing in capital markets on alternative investments of equivalent risk." They cite four concepts contained in this definition – the cost of capital:

1. Is a forward-looking concept. It is an expected rate of return;
2. Is an opportunity cost concept;
3. Is determined in capital markets; and,
4. Depends on the risk of investment.

This part of the manual describes the major cost of equity methods. In doing so, no particular method is being endorsed. Rather, the description of each model is done from an informational perspective in order for the reader to review the theoretical basis of each model, the assumptions of each model, and various ways to estimate the inputs of each model. The following chapters describe, in alphabetical order, the most commonly-used cost of equity models – capital asset pricing model, comparable earnings, discounted cash flow, and risk premium.

Use of Models

All methods and models are necessarily based upon simplifying assumptions which are employed in order to make the particular method usable in rate proceedings or for other uses in finance. It is often argued that certain of these assumptions are not reflective of actual capital market behavior. While this is true, it is important for the analyst to recognize and focus not on the strict existence of the model's assumptions but rather whether the relaxation of these assumptions limits the usefulness of the model to explain or predict economic phenomena, including stock prices. In the final analysis, the value of any return on equity method depends on its ability to capture market expectations and provide a reasonable working approximation of stock valuation. "The 'end result' doctrine is reminiscent of the philosophy of economic positivism, which states that the value of a model or theory should not be assessed by the severity or realism of its assumptions, but rather by its ability to explain or accurately economic phenomena." (Morin, 2006, 14).

On the other hand, economic and financial models are simplified representations, constructed by theoreticians, which attempt to describe how investors should act or react in making investment decisions in the "real world." Thus, models attempt to describe how investors behave. However, it is unlikely that the typical investor consults models to learn how to behave in the financial markets. In particular, as noted above, each model employs simplifying assumptions which permit an application of economic and financial theory to assist in developing rigorous models to explain investor behavior. As noted, it is not necessary for these assumptions to be explicitly verifiable for the models to be useful tools. Yet, both analysts and regulators should recognize that no model can be refined to the extent that the cost of common equity for any firm can be reduced to a simple formulistic exercise and be exactly measured. Investor expectations differ and it is apparent that all investors do not rely upon the same information and models in making investment decisions. Consequently, so single model and model variant can be demonstrated to capture all investor expectations.

Furthermore, no single model is so inherently precise that it can be relied on solely to the exclusion of other theoretically sound models. Each model requires the exercise of judgment as to the reasonableness of the underlying assumptions of the methodology and on the reasonableness of the proxies used to validate the theory. Each model has its own way of examining investor behavior, its own premises, and its own set of simplifications of reality. Each method proceeds from different fundamental premises, most of which cannot be validated empirically. Investors clearly do not subscribe to any singular method, nor does the stock price reflect the application of any one single method by investors. Therefore, it is essential that estimates of investors' required rate of return produced by one method be compared with those produced by other methods, and that all cost of equity estimates be required to pass fundamental tests of reasonableness and economic logic. "The concept of a fair rate of return, therefore, represents a range or a zone of reasonableness" (Phillips, 1988, 357-358).

Two texts have evaluated the various cost of equity models (Kolbe, Read and Hall, 1986; Thompson, 1991). These texts, while informative to the process of evaluating alternative methods, do not establish a single model as superior to the others. In addition, the texts do not evaluate the alternative methodologies available for implementing each model. Nevertheless, they do provide informative insights to the interested reader.

Classification of Models

There are numerous ways that the various cost of equity models can be classified. One way is to classify models according to their underlying financial theory. The capital asset pricing model (CAPM) is based upon portfolio theory; the comparable earnings method is based upon the economic concept of opportunity cost; the discounted cash flow (DCF) model is based on the

THE RATE OF INTEREST

ITS NATURE, DETERMINATION AND RELATION TO ECONOMIC PHENOMENA

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CHAPTER III

COST THEORIES

§ 1

We turn now from those theories of interest based mainly on the idea of *productivity* to those based mainly on that of *cost*.

The first of the cost theories to be examined resembles closely the productivity theories, the only difference being that the "cost of production of capital" takes the place of the value of capital. In the productivity theories, the rate of interest was sought in the ratio between the income from capital and the *value of that capital*. In the cost theory now considered, on the other hand, the rate of interest is sought in the ratio between the income from capital and the *cost of that capital*. This theory is subject to many of the objections which apply to the productivity theories. In the first place, it is necessary, before the ratio of income to cost can be regarded as even commensurable with a rate of interest, that income and cost shall have been reduced to a common denomination of value, as, for instance, dollars. A loom renders its return, or service, by the operation called weaving. The cost of the loom, on the other hand, consists of raw materials, the use of tools, dies, lathes, and other machine-shop appliances, together with human labor. Only when these miscellaneous items are reduced to some common standard of value does the ratio of income to cost become a mere percentage like the rate of interest. But when this reduction to a common standard is effected, the suspicion immediately arises that, after all, the question of interest may have been begged in the process,—that the labor, materials, and use of tools all derive their value as costs, in part, at least, from discounting the prospective product to which they contribute. In other words, since the cost of capital must be obtained by a process of valuation, this valuation may involve the very rate of interest to be determined.

Nevertheless, the theory which seeks the rate of interest in the ratio of return to cost of capital has certain advantages over that which seeks it in the ratio of return to value of capital; for there are some costs which are not merely the discounted value of expected services. There are two kinds of costs, (1) "interactions"[1] and (2) labor-and-trouble. The value of the former is always determined by discounting some future service; the value of the latter is determined (to the laborer) by the irksomeness or "undesirability" of labor compared with the desirability of money. We are not called upon, however, to strengthen the cost theories by recourse to this distinction between costs which involve discounting and costs which do not; for the cost theories as actually held and advocated take no account of such a distinction, and the costs usually cited are mainly costs which do involve discounting,—in other words, interactions. Such costs certainly cannot be taken as a sufficient foundation for explaining the rate of interest. The tailor reckons among his costs the value of the cloth which he buys; the manufacturer of the cloth reckons among his costs the value of the yarn; the producer of the yarn reckons in his cost the value of the wool. But the value of the wool is found in part by discounting the value of the yarn to which it contributes; that of the yarn, by discounting the value of the cloth; that of the cloth, by discounting the value of the clothes.

It is seldom possible in practice to find a case so pure as not to be obscured by a number of different elements; but let us, for the sake of illustration, consider

[1] See *The Nature of Capital and Income*, Chaps. VII–X.

a dealer in trees, who buys saplings and sells them after they are full grown. In this case there are few other costs besides the cost of *buying* the saplings. We can here see clearly the fallacy involved in regarding the rate of interest as determined by the ratio of the value of the full-grown tree to the cost of the sapling; for the cost of buying the sapling is evidently itself obtained by discounting the value of the tree. In fact, in this case the cost theory becomes identical with the productivity theory; for the cost of buying the sapling is nothing more nor less than the value of the sapling. The only distinction between them is a formal one: the cost of buying the sapling is regarded as pertaining to the income and outgo account; the value of the sapling, to the capital account. Since, then, the cost of buying the sapling is the discounted value of the tree, this cost can be computed only by discounting, and discounting presupposes a rate of interest. In many cases, therefore, "cost" is merely the discounted value of "return." The cost, in these cases at least, depends on the rate of interest, not the rate of interest on the cost.

§ 2

It is true that an article sometimes costs less (or more) than the discounted value of the returns. The ratio of future return to present cost may then temporarily differ from the rate of interest on loans. Thus, a manufacturer calculates that a newly invented machine will earn him $10 a year for twenty years. If we suppose he is willing to invest on a 5 per cent. basis, namely, that subjectively he values this year's goods at a premium of 5 per cent. compared with next year's goods, then the price he is willing to pay for the machine is $125, this being the present worth, at 5 per cent., of $10 a year for twenty years. But it may be that the cost of obtaining the machine is not $125 but, say, $100, which corresponds to an 8 per but the sums given in the table; namely, $61, $65, $68, and so forth?

To push this criticism to the limit, let us finally consider a perpetual annuity of $100 a year. In this case we shall find that the "cost of waiting" each year is $100; for the value of such an annuity, reckoned at 5 per cent., is $2000 reckoned at the beginning of each year, and $2100 reckoned at the end. If this cost of waiting is to be regarded as a deduction from income, like other costs, we are forced to conclude that the owner of such a perpetual annuity receives each year no income whatever! For, if we deduct from the $100 of money-income the $100 of waiting, the remainder each year is zero!

It may be said that we have not always a mere *annuity* to deal with but a definite capital such as a *house* or a *factory* which has involved cost in its construction and the "sacrifice" of waiting for an income, whereas the capital might have been consumed at once. In all such cases, however, we are dealing with the very same principle. The possession of the house or factory, like the title to the annuity, is valuable *only because* of the service or the income which it is expected to yield. If there is for the house or factory an initial labor-cost or expense, this is also true of the annuity. On the other hand, the one as well as the other may come by inheritance and so involves no cost to its owner. What it is desired to emphasize is that in any case the present value is the discounted value of the expected future services or income and that it is *not* any sacrifice or cost of waiting which produces this value but that, on the contrary, it is the existence of this future value which prompts the waiting.

§ 11

It is obvious that the theory which calls "waiting" a cost has worked out its own absurdity. The most that can be said in its favor is that it makes the capital-value of any article equal to its cost of production. The idea that the value of an article should equal its cost seems to possess a certain fascination for many, if not most, students of economics. That it is false has been sufficiently shown by Böhm-Bawerk through reasoning somewhat similar to the foregoing. That it is absurd when carried to its logical conclusion is evident when we consider what happens if the same method of bookkeeping is carried out with respect to the future as well as the past. It is a poor rule which will not work both ways. This rule, applied to future expected income and outgo, yields the strange result that the capital value of any article is normally not less than, but equal to, the expected income. Thus, to revert to the case of the tree, let us take its value at the end of 14 years. It is then worth $2, which, in the parlance of the abstinence theorists, is equal to its previous cost of production, consisting of $1 worth of labor plus $1 worth of waiting during the 14 years. It is also, in like manner, equal to the future income to be derived from it, which consists of $3 worth of actual receipts from the sale of the tree, due at the end of eleven more years, less the cost of waiting for those $3, which amounts to $1.

In the same way, the ten-year annuitant just considered has, at the beginning, property worth $772. This, according to any proper bookkeeping, is the discounted value of the future income of $100 a year for 10 years, the total amount of which is $1000. But, according to the abstinence theorists, the income which he receives for the whole period is, as has been shown, not this $1000, but $772, which is just equal to the value of the property. Pursuing the method of limits, we find that for the owner of a perpetual annuity the same proposition would hold good. According to the true and ordinary method of reckoning, the total income from such an annuity is infinity, although its present capital value is only $2000. But according to the abstinence theorists the income itself is not infinite, but only $2000.[1]

Those who are enamored of the simplicity and neatness of the formula of the abstinence theorists, by which the capital value is not greater than *past* cost of production, but exactly equal to it, can scarcely be attracted by the exaggerated simplicity of the inverse theorem which is also involved; namely, that the capital value of any *future* expected income is not less than that income, but exactly equal to it also.

§ 12

The fallacy of the abstinence theorists lies in the simple fact that waiting has no independent existence as a "cost." We can never locate it in time, nor estimate its amount, without first knowing some *other* more tangible costs. Waiting means nothing unless there is something waited for, and the cost of waiting can only be estimated in proportion to the magnitude of what is waited for.

It will doubtless take a long time for many to accept the doctrine that the value of capital is not only less than its future expected income, but normally greater than its past cost. Even to those who do not formally accept any cost theory of interest, the interest itself will seem in some sense to be a cost; and in most books on economics, interest, however explained, is regarded as one of the costs of production. It is true that for a debtor who pays interest, the interest is, to him, a real cost, and is debited on

[1] Lest the non-mathematical reader should be puzzled by this result, which seems to contradict the fact already brought out, that under the pseudo-reckoning of the abstinence theorists the net income is zero every year, it must be remembered that this zero income is repeated an infinite number of times, and that when we deal with infinity we can get reliable results only by the method of limits. The mathematical reader will find no difficulty in showing, by the method of limits, that there is a "remainder term" which will, in the supposed accounting, make the total income distributed through all eternity simply equal to the capital value, $2000.

CHAPTER V

APPRECIATION AND INTEREST

§ 1

In the four preceding chapters we have criticised those theories of interest which enjoy the greatest currency in present economic and business circles. Inasmuch as we have found radical defects in all of them, our best course now is to formulate *de novo* what seems to us to be the correct theory. At the outset we need to note an oversight common to all the theories reviewed. In none of them is any account taken of the fact that the number expressing the rate of interest depends upon the monetary standard of value in terms of which that rate of interest is expressed. To say that the rate of interest is 4 per cent. means[1] that the quantity of this year's goods which is worth $100 is equivalent to the quantity of next year's goods which is worth $104. In this statement we observe that the "goods" which are considered are expressed not in their own special units, — pounds, bushels, yards, etc., — but in terms of a standard of value. The standard of value chosen is usually money. This money, the $100 and $104, is nominally exchanged; but actually it merely measures the "goods" which are exchanged. When a man lends $100 this year in order to obtain $104 next year, he is really sacrificing not one hundred dollars in money, but one hundred dollars' worth of goods such as food, clothing, books, or pleasure trips, in order to obtain next year not one hundred and four dollars in money, but one hundred and four dollars' worth of other goods which he desires.

[1] See Glossary at end of this volume; also the writer's *The Nature of Capital and Income* (Chap. XI), the nomenclature of which book is followed in the present work.

Yet the fact that both sets of goods are *measured* in money introduces a monetary factor into the problem of interest. Interest, being a premium in the exchange between the *money* values of this year's and next year's goods, is therefore not wholly an affair of goods, but is partly one of money. The relation of the rate of interest to goods will form the subject of subsequent chapters. The present chapter is devoted to a study of the relation which subsists between the rate of interest and the monetary standard in terms of which it is expressed.

The monetary standard affects the rate of interest in so far as there is a *change* in the value of that standard in reference to other standards. Could it always be assumed that the monetary standard was invariable in value with reference to all goods, the rate of interest reckoned in money would be the same as though it were reckoned in terms of the goods themselves. But if money and goods are to change with reference to each other — in other words, if the money standard "appreciates" or "depreciates" — the number expressing the rate of interest will be affected.

§ 2

The influence of monetary appreciation or depreciation on the rate of interest will be different according to whether or not that appreciation or depreciation is foreseen. If it is not foreseen, the appreciation of money necessarily injures the debtor, because, the purchasing power of money being increased, the principal of his debt, when due, represents a larger quantum of goods than was anticipated when the debt was contracted. But if the appreciation is foreseen, any increased burden in the "principal" may be offset by a reduction in the rate of interest. This fact, strangely enough, has seldom been recognized. The assumption has been tacitly made that contracting parties are powerless to forestall gains or losses due to an upward or downward movement of the monetary standard. Yet no reason has been given to show that it is any more difficult to make allowance for a change in the unit of value than for a change in any other unit. If the unit of length were changed, and its change were foreknown, it is clear that contracts would be modified accordingly. Suppose, for instance, that a yard were defined (as possibly it once was) as the length of the king's girdle, and suppose the king to be a child. Everybody would then know that the "yard" would probably increase with the king's age, and a merchant who should agree to deliver one thousand "yards" ten years hence would make his terms correspond to his expectations. It would be strange if, in some similar way, an escape could not be found from the effects of changes in the monetary yardstick, provided these changes were known in advance. To offset a foreseen appreciation, it would only be necessary that the rate of interest be correspondingly lower, and to offset a foreseen depreciation, that it be correspondingly higher.[1]

If a debt is contracted optionally in either of two standards and one of them is *expected* to change with reference to the other, the rate of interest will by no means be the same in both. A few years ago, during the uncertainty as to the adoption or rejection of "free silver," a syndicate offered the United States government the alternative of some $65,000,000 of bonds on a 3 per cent. basis in gold, or on a 3¾ per cent. basis in "coin." Every one knew that the additional ¾ per cent. in the latter alternative was due to the mere *possibility* that "coin" might not continue at full gold value, but sink to the level of silver. If the alternative had been between repayment in gold and a — not merely possible but actual — repayment in silver, the additional interest would obviously have exceeded ¾ per cent.

[1] For the history of the theory of appreciation and interest, see Appendix to Chap. V, § 1.

§ 3

The relation between the rate of interest and the rate of a foreseen appreciation or depreciation of money may be readily illustrated. In order to illustrate the theory, we may imagine two specified standards of value diverging from each other, in either of which loan contracts may be expressed. Let the two standards be gold and wheat, and let a bushel of wheat be first worth $1. If the two standards did not diverge, that is, if the price of wheat in terms of gold held good till next year, it is clear that the rate of interest in a gold contract and a wheat contract would be the same; if it were 4 per cent. in gold, it would be 4 per cent. in wheat also. This may be expressed as follows: —

If to-day 100 dollars is the equivalent of 100 bu. @ $1 per bu., then next year 104 dollars is the equivalent of 104 bu. @ $1 per bu.

But let us suppose that the price of wheat rises from $1 to $1.01. We then readily see that: —

Whereas to-day 100 dollars is the equivalent of 100 bu. @ $1 per bu., next year 104 × 1.01 dollars is the equivalent of 104 bu. @ $1.01 per bu.

If we calculate out the 104 × $1.01, we shall obtain $105.04 as the sum which next year should be repaid in gold to be equivalent to 104 bu. payable in wheat. In other words, if 4 per cent. is the interest in the wheat standard, its equivalent is $5\frac{4}{100}$ per cent. in the gold standard; or, again, if the rate of interest in wheat is 4 per cent., an appreciation of wheat of 1 per cent. is exactly offset by a rise of $1\frac{4}{100}$ per cent. in the rate of interest in gold. It is thus a matter of indifference whether, under our supposed circumstances, a man who borrows $1000 expresses his contract in gold and agrees to pay $5\frac{4}{100}$ per cent. interest or translates the same contract into terms of wheat, borrowing the value of

1000 bushels and agreeing to pay 4 per cent. interest. By the first form of contract he pays back $1000 of gold principal and $50.40 of gold interest; by the second, he pays back the value of 1000 bu. as principal and of 40 bu. as interest. At the end of a year his debt by the one reckoning is $1050.40, by the other, 1040 bu., and these are equivalent.

It is to be noted that we have been regarding gold or wheat as standards of value and not as media of exchange. In either contract the actual liquidation need not be made either in actual gold or wheat. The speculator who sells wheat "short" comes very close to using wheat as a standard, but not as a medium.

The relative change in the two standards may be spoken of either as an appreciation of wheat relatively to gold, or as a depreciation of gold relatively to wheat. We are not compelled to inquire which is the "absolute" change. If we use the first of these two modes of expression, we may say that since one bushel changes in value from $1 to $1.01, wheat has appreciated 1 per cent.; if we use the second mode of expression, we may say a gold dollar has fallen in its wheat value from one bushel to $\frac{100}{101}$ of a bushel, and has therefore depreciated by $\frac{1}{101}$ or $.99\frac{1}{101}$ per cent.[1]

§ 4

In our numerical example, the appreciation (1 per cent.) of one standard relatively to the other, and likewise the depreciation ($.99\frac{1}{101}$ per cent.) of the latter standard relatively to the former, are not quite so great as the difference ($1\frac{4}{100}$ per cent.) in the rate of interest. This slight disparity must always exist so long as the rate of interest is reckoned annually or discontinuously. But the shorter the period of "compounding," the less the disparity; that is, the more

[1] For the general formula connecting the rates of interest in any two diverging standards, see Appendix to Chap. V, § 2.

nearly equal are the two magnitudes: (1) the rate of divergence between the two standards, whether measured as appreciation or depreciation, and (2) the difference between the rates of interest in the two standards. When the rates are "reckoned continuously," the disparity disappears altogether.[1]

§ 5

Having established the truth and generality[2] of the principle connecting the rates of interest in two standards and the appreciation of one of them relatively to the other, we next inquire what limits, if any, are imposed on the three magnitudes; namely, the two rates of interest in the respective standards and the rate of relative appreciation between the standards. From what has been said it might seem that, when the appreciation is sufficiently rapid, the rate of interest in the upward-moving standard, in order to equalize the burden, would have to be zero or even negative. For instance, if the rate of interest in gold is 4 per cent., and if wheat appreciates relatively to gold at 4 per cent. also, the rate of interest in wheat, if perfectly adjusted, would have to sink to zero! But we know that zero or negative interest is practically impossible. Wheat would be hoarded, and this action would effectually prevent the rate of interest in terms of wheat from passing below the zero mark. But this very limitation on the possible rate of interest carries with it a limitation on the

[1] For the mathematical demonstration of this proposition, see Appendix to Chap. V, § 3. For the significance of "continuous" reckoning, see *The Nature of Capital and Income*, Chap. XII; also Chap. XIII and Appendix. We have here an example of the fact there observed that, considered mathematically, the analytical relations connected with the rate of interest are simplest when that rate is reckoned continuously. Since, however, the rate of interest reckoned continuously is so rarely used in practice, we shall adhere, in the remainder of our discussion, to the system of annual reckoning.

[2] For mathematical proofs, numerical illustrations, and formulæ see Appendix to Chap. V, §§ 4 to 9 inclusive.

possible rate of appreciation. If interest on money, for instance, were 4 per cent., it would be impossible for wheat to have a foreknown appreciation of 10 per cent. per annum relatively to money; for it would immediately be bought and held for the rise. It would therefore rise *at once* to the discounted value of its future expected value, and its succeeding rise could not exceed the rate of interest.[1] In other words, if interest is 4 per cent., it is impossible that wheat should be worth $1 to-day and $1.10 next year foreknown to-day. For, under these circumstances, holding for a rise would give a sure return of 10 per cent. The lowest price of present wheat possible would be the $1.10 discounted at 4 per cent., or about $1.06. At this figure the rate of interest in gold is 4 per cent., but *in wheat* it is zero per cent. We should have: —

To-day $106 equivalent to 100 bu. @ $1.06 per bushel.
Next year $110 equivalent to 100 bu. @ $1.10 per bushel.

and the two alternative forms of contract would be: for $106 this year $110 are returned next year, or (about) 4 per cent., and for 100 bu. this year 100 bu. are returned next year, or zero per cent. Every case of holding wheat or land or other wealth for a rise may be, in fact, regarded as a case of zero interest in terms of these articles as standards of value.

The same principle which prevents the rate of interest in wheat or land from being negative also prevents a negative interest in money. A lender, rather than exchange $101 to-day for $100 next year, would hoard his $101. It is important to emphasize the fact that the limits imposed on the rates of interest and appreciation come from the possibility of hoarding money without loss. If money were a perishable commodity, like fruit, the limit would be pushed into the region of negative quantities.

[1] See *The Nature of Capital and Income*, on the rate of rise of "discount curves," Chap. XIII.

One can imagine a loan based on strawberries or peaches, contracted in summer and payable in winter, with *negative* interest.[1] Or, again, we may define a "dollar" as consisting of a constantly increasing number of grains of gold, the weight of which is to double yearly. *Such "dollars" cannot be hoarded without necessarily becoming fewer with time*, and if interest in the old fixed-weight dollars is 5 per cent., it will be *minus* 47½ per cent. in the new dollars of increasing weight; for he who borrows $100 (2580 grains) to-day will need to pay back only $52.50 (2709 grains) one year hence.

§ 6

The relation existing between interest and appreciation implies, then, that the "rate of interest" is always relative to the standard in which it is expressed. The fact that interest *in money* is high, say 15 per cent., may merely indicate that general prices are expected to rise at the rate of 10 per cent., and that the rate of interest in terms of *goods* is not high, but only 4½ per cent.

We thus need to distinguish between interest in terms of money and interest in terms of goods. The first thought suggested by this fact is that the rate of interest in money is "nominal," and that in goods "real." But this distinction is not sufficient, for no two forms of goods maintain, or are expected to maintain, a constant price ratio toward each other. *There are therefore just as many rates of interest in goods as there are forms of goods diverging in value.*

Is there, then, no absolute standard of value, as utility, in terms of which "real" interest should be expressed? To this we reply that any absolute standard is absolute only for a particular individual.[2] The fact that a dollar

[1] Cf. Böhm-Bawerk, *The Positive Theory of Capital*, pp. 252, 297; Landry, *L'Intérêt du Capital*, p. 49.

[2] Marshall, *Principles of Economics*, Vol. I, 3d ed. New York (Macmillan), 1895, p. 198, and *Royal Commission on Depression of*

is a smaller unit to a millionaire than to a poor laborer has as its consequence that, as the millionaire grows poorer his dollar grows larger, while as the laborer grows richer his dollar grows smaller. On account of such changes in personal fortunes, the dollar will be constantly appreciating and depreciating in different degrees among different men and classes. But if the dollar appreciates in terms of absolute utility in the eyes of one man, and depreciates in a corresponding standard of utility in the eyes of another, the rates of interest in the men's "absolute" standards must be different in the two cases; for the rates of interest to both persons in terms of objective units, such as money, *must by the operations of the market be the same.* If, in the gold standard, $100 to-day is equivalent to $104 due one year hence, both for him who is growing richer and for him who is growing poorer, the rates in terms of absolute utility will be different for the two men. Thus, suppose that the dollar to-day is worth to each man one unit of utility, but that one year hence, to the man who is growing richer, the dollar will be worth slightly less — let us say, $\frac{99}{100}$ of one unit of utility. Consequently, when he considers $100 to-day as equivalent to $104 due next year, he is virtually contrasting in his mind 100 units of utility to-day with $104 \times .99$, or about 103 units of utility next year. His rate of interest, therefore, in terms of absolute utility, is 3 per cent. Similar calculations for the man whose fortunes were declining, and to whom the marginal utility of the dollar was increasing 1 per cent. per annum, would show that whereas $100 to-day is equivalent in his estimation to $104 next year, 100 units of present utility are equivalent to about 105 units of next year's utility. To him, therefore, the rate of interest in the absolute standard would be 5 per cent.

Trade, 1886, p. 423; the writer's "Mathematical Investigations in the Theory of Value and Prices," *Transactions of the Connecticut Academy*, New Haven, 1892, pp. 11–23, 86–89; A. C. Pigou, "Some Remarks on Utility," *Economic Journal*, March, 1903, p. 60.

From this explanation it is very evident that if we seek to postulate an absolute standard of value in which the rates of interest are to be reckoned, we cannot fix one which will be uniform for all the individuals in the market. Supply and demand operate only to make *objective* rates equal. Hereafter we shall confine ourselves to a study of objective interest; and since the objective standard usually employed is money, the rate of interest, unless otherwise specified, will be taken in this book to mean the rate of interest in terms of the money standard.

As was observed at the beginning of this chapter, it makes a great difference whether the relative divergence of the different standards is or is not known in advance. In actual fact it usually happens that future appreciation or depreciation is neither entirely foreseen nor entirely unforeseen. An intermediate condition is usually maintained. When prices are rising, the rate of interest is usually high, but not as high as it should be to compensate for the rise; and when prices are falling, the rate of interest is usually low, but not as low as it should be to compensate for the fall. The facts as they are actually found in the market will be given in Chapter XIV.

CHAPTER VI

TIME-PREFERENCE

§ 1

In the last chapter we saw that the number expressing the rate of interest depends on the standard of value in which present and future goods are expressed. We saw how the rate of interest in one standard is to be derived from the rate of interest in any other standard.

It is clear that this translation of the rate of interest from one standard to another does not constitute *a complete determination of the rate of interest in any standard whatever;* for it assumes that the rate in *some one* standard is already known, and merely enables us on the basis of this known rate to calculate the rates in other standards. The case is similar to the conversion of temperature from the Fahrenheit system into the Centigrade or the Réaumur, which clearly does not determine temperature itself; or, to the conversion of the price of cotton in dollars into its price in shillings or francs, which does not determine the price of cotton itself. The relation which has been shown between appreciation (or depreciation) and interest therefore solves merely the problem of *translating* the rate of interest from one standard into another; but the problem of *determining* the rate of interest is still left untouched. This problem — the problem of determining the rate of interest — now demands attention.

In our theory we shall find a place for each of the partial truths which we have found in the foregoing review of the productivity, cost, and agio theories. Our presentation may, in fact, be classified as a form of the agio theory, differing from Böhm-Bawerk's version chiefly by the omission of the "technical advantage of present over future goods," and from agio theories in general by the explicit introduction of the income-concept. The income-concept plays the central rôle.

The theory of interest bears a close resemblance to the theory of prices, of which, in fact, it might be regarded as a part; for, as was shown in *The Nature of Capital and Income*, Chap. XII, the rate of interest expresses a price in the exchange between present and future goods. Just as in the ordinary theory of prices the ratio of exchange of any two articles is based on a psychological or subjective element, — their comparative marginal utility, — so in the theory of interest the rate of interest, or the premium in the exchange between present and future goods, is based on a subjective prototype; namely, the preference for present over future goods.

This "time-preference" is the central fact in the theory of interest.[1] It is what Rae calls the "effective desire for accumulation," and very nearly what Böhm-Bawerk calls the "perspective undervaluation of the future."[2] It is the (percentage) excess of the present desirability[3] of present goods over the present desirability of an equal amount of future goods.

[1] Cf. Bullock, *Introduction to the Study of Economics* (Silver, Burdett & Company), 1900, p. 390; Fetter, *Economics*, New York (Century Co.), 1904, p. 135.

[2] At least, as applied to objective goods. Böhm-Bawerk applies it to subjective pleasures, which he translates into objective goods at a ratio depending on the "relative provision for present and future needs." As we have seen in § 6 of the preceding chapter, it is possible to translate the rate of interest (and, it might have been added, the rate of preference) from an objective to a subjective standard, or *vice versa*, provided we know the rate at which the two standards are diverging. We prefer to base our reasoning in this book on rates of preference and rates of interest expressed in terms of an objective, monetary standard. As we have seen, the rate of preference expressed in terms of subjective standards will be different for different individuals.

[3] Or "ophelimity," or "utility." See *The Nature of Capital and Income*, Chap. III.

§ 2

But what are these "goods" which are thus contrasted? At first sight it might seem that the "goods" compared may be indiscriminately *wealth*, *property*, or *services*.[1] It is true that present machines are preferred to future machines; present houses to future houses; land possessed to-day to land available next year; present food or clothing to future food or clothing; present stocks or bonds to future stocks or bonds; present music to future music, and so on. But a slight examination will show that some of these cases of preference are reducible to others. When present capital (whether capital-wealth or capital-property) is preferred to future capital, this preference is really a preference for the income of the first capital as compared with the income of the second. The reason we would choose a present fruit tree rather than a similar tree available in ten years is that the fruit production of the first will occur earlier than that of the second. The reason one prefers immediate tenancy of a house to the right to occupy it in six months is that the uses of the house begin six months earlier in one case than in the other. In short, capital-wealth available early is preferred to capital-wealth of like kind available at a more remote time, because the *income* of the former is available earlier than the *income* of the latter. For the same reason, early capital-property is preferred to late capital-property of the same description. For property is merely a claim to future income; and the earlier the property is acquired, the earlier will the income accrue, of the right to which the property consists.

Thus, all time-preference resolves itself into the preference for early income over late income. Moreover, the preference for present income over future income resolves itself into the preference for present *final* income over future *final* income. The income from an article of capital which

[1] For definitions of these terms, see Glossary.

consists merely of an "interaction"[1] or "preparatory service"[2] is desired for the sake of the final income to which that interaction paves the way. We prefer present bread baking to future bread baking because the enjoyment of the resulting bread is available earlier in the one case than in the other. Present weaving is preferred to future weaving, because the earlier the weaving takes place the sooner will the cloth be manufactured, and the sooner will the clothing made from it be worn by the consumer.

When, as is usually the case, exchange intervenes between the weaving and the use of the clothes, the goal in the process is somewhat obscured by the fact that the manufacturer feels his preference for present weaving over future weaving, not because the clothes will be more early available, but because he will be enabled to sell the cloth earlier. To him, early sales are more advantageous than deferred sales, because the earlier the money is received the earlier can he spend it for his own personal uses, — the shelter and the comforts of various kinds constituting *his* real income. It is not he, but his customers, those who buy the cloth he manufactures, that base their preference for present cloth over future cloth on the earlier availability of the clothes which can be made from it. But in both cases the mind's eye is fixed on some ultimate enjoyable income to which the interaction in question is a mere preparatory step. We thus see that all preference for present over future goods resolves itself, in the last analysis, into a *preference for early enjoyable income over late enjoyable income.* This simple proposition would have received attention before had there been at hand a clear-cut concept of income.

§ 3

In *The Nature of Capital and Income*[3] it was shown that income ultimately consists of the stream of conscious-

[1] See Glossary.
[2] See *The Nature of Capital and Income*, Chap. IX.
[3] Chap. X.

ness. Or, if we prefer to stop just short of this subjective income, we may say that income consists of the objective services which impinge upon our persons and are on the point of producing the subjective effects on consciousness. In short, the income-stream consists of nourishment, clothing, shelter, amusements, the gratification of vanity, and other miscellaneous items. It is this income-stream upon which attention now centers. Henceforth, instead of speaking vaguely and loosely of the preference for present "goods" over future "goods," we shall speak of the preference for *present enjoyable income* over *future enjoyable income.* "Present" and "future" are, of course, used in a comparative sense only; in a more accurate statement we should substitute "early" and "deferred."

It should be noted that the preference for present over future goods, when thus reduced to its lowest terms, rids the values of the contrasted present and future goods of the interest element. When any other goods than enjoyable income are considered, their values already imply a rate of interest. When we say that interest is the premium on the value of a present house over that of a future house, we are apt to forget that the value of each house is itself based on a rate of interest. We have seen[1] that the price of a house is the discounted value of its future income. In the process of discounting there lurks a rate of interest. The value of houses will rise or fall as the rate of interest falls or rises. Hence, when we compare the values of present and future houses, both terms of the comparison involve the rate of interest. If, therefore, we undertake to make the rate of interest depend on the relative preference for present over future houses, we are making it depend on two elements, in each of which it already enters. The same is true of all capital, and also of those items of income which we have called interactions; for the value of an interaction is the discounted value of the ultimate income

[1] See *supra*, Chap. II, and *The Nature of Capital and Income*, Chap. XIII.

to which that interaction leads. We could not rest satisfied in the statement that interest is the premium on the value of present tree-planting over that of future tree-planting; for the value of each tree-planting itself depends on the rate at which the future income from the tree is discounted. But when present *ultimate* income is compared with future *ultimate* income, the case is different, for the value of ultimate income involves no interest whatever. We see, therefore, that the reduction of the problem of interest to a comparative value of present and future enjoyable income avoids the difficulty of making interest depend on magnitudes which themselves depend directly on interest.

§ 4

Having seen that time-preference is really a preference for early enjoyable income compared with remote enjoyable income, we next note that this preference depends on the entire future income-stream, that is, the amount of income and the manner in which it is distributed in time. It depends on the relative abundance of the early and remote incomes — or what we may call the time-shape of the income-stream. If future income is particularly abundant, its possessor would evidently be willing to sacrifice a large amount of it for the sake of a relatively small amount of present income.[1] Thus, in winter, the possessor of a strawberry patch might be willing to sell two boxes of strawberries, due in six months, for one available to-day, while in strawberry season he might, on the contrary, be

[1] It is noteworthy that, though lacking any definite theory of income, those writers who have made the most successful analysis of the rate of interest have, in substance, made it depend, to some extent, at least, on income. Thus Böhm-Bawerk, as has been observed, gives as one of the "three circumstances" affecting the "preference for present goods" the "relative provision for present and future"; and Landry virtually states the same relation, on p. 55 of *L'Intérêt du Capital*.

willing to give up two boxes of his then abundant crop for the right to one box in the succeeding winter.

It is, therefore, not necessary here to distinguish, as Böhm-Bawerk does, between the principles which lead to the *existence* of interest and those which regulate the *rate* of interest; for to determine the rate of interest will include the determination of whether the rate must necessarily always be greater than zero. As a matter of fact, the rate may theoretically be negative, as in the case just mentioned of strawberries in strawberry season, or in the case cited by Böhm-Bawerk himself, of ice in winter. The reason such negative interest is not actually encountered in the market is that perishable articles such as ice and strawberries are never used as standards of value. We express our rates of interest in money, even if our contracts relate to strawberries or ice. But money possesses durability, and may be hoarded without loss. This explains why the rate of interest in terms of money can never be negative.[1]

The proposition that the preference of any individual for present over future income depends upon his prospective enjoyable income corresponds to the proposition in the theory of prices, that the marginal utility of any article depends upon the quantity of that article; both propositions are fundamental in their respective spheres.

When it is said that the time-preference of an individual depends on his enjoyable income, it is meant that the rate of preference for, say, $100 worth of this year's enjoyable income over $100 worth of next year's enjoyable income depends upon the entire character of the individual's income-stream.

An income-stream is made up of a large number of different elements, some of which contribute to nourishment, others to shelter, others to amusement, etc. In a complete enumeration of these elements, we should need to distinguish the use of each different kind of food, the

[1] See *Supra*, Chap. V, § 5.

gratification of every variety of human want. Each of these constitutes a particular filament of the income-stream, extending from the present out into the indefinite future and varying at different points of time in respect to size and probability of attainment. A man's rate of time-preference, therefore, depends on the size and probability at various moments of the entire collection of income-elements. For the graphic representation, however, of size and distribution in time, it is simpler to lump together these innumerable elements of income, expressed in terms of money. We may say, therefore, that an individual's time-preference depends on the following four elements:—

1. On the *size* of the income-stream.
2. On its *distribution in time*,—according as it accrues evenly or unevenly, and if unevenly, according to the periods at which it is expected to be relatively abundant and the periods at which relatively scarce.
3. On the *composition* of the income-stream,—what part consists of nourishment, what part clothing, what part shelter, etc.
4. On the *probability* of the income-stream and its constituent elements.

We shall consider these in order.

§ 5

Our first step, then, is to show how a person's time-preference depends on the *size* of his income. In general, it may be said that the smaller the income the higher is the preference for present over future income. It is true that a small income implies a keen appreciation of future wants as well as of immediate wants. Poverty bears down heavily on all parts of a man's life, both that which is immediate and that which is remote. But it enhances the utility of immediate income *even more* than of future income. This result is partly rational, because of the importance, by supplying present needs, of keeping up the continuity of life and the ability to cope with the future; and partly irrational, because the pressure of present needs blinds one to the needs of the future. As to the rational side, it is clear that present income is absolutely indispensable, not only for the present, but even as a precondition to the attainment of future income. "A man must live." Any one who values his life would prefer to rob the future for the benefit of the present, so far, at least, as to keep life going. If one has only one loaf of bread he would not preserve it for next year; for if he did he would starve in the meantime. A single break in the thread of life suffices to cut off all the future. And not only is a certain minimum of present income necessary to prevent starvation, but the nearer this minimum is approached the more precious does present income appear, relatively to future income.

As to the irrational side, the effect of poverty is often to relax foresight and self-control and tempt one to "trust to luck" for the future, if only the all-absorbing clamor of present necessities is satisfied.

We see, then, that a low income tends to produce a high time-preference, partly from lack of foresight and self-control, and partly from the thought that provision for the present is necessary both for itself and for the future as well.

§ 6

We come next to the influence upon time-preference of the distribution of income in time — the *time-shape* of the income-stream. The concept of the time-shape of one's income-stream is fundamental in the following chapters. Four different types of time-shape may be distinguished:

uniform income, as represented in Figure 2;[1] increasing income (Fig. 3); decreasing income (Fig. 4); and fluctuating

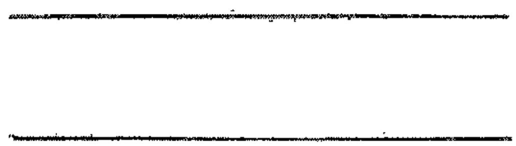

Fig. 2.

income (Fig. 5). The effect of possessing an increasing income is to make the preference for present over future

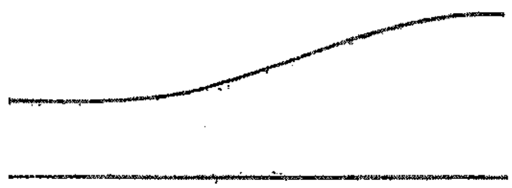

Fig. 3.

income higher than otherwise, for it means that present income is relatively scarce and future income abundant.

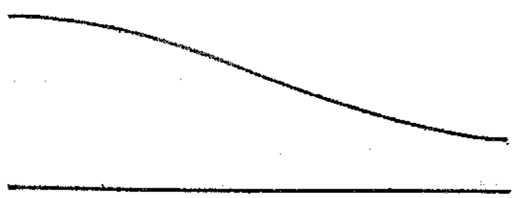

Fig. 4.

A man who is now enjoying an income of only $1000 a year, but expects in ten years to be enjoying one of $10,000 a year, will prize a dollar to-day far more than a dollar due ten years hence. He may, in fact, borrow

[1] In these curves, time is represented horizontally and rate of flow of income vertically, as in *The Nature of Capital and Income*, Chap. XIII.

money to eke out this year's income, and make repayment by sacrificing from the more abundant income ten years later. Reversely, a gradually decreasing income, making, as it does, present income relatively abundant and future income scarce, tends to reduce the preference for present as compared with future income. A man who has a salary of $10,000 at present, but expects to retire in a few years on half pay, will not have a very high preference for present income over future. He will want to save from his present abundance to provide for coming needs.

The extent of these effects will of course vary greatly with different individuals. Corresponding to a given ascend-

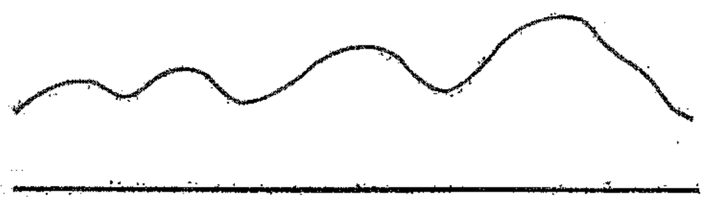

FIG. 5.

ing income, one individual may have a preference of 10 per cent., and another only 4 per cent. What we need here to emphasize is merely that, given a descending instead of an ascending income, both of these individuals would experience a reduction of time-preference, — the first, say, to 5 per cent. and the second, say, to 2 per cent.

If we consider the combined effect on time-preference of both the *size* and *time-shape* of income, we shall observe that those with small incomes are much more sensitive to time-shape in their feeling of time-preference than are those with large incomes. For a poor man, a *very slight* stinting of the present suffices to enhance enormously his preference for present over future income; and reversely, a *very slight* increase in his present income will suffice to enormously lessen that preference. A rich man, on the other hand, requires a relatively large variation in the comparative amounts of this year's and next year's income to suffer any material change of time-preference.

It is clear that the dependence of time-preference on time-shape of income is practically identical with what Böhm-Bawerk calls the "first circumstance" making for the superiority of present over future goods:[1]

> "The first great cause of difference in value between present and future goods consists in the different circumstances of want and provision in present and future. . . . If a person is badly in want of certain goods, or of goods in general, while he has reason to hope that, at a future period, he will be better off, he will always value a given quantity of immediately available goods at a higher figure than the same quantity of future goods."

§ 7

We come next to the influence of the *composition* of the income-stream on the time-preference of its possessor. An income worth $5000 may, for one individual, comprise one set of enjoyable services, and for another, an entirely different set. The inhabitants of one country may have relatively more house-shelter and less food-element in their incomes than those of another. These differences will have an influence in one direction or the other upon the time-preference. Diminution of any one constituent of income would have an effect upon the time-preference similar to the effect of diminution of income in general. A decrease of the food element would be felt especially, both because this element usually forms a considerable part of income and because it is a prime necessity.

Were we to pursue the subject in detail, we should need to resolve a person's income into the elements of which it is composed, — nourishment, shelter, clothing, and other gratifications. As we have seen, the income-stream is a complex magnitude consisting of a large number of sepa-

[1] *The Positive Theory of Capital*, p. 249.

rate filaments, one for each separate constituent. Any individual's rate of preference depends on this complex magnitude in its entirety. Theoretically a change in any of these individual partial income-streams will influence the rate of preference. A bread famine, a large wheat crop, the outlook for the fuel supply, electric light service, shoes, or diamonds, all should be taken into account in a statement designed fully to cover the influence of the income-stream upon time-preference.

It is not necessary to formulate the concept of "composition" of an income-stream in such a way as to divorce it from the concepts of size and time-shape; for the composition of an income-stream is included in a statement of the size and time-shape of each filament of which that income-stream consists. We content ourselves by considering all these elements of income lumped together in a single sum of money value. We need not here concern ourselves with the principles which govern the valuation of the sum. These principles constitute the theory of prices, not of interest; and these prices, as we have already observed, being prices of *final* or enjoyable elements of income, do not, like the prices of capital or of interactions, embarrass us by direct dependence on the rate of interest which we are seeking to solve. Assuming, then, the elements of which incomes are composed to be adjusted according to the principles which regulate prices, we shall hereafter usually treat an income-stream as a homogeneous quantum expressible in terms of gold or some other monetary standard. Our task is therefore reduced to answering the question: Enjoyable incomes being expressed in terms of money, what determines the rate of interest in terms of this same money?

§ 8

We come finally to the element of *risk.* Income, being future, is always subject to some uncertainty, and this uncertainty must naturally have an influence on the rate of time-preference of the possessor. We have seen that time-preference is the preference for $1 *certain* added to immediate income over $1, also *certain*, added to income one year hence. The influence of risk on time-preference therefore means the influence of uncertainties in the anticipated income of an individual upon his relative valuation of present and future small increments of income, both increments being *certain*. The manner in which risk operates upon time-preference will differ according to the particular periods in the future to which the risk applies. If the possessor of income regards the income of the immediate future as fairly well assured, but fears the loss of income in more remote periods, he may be aroused to a high appreciation of the needs of that remote future and save from his present *certain* abundance in order to provide for the later *possible* scarcity. Income in which this sort of risk exists tends, therefore, to produce a low rate of time-preference for income which is immediate and certain as compared with income which is remote and uncertain. In actual fact, such a type is not uncommon. The remote future is usually less known than the immediate future. This means that the risk connected with distant income is greater than that connected with income near at hand. The chance of disease, accident, disability, or death is always to be reckoned with, but under ordinary circumstances is greater in the remote future than in the immediate future. Consequently there is usually a tendency toward a low time-preference. This tendency is expressed in the phrase to "lay up for a rainy day."

But the influence of risk is not always in the direction of lowering time-preference. Sometimes the relative uncertainty is reversed, and immediate income is subject to higher risk than remote income. Such is the case in war or other temporary threat of misfortune. Such is also the case when an individual is assured a permanent position with a salary after a certain time, but in the meantime must obtain a precarious subsistence. In these cases the effect of the risk element is to enhance the estimation in which immediate income is held. Again the risk may, instead of applying especially to remote periods or especially to immediate periods, apply to all alike. Such a condition largely explains why salaries and wages are lower than the average earnings of those who work for themselves. Those who choose salaries rather than profits are willing to accept a low income in order to get rid of a precarious one. Since a risky income, if the risk applies evenly to all parts of the income-stream, is nearly equivalent to a low income, and since a low income, as we have seen, tends to create a high time-preference, risk, if uniformly distributed in time, must tend to raise time-preference.

We see, then, that risk tends in some cases to increase and in others to decrease the rate of time-preference. But there is a common principle in all these cases. Whether the result is a high or a low time-preference, the primary fact is that the risk of losing the income in a particular period of time operates as a virtual impoverishment of the income in that period, and hence increases the estimation in which it is held. If that period is a remote one, the risk to which it is subject makes for a high appreciation of remote income; if the period is the immediate future, the risk makes for a high appreciation of immediate income; if the risk is in all periods of time, it acts as a virtual decrease of income all along the line.

There are, however, anomalous individuals in whom caution is absent or perverted. Upon these, risk will have quite the opposite effects. Some persons, who see great speculative chances in the remote future, may treat that future as though it were especially well-endowed, and therefore be willing to sacrifice a large amount of their "great expectations" in the future for the sake of a relatively small addition to their present income. In other words, they will have a high time-preference. The same individuals, if receiving an income which is risky for all periods of time alike, might have, as a result, a low instead of a high time-preference.

The income to which risk applies may be either the income from articles of capital external to man, or the income from man himself. In the latter case the risk of losing the income is the risk of death or invalidism. This risk — the uncertainty as to human life and health — differs somewhat from the uncertainty of income dependent on objective capital; for the cessation of life not only produces a cessation of income from the human machine, but a cessation of the enjoyment of all income whatsoever. For persons who have children whose future welfare they have at heart, this consideration loses much of its force. A man with wife and children is willing to pay a high insurance premium in order that they may continue to enjoy an income after his death, while an unmarried man, or a man who cares only for self-indulgence and wishes to "make the day and the journey alike," will not try to continue the income after his death. Uncertainty of life in the latter case is especially calculated to produce a high degree of time-preference. Sailors offer a good example. They are natural spendthrifts, and when they have money use it lavishly. The risk of shipwreck is constantly before them, and their motto is, "A short life and a merry one."

The effect of risk, therefore, is manifold, according to the degree and range of application of risk to various periods of time; according to the cautious or incautious character of the individual; according to whether or not the risk in question applies to human life, and if so, according to whether or not the individual's interest in the future extends beyond his own lifetime. The manner in which these tendencies operate upon the rate of interest will be discussed in Chapter XI.

§ 9

The proposition that the preference for present over future income depends upon the income, its size, time-shape, composition, and probability, does not deny that it may depend on other factors also, just as, in the theory of prices, the proposition that the marginal utility of an article depends upon the quantity of that article does not deny that it may depend on other elements as well. But the dependence of time-preference on income is of most importance, for time-preference is a preference *for* income. It is in the same way that the dependence of the marginal utility of bread on the quantity of bread is more important than its dependence on the quantity of some other commodity, such as butter. As to the dependence of this time-preference for income on other factors than that income, these other factors may conveniently be regarded as affecting the "form of the function" which expresses its dependence on income. In this light may be considered the influence of "the personal equation." It is clear that the rate of time-preference which corresponds to a specific income-stream will not be the same for everybody. One man may have a time-preference of 5 per cent. and another 10 per cent., although both have the same income. The difference will be due to the personal characteristics of the individuals. These characteristics are chiefly five in number:[1] (1) foresight, (2) self-control, (3) habit, (4) expectation of life, (5) interest in the lives of other persons. We shall take these up in order.

(1) First, as to foresight. Generally speaking, the greater the foresight, the less the rate of time-preference, and *vice versa*.[2] In the case of primitive races and uninstructed

[1] Cf. Rae's *Sociological Theory of Capital*, p. 54. Also Böhm-Bawerk, *The Positive Theory of Capital*, Book V, Chap. III.

[2] To be exact, we should observe that lack of foresight may either increase or decrease time-preference. Although most persons who lack foresight err by failing to give due weight to the importance of future needs, or, what amounts to the same thing, by overestimating the provision existing for such future needs, cases are not lacking in which the opposite error is committed; that is, the individual exaggerates the needs of the future or underestimates the provision likely to be made for them. In order not to complicate the text, only the former

classes of society, the future is seldom considered in its true proportions. The story is told of such a person that he would not mend his leaky roof when it was raining, for fear of getting more wet, nor when it was not raining, because he did not then need shelter. Among such persons, the preference for present gratification is powerful because their comprehension of the future is weak. In regard to foresight, Rae states:[1]—

"The actual presence of the immediate object of desire in the mind, by exciting the attention, seems to rouse all the faculties, as it were, to fix their view on it, and leads them to a very lively conception of the enjoyments which it offers to their instant possession. The prospects of future good, which future years may hold out to us, seem at such a moment dull and dubious, and are apt to be slighted, for objects on which the daylight is falling strongly, and showing us in all their freshness just within our grasp. There is no man, perhaps, to whom a good to be enjoyed to-day, would not seem of very different importance, from one exactly similar to be enjoyed twelve years hence, even though the arrival of both were equally certain."

The sagacious business man represents the other extreme; he is constantly forecasting. These differences in degrees of foresight produce corresponding differences in the dependence of time-preference on the character of income. Thus, for a given income, say $1000 a year, the reckless might have a time-preference of 10 per cent., when the forehanded would experience a preference of only 5 per cent. In both cases the preference will depend on the size of the income, being higher the lower the income; but the particular rates corresponding to a particular income in the two cases will be entirely different. Therefore the rate of preference, in general, will be higher in a community consisting of reckless individuals than in one consisting of the opposite type.

and more common error will be hereafter referred to when "lack of foresight" is mentioned. But the reader may in each such case readily add the possibility of the contrary error.

[1] *Sociological Theory of Capital*, p. 54.

(2) We come next to self-control. This trait, though distinct from foresight, is usually associated with it and has very similar effects. Foresight has to do with *thinking*, self-control with *willing*. A weak will usually goes with a weak intellect, though not necessarily, and not always. The effect of a weak will is similar to the effect of inferior foresight. Like those workingmen who cannot carry their pay home Saturday night, but spend it on the way in the grogshop, many persons cannot deny themselves any present indulgence, even when they know definitely what the consequences will be in the future. Others, on the contrary, have no difficulty in stinting themselves in the face of all temptations.

(3) The third characteristic of human nature which needs to be considered is habit. That to which one is accustomed exerts necessarily a powerful influence upon his valuations and therefore upon his time-preference. This influence may be in either direction. Rich men's sons, accustomed to the enjoyment of a large income, are apt to put a higher valuation on present compared with future income than would persons of the same income who were brought up under different conditions. If they suffer a reverse of fortune, they find it harder to live moderately than those of equal means who have risen instead of fallen in the economic scale; and this will be true even if foresight and self-control are the same in the two cases.

(4) The fourth circumstance which may influence the form of the function by which time-preference depends on the character of income has to do with the uncertainty of life of the recipient of that income. We have already seen in a different connection that the time-preference of an individual will be affected by the prospect of a long or short life, both because the termination of life brings the termination of the income from labor, and because it also terminates the enjoyment of all income. It is the latter fact in which we are here interested; the expectation of life affects the dependence of time-preference on income. There

will be differences among different classes, different individuals, and different ages of the same individual. So far as age is concerned, the usual course of events is as follows: The time-preference in the early periods of life is high because foresight and self-control are weak. Children are notorious spendthrifts. A little later, when the individual has acquired some self-control and foresight, he will still have a high rate of preference, but for another reason, — the prospect of an ascending income-stream. His present income is small, but he looks forward to having an ample income in five or ten years. As the time of marriage and middle life approaches, the opposite tendency may assert itself. Foreseeing the needs of middle life and anticipating no increase in the provision for those needs, he will cease to borrow and begin to save. After he has passed middle age, when his children have become self-supporting, and he looks forward to declining years, matters are reversed again. He will want to enjoy his income while he may, the income beyond his death being of no significance to him except as it can be bequeathed to his descendants. The prospect of death plays an important rôle in the thoughts of the old. One evidence of this is the prominence given to it in all philosophical and religious systems.[1] The philosophy of Horace, for instance, was summed up in the maxim "*carpe diem*," which is practically the same as the still older maxim, "eat, drink, and be merry, for tomorrow we die." The chance of death may be said to be the most important *rational* factor tending to make the rate of time-preference high, and anything that would tend to prolong human life would tend at the same time to reduce the rate of time-preference. As Rae says:[2] —

"Were life to endure forever, were the capacity to enjoy in perfection all its goods, both mental and corporeal, to be prolonged

[1] See Metchnikoff, *Nature of Man*, English translation, New York (Putnams), 1903, Part II.

[2] *The Sociological Theory of Capital*, pp. 53–54.

with it, and were we guided solely by the dictates of reason, there could be no limit to the formation of means for future gratification, till our utmost wishes were supplied. A pleasure to be enjoyed, or a pain to be endured, fifty or a hundred years hence, would be considered deserving the same attention as if it were to befall us fifty or a hundred minutes hence, and the sacrifice of a smaller present good, for a greater future good, would be readily made, to whatever period that futurity might extend. But life, and the power to enjoy it, are the most uncertain of all things, and we are not guided altogether by reason. We know not the period when death may come upon us, but we know that it may come in a few days, and must come in a few years. Why then be providing goods that cannot be enjoyed until times, which, though not very remote, may never come to us, or until times still more remote, and which we are convinced we shall never see? If life, too, is of uncertain duration and the time that death comes between us and all our possessions unknown, the approaches of old age are at least certain, and are dulling, day by day, the relish of every pleasure."

The shortness of life thus tends powerfully to raise the rate of time-preference. This is especially evident when the income-streams compared are long. A lover of music will prefer a piano at once to a piano available next year, because, since either will outlast his own life, he will get one more year's use out of the piano available at once.

From what has been said it is clear that there are three periods in his life when a man's time-preference is especially high: (1) in early life it is high because of youthful recklessness; (2) in the preparatory stage, because future income seems relatively abundant; and (3) late in life, because future income seems relatively superfluous.

(5) But whereas the shortness or uncertainty of life tends to raise the rate of time-preference, its effect is greatly mitigated by the fifth circumstance, the care for the welfare of posterity. Probably the most powerful cause tending to reduce the rate of interest is the love of one's children and the desire to provide for their good. When these sentiments decay, as they did at the time of the decline and fall of the Roman Empire, and the fashion is to exhaust wealth in

self-indulgence and leave little or nothing to offspring, the rate of time-preference and rate of interest will be high. At such times the motto, "After us the deluge," indicates the feverish desire to squander in the present, at whatever cost to the future.[1]

In a community like the United States, where parents regard their lives as continuing after death in the lives of their children, there exists a high appreciation of the needs of the future which tends, therefore, to produce a low rate of time-preference. It is this sentiment which is responsible for the enormous extension of life insurance. At present in the United States the insurance on lives amounts to $20,000,000,000. This represents, for the most part, an investment of the present generation for the next. The investment of this sum springs out of a low time-preference, and tends to produce a low rate of interest.

Not only does the regard for posterity lower interest, but the increase of posterity has in part the same effect. So far as an increase in the size of a family reduces the income *per capita* of that family, it operates, like impoverishment, to increase time-preference. So far as it adds to future needs rather than to immediate needs, it operates, like a descending income-stream, to diminish time-preference. Parents with large families feel the importance of providing for future years far more than parents otherwise similar but with small families. They try harder to save and to take out life insurance. In other words, their rate of preference for present over future income is lowered. An increase of population, therefore, will, other things being equal, reduce the rate of interest. This proposition must not be thought to conflict with the reciprocal proposition that the same prudent regard for the future which is created by the responsibilities of parenthood itself tends to diminish the number of offspring. An increase of population tends toward a low time-preference, but reciprocally a low

[1] See Rae, *The Sociological Theory of Capital*, p. 97.

time-preference tends to check such increase. Hence it is that the thrifty Frenchman and Scotchman have small families.

§ 10

Time-preference, therefore, depends for each individual on his income; that is, its size, time-shape, composition, and probability; but the *form* of this dependence differs according to the various circumstances of the individual. The circumstances which will tend to make his time-preference high are (1) shortsightedness, (2) a weak will, (3) the habit of spending freely, (4) the shortness and uncertainty of his life, (5) selfishness, or the absence of any desire to provide for posterity. The reverse conditions will tend to make his rate of preference low; namely, (1) a high degree of foresight, which enables him to give to the future such attention as it deserves; (2) a high degree of self-control, which enables him to abstain from present income in order to increase future income; (3) the habit of thrift; (4) the probability of long life; (5) the possession of a family and a high regard for their welfare after his death.

The resultant of these various tendencies in any one individual will determine the degree of his time-preference *in relation to any particular income.* This result will differ as between individuals, and as between different times for the same individual. The essential fact, however, is that *for any given individual at any given time, his time-preference depends in a definite manner upon the size, shape, composition, and probability of his income-stream.*

§ 11

This view, that the rate of time-preference and consequently the rate of interest depend upon income, needs to be contrasted with the common view, which makes the rate of interest depend merely on the scarcity or abundance of capital. It is commonly believed that where capital is scarce, interest is high, and where capital is plentiful, interest is low. In a general way there is undoubtedly some truth in this proposition; and yet it contains a misinterpretation of borrowing and lending. It is true that when and where men are anxious to lend, interest is low, and when and where men are anxious to borrow, interest is high. But it is not true that the more capital a man has the more anxious he is to lend, and the less capital he has the more anxious he is to borrow. The willingness to lend or borrow depends primarily, not upon the amount of one's capital, but upon the character of the income which he gets from it, — whether this income is large or small, immediate or deferred, of what elements it consists, whether it is certain or uncertain.

The proposition that abundance of capital tends to lower interest is thus very superficial; for abundant capital merely means abundant income. Capital-value is discounted income. Behind, or rather beyond, a capital of $100,000 is the income which that capital represents. To fix attention on the $100,000 capital instead of on the income is to use the capital as a cloak to cover up the real factor in the case. Moreover, capital-value is itself dependent on the rate of interest. The capital-value of a farm will be doubled if the rate of interest is halved. In such a case there would be found more capital in farms; for the farms in a community would rise, say, from $10,000,000 to $20,000,000. But it is not the rise in capital which produces the fall in interest. On the contrary, it is the fall in the interest rate which produces the rise in the valuation of capital. If we attempt to make the rate of interest depend on capital-value, then, since capital-value depends on two factors, — the prospective income *and the rate of interest*, — we thereby make the interest rate depend partly on income and partly on itself. The dependence on itself is of course nugatory, and we are brought back to its dependence on income as the only fact of real significance.

But even as thus amended and explained, the proposition that the rate of interest depends on the amount of capital is not satisfactory. The mere amount of capital does not tell us much about the income for which that capital stands. To know that one man has a capital worth $100,000, and another $200,000, shows, to be sure, that the latter man may have an income of double the value of the former; but it tells us absolutely nothing as to the "time-shapes" of the two incomes; and the time-shape of income has, as we have seen, a most profound influence on the time-preference of its possessor.

Let us suppose two communities similar in population, distribution of wealth, and all other particulars except in the amount of their capital and the character of the income which that capital represents. One of these two communities we shall suppose has a capital of $100,000 invested, as in Nevada, in mines and quarries nearly exhausted, while in the other community there is $200,000 of capital invested in young orchards and forests, as in Florida. According to the theory that abundance of capital makes interest low, we should expect the Nevada community to have a high rate of interest compared with the Florida community. But it is evident that, unless other circumstances should interfere, the opposite would be the case; for Nevada has to contemplate a decreasing future income, and in order to offset the depreciation of capital which follows from this condition,[1] she would be seeking to lend or invest part of the income of the present or immediate future, in the hope of offsetting the decreased product of the mines in the more remote future. The Florida planters, on the contrary, would be inclined to borrow against their future crops. If the two communities are supposed to be commercially connected, it would be Nevada which would lend to Florida, notwithstanding the fact that the lending community was the

[1] See *The Nature of Capital and Income*, Chap. XIV.

poorer in capital of the two. From the illustration it is clear that the mere amount of capital-value is not only a misleading but a very inadequate criterion of the rate of interest.[1]

Apologists for the common statement that abundance or scarcity of capital lowers or raises interest might be inclined to argue that it is not the total capital, but only the "loanable capital" which should be included, and that the Nevada community had more "loanable capital" than the Florida community. But the phrase "loanable capital" is merely another cloak to cover the fact that it is not the amount of capital, but the decision to lend or borrow it, which is important. To give this proposition meaning, "loanable capital" must be taken, not in the literal sense of capital which *can* be lent, — for all capital is loanable in this sense; but in the sense of capital which persons are *willing* to lend. Hence, to state that in any community there is abundance of loanable capital is merely to state that there is in that community a willingness to lend a great deal of capital. Consequently, the proposition that the rate of interest, or preference for present over future goods, is low when loanable capital is abundant becomes reduced to the platitude that the rate of preference for present over future goods is low when men wish to lend.

But it may be said, surely in a money market there exists at one time a large visible supply of loanable money and at another time a small visible supply, and this supply affects the rate of interest. This, again, is a true but a superficial statement. A little examination will show that the abundance or shortage of loanable bank funds is merely a measure of the decision of merchants to discount or deposit, — in other words, to borrow or lend, — and does not give us any clew as to the reason why they do so. The money or credit

[1] One of the few defects in Rae's analysis of interest is his emphasis on the accumulation of capital. Since this accumulation is merely in anticipation of future income, the emphasis belongs on the latter.

is, of course, the mere vehicle by which the bank acts as an intermediary or broker between borrowers and lenders, and does not represent any independent factor in the case.

We end, therefore, by emphasizing anew the importance of fixing our eyes on income and not on capital. It is only as we look through capital-value, beyond to the income which it represents, that we reach the efficient causes which operate upon the rate of interest. The absence hitherto of a definite theory and conception of income has prevented economists from doing this. Borrowing and lending are in form a transfer of capital, but they are in fact a transfer of income of which that capital is merely the present value. In our theory of interest, therefore, we have to consider not primarily the *amount* of capital of a community, but the income for which that capital stands.

§ 12

Unfortunately for purposes of exposition, the relation between time-preference and income cannot be expressed in a simple schedule or curve, as can the relation between demand and price, or supply and price, or utility and quantity consumed, for the reason that income means not a single magnitude merely, but a conglomeration of a number of magnitudes. As mathematicians would express it, to state that time-preference depends on the character of income, its size, shape, composition, and probability, is to state that time-preference is a function of all the different magnitudes which need to be specified in a complete description of that income. A geometrical representation, therefore, of the dependence of time-preference on the various magnitudes which characterize income, would be impossible. For a curve can only represent the dependence of a magnitude on one independent variable; even a surface can only represent dependence on two; but for our requirements we should need a space of n dimensions. We may represent the relation between time-preference and income by a "schedule" like the ordinary "demand schedule" and "supply schedule," if we make a list of all possible incomes, specifying for each individual income all its characteristics, — its size, time-shape (that is, its relative magnitude for each successive time-interval considered), its composition (or the amount, at each period, of each individual constituent, as nourishment, shelter, etc.), and the certainty or uncertainty attached to all these elements. Having thus compiled a list of all possible incomes, it would only be necessary for us to assign to each of them the rate of time-preference pertaining to it. Such a schedule would be too complicated and cumbersome to carry out in detail; but the following will roughly indicate some of the main groups of which it would consist. In this schedule we have represented by the three vertical lines three different classes of income, — two extreme types and one mean type, — so that the corresponding rates of time-preference range themselves in a descending series of numbers. We have also represented by the three vertical columns three different classes of individuals, two being of extreme types of individuals, and the third of a mixed or medium type. Thus the numbers in the table descend as we proceed either down or toward the right, the lowest number of all being in the lower right-hand corner.

DESCRIPTION OF INCOME				CORRESPONDING TIME-PREFERENCE to an individual who is		
SIZE	TIME-SHAPE	COMPOSITION	PROBABILITY	shortsighted, weak-willed, accustomed to spend, without heirs	of a mixed or medium type	farsighted, self-controlled, accustomed to save, desirous to provide for heirs
small	increasing	food scanty	precarious	20%	10%	5%
of a mixed or medium type				10%	5%	2%
large	decreasing	food abundant	assured	5%	2%	1%

Out of the large number of possible incomes represented in such a schedule, of course only one can be the actual income of the individual. The one which exists in any case is to a large extent a matter of choice, as we shall see in the next chapter. Since time-preference may be varied by voluntarily varying the character of the income-stream on which it depends, it follows that the shortsighted, weak-willed spendthrift individual may not have, as a matter of fact, any higher rate of time-preference than his farsighted, self-controlled, abstemious brother. In fact, where a loan market is in full operation, the tendency is for the two individuals to select such income-streams as will bring their time-preference into unison. How this is accomplished will form the subject of the following chapter.

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IRVING FISHER, *THE THEORY OF INTEREST, AS DETERMINED BY IMPATIENCE TO SPEND INCOME AND OPPORTUNITY TO INVEST IT* (1930)

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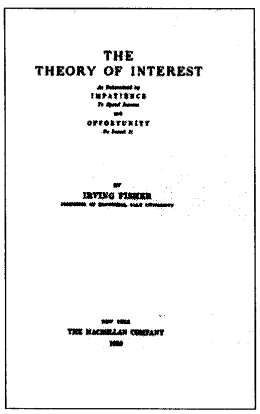

ABOUT THE AUTHOR
Irving Fisher was one of America's greatest mathematical economists and one of the clearest economics writers of all time. He had the intellect to use mathematics in virtually all his theories and the good sense to introduce it only after he had clearly explained the central principles in words. Although he damaged his reputation by insisting throughout the Great Depression that recovery was imminent, contemporary economic models of interest and capital are based on Fisherian principles. Similarly, monetarism is founded on Fisher's principles of money and prices.

ABOUT THE BOOK
Fisher was one of America's greatest mathematical economists. This book is still used a textbook and is an outstanding example of clearly written economic theory.

THE EDITION USED
The Theory of Interest, as determined by Impatience to Spend Income and Opportunity to Invest it (New York: Macmillan, 1930).

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IRVING FISHER, *THE THEORY OF INTEREST, AS DETERMINED BY IMPATIENCE TO SPEND INCOME AND OPPORTUNITY TO INVEST IT* (1930)

THE THEORY OF INTEREST

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THE
THEORY OF INTEREST

AS DETERMINED BY
IMPATIENCE
TO SPEND INCOME

AND
OPPORTUNITY
TO INVEST IT

BY
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TO
THE MEMORY
OF
JOHN RAE
AND OF
EUGEN VON BÖHM-BAWERK
WHO LAID THE FOUNDATIONS
UPON WHICH
I HAVE ENDEAVORED
TO BUILD

ERRATA

PAGE XXVI, CHART TITLE 45: FOR "P" READ "*P″*"; CHART TITLE 46, THIRD LINE: FOR "P'S" READ "*P″*S."

PAGE 182, LINE 5: FOR "EFFECT" READ "AFFECT."

PAGE 305, LINE 1: FOR "*I*" READ "*I′*."

PAGE 418, LINE 5: FOR "&PLUS;" READ "–."

PAGE 423, SIXTH LINE FROM BOTTOM: FOR "6.7" READ "7.3."

PAGE 424, IN CHART TITLE: FOR "*P, P′, P″*" READ "*P, P′,* P."

PAGE 426, LINE 2: FOR "*P′* AND *P″*" READ "*P′* AND P"; LINE 4: FOR "*P″*" READ "P"; LINE 7: FOR "*P″*" READ "P."

PAGE 442, LINE 6: FOR "LEAVES" READ "LEAVING"; LINE 10, FOR "LEAVES" READ "LEAVING."

PREFACE

THE TREMENDOUS EXPANSION OF CREDIT DURING AND SINCE THE WORLD WAR TO FINANCE MILITARY OPERATIONS AS WELL AS POST-WAR REPARATIONS, RECONSTRUCTION, AND THE REBUILDING OF INDUSTRY AND TRADE HAS BROUGHT THE PROBLEMS OF CAPITALISM AND THE NATURE AND ORIGIN OF INTEREST HOME AFRESH TO THE MINDS OF BUSINESS MEN AS WELL AS TO ECONOMISTS. THIS BOOK IS ADDRESSED, THEREFORE, TO FINANCIAL AND INDUSTRIAL LEADERS, AS WELL AS TO PROFESSORS AND STUDENTS OF ECONOMICS.

INFLATION DURING AND SINCE THE WAR CAUSED PRICES TO SOAR AND REAL INTEREST RATES TO SAG IN GERMANY AND OTHER NATIONS FAR BELOW ZERO THUS IMPOVERISHING MILLIONS OF INVESTORS. IN ALL COUNTRIES GILT-EDGE SECURITIES WITH FIXED RETURN BECAME HIGHLY SPECULATIVE, BECAUSE OF THE EFFECT OF MONETARY FLUCTUATIONS ON REAL INTEREST RATES. AFTER THE WAR THE IMPATIENCE OF WHOLE PEOPLES TO ANTICIPATE FUTURE INCOME BY BORROWING TO SPEND, COUPLED WITH THE OPPORTUNITY TO GET LARGE RETURNS FROM INVESTMENTS, RAISED INTEREST RATES AND KEPT THEM HIGH. INCREASED NATIONAL INCOME HAS MADE THE UNITED STATES A LENDER NATION. AT HOME, REAL INCOMES HAVE GROWN AMAZINGLY BECAUSE OF THE NEW SCIENTIFIC, INDUSTRIAL, AND AGRICULTURAL REVOLUTIONS.

INTEREST RATES HAVE DECLINED SOMEWHAT SINCE 1920, BUT ARE STILL HIGH BECAUSE THE RETURNS UPON INVESTMENTS REMAIN HIGH. IMPATIENCE TO SPEND HAS BEEN EXEMPLIFIED BY THE ORGANIZATION OF CONSUMERS' CREDIT IN THE FORM OF FINANCE COMPANIES SPECIALLY ORGANIZED TO ACCOMMODATE AND STIMULATE INSTALLMENT SELLING AND TO STANDARDIZE AND STABILIZE CONSUMPTION.

THIS BOOK, *THE THEORY OF INTEREST*, WAS BEGUN AS A REVISION OF *THE RATE OF INTEREST*, WHICH WAS PUBLISHED IN 1907, AND HAS LONG SINCE BEEN OUT OF PRINT. REQUESTS FOR ANOTHER EDITION OF THAT WORK HAVE BEEN MADE FROM TIME TO TIME; BUT I HAVE POSTPONED IT YEAR BY YEAR FOR OVER TWO DECADES, BECAUSE I WISHED TO REVISE THE PRESENTATION, AND TO REWRITE THOSE PORTIONS WHICH, IF I MAY JUDGE FROM CRITICISMS, HAVE NOT BEEN UNDERSTOOD.

I HAVE CONSIDERED THE CRITICISMS OF THE FORMER BOOK WHICH HAVE COME TO MY NOTICE, AND HAVE, AS A CONSEQUENCE, MODIFIED THE FORM OF PRESENTATION MATERIALLY. THOUGH, IN SUBSTANCE, MY THEORY OF INTEREST HAS BEEN ALTERED SCARCELY AT ALL, ITS EXPOSITION HAS BEEN SO AMPLIFIED AND RECAST THAT IT WILL, I ANTICIPATE, SEEM, TO THOSE WHO MISUNDERSTOOD MY FIRST BOOK, MORE CHANGED THAN IT SEEMS TO ME. THE RESULT HAS BEEN A NEW BOOK, *THE THEORY OF INTEREST*, A COMPLETE REWRITING OF THE FORMER BOOK, WITH ADDITIONS OF NEW MATERIAL.

I WAS ENCOURAGED TO WRITE THIS NEW EXPOSITION OF THE THEORY OF INTEREST BY VARIOUS ECONOMISTS AND LEADING BUSINESS MEN AND ESPECIALLY BY MR. OSWALD T. FALK, ONE OF THE REPRESENTATIVES OF GREAT BRITAIN AT THE VERSAILLES PEACE CONFERENCE, WHO WAS KIND ENOUGH TO SAY THAT HE HAD GAINED MORE INSIGHT INTO ECONOMIC THEORY FROM *THE RATE OF INTEREST* THAN FROM ANY OTHER BOOK.

YEARS AFTER *THE RATE OF INTEREST* WAS PUBLISHED, I SUGGESTED THE MORE POPULAR TERM "IMPATIENCE" IN PLACE OF "AGIO" OR "TIME PREFERENCE." THIS CATCHWORD HAS BEEN WIDELY ADOPTED, AND, TO MY SURPRISE, HAS LED TO A WIDESPREAD BUT FALSE IMPRESSION THAT I HAD OVERLOOKED OR NEGLECTED THE PRODUCTIVITY OR INVESTMENT OPPORTUNITY SIDE ENTIRELY. IT ALSO LED MANY TO THINK THAT, BY USING THE NEW WORD IMPATIENCE, I MEANT TO CLAIM A NEW IDEA. THUS I FOUND MYSELF CREDITED WITH BEING THE AUTHOR OF "THE IMPATIENCE THEORY" WHICH I AM NOT, AND NOT CREDITED WITH BEING THE AUTHOR OF THOSE PARTS LACKING ANY CATCHWORD. IT WAS THIS MISUNDERSTANDING WHICH LED ME, AFTER MUCH SEARCH, TO ADOPT THE CATCHWORD "INVESTMENT OPPORTUNITY" AS A SUBSTITUTE FOR THE INADEQUATE TERM "PRODUCTIVITY" WHICH HAD COME INTO SUCH GENERAL USE.[1]

IN ECONOMICS IT IS DIFFICULT TO PROVE ORIGINALITY; FOR THE GERM OF EVERY NEW IDEA WILL SURELY BE FOUND OVER AND OVER AGAIN IN EARLIER WRITERS. FOR MYSELF, I WOULD BE SATISFIED TO HAVE MY CONCLUSIONS ACCEPTED AS *TRUE* EVEN IF THEIR ORIGIN SHOULD BE CREDITED BY THE CRITICS WHOLLY TO EARLIER WRITERS. WHILE I HOPE I MAY BE CREDITED WITH A CERTAIN DEGREE OF ORIGINALITY, EVERY THOROUGH STUDENT OF THIS SUBJECT WILL RECOGNIZE IN MY TREATMENT OF INTEREST THEORY FEATURES OF HIS OWN. MY OWN THEORY IS IN SOME DEGREE EVERY ONE'S THEORY. EVERY ESSENTIAL PART OF IT WAS AT LEAST FORESHADOWED BY JOHN RAE IN 1834.

IF THIS COMBINED "IMPATIENCE AND OPPORTUNITY" THEORY CAN BE SAID TO BE AT ALL DISTINCT FROM ALL OTHERS, IT IS BECAUSE IT EXPLICITLY ANALYSES OPPORTUNITY, AND FITS TOGETHER IMPATIENCE AND OPPORTUNITY AND INCOME. THE INCOME CONCEPT PLAYS THE BASIC RÔLE IN THE THEORY OF INTEREST. I VENTURE TO HOPE THAT THE THEORY, AS HERE PRESENTED, WILL BE FOUND NOT SO MUCH TO OVERTHROW AS TO CO-ORDINATE PREVIOUS THEORIES, AND TO HELP IN MAKING THE CHAIN OF EXPLANATION COMPLETE AND STRONG.

CHAPTER I IS ADDED FOR THE PURPOSE OF GIVING THE READER WHO HAS NOT READ MY *NATURE OF CAPITAL AND INCOME*, A BRIEF SUMMARY OF ITS CONTENTS.

I HAVE, FOR THE FIRST TIME, IN A BOOK ON PURE ECONOMIC THEORY, INTRODUCED MATHEMATICS INTO THE TEXT, INSTEAD OF RELEGATING IT ENTIRELY TO APPENDICES. THIS IS DONE IN VIEW OF THE INCREASING USE OF MATHEMATICS AND THE INCREASING NUMBERS OF STUDENTS EQUIPPED TO READ MATHEMATICAL ECONOMICS AND STATISTICS.

PARTS OF CHAPTERS II AND XIX, WITH THEIR APPENDICES, HAVE APPEARED IN DIFFERENT FORM IN MY MONOGRAPH, "APPRECIATION AND INTEREST." THANKS ARE DUE TO THE AMERICAN ECONOMIC ASSOCIATION FOR PERMISSION TO USE PARTS OF THIS MONOGRAPH UNALTERED. SINCE IT APPEARED THREE DECADES AGO, THE VIEW EXPRESSED IN IT (THAT APPRECIATION OR DEPRECIATION IN THE VALUE OF MONEY SHOULD, AND TO SOME EXTENT DOES, LOWER OR RAISE THE RATE OF INTEREST) HAS GAINED CONSIDERABLE CURRENCY, AND HAS BEEN ILLUSTRATED AND VERIFIED BY WAR-TIME EXPERIENCE.

CHAPTER XIX IS MADE UP, FOR THE MOST PART, OF A NEW AND INTENSIVE STUDY OF THE RELATIONSHIPS EXISTING BETWEEN PRICES AND INTEREST RATES. THESE RELATIONSHIPS ARE TESTED BY NEW AND RIGOROUS STATISTICAL METHODS OF ANALYSIS. WHILE THE CONCLUSIONS PRESENTED AS THE RESULTS OF THESE ANALYSES ARE ONLY TENTATIVE, YET THEY ARE, I THINK, WORTHY OF FURTHER STATISTICAL STUDIES INTO THE RELATION OF INTEREST RATES ON THE ONE HAND, AND PRICES, BUSINESS ACTIVITY, BANK RESERVES, AND BANK LOANS ON THE OTHER.

IN THE PREPARATION OF THE ORIGINAL BOOK I RECEIVED IMPORTANT AID FROM MANY PERSONS. FINANCE MINISTER BÖHM-BAWERK, WHOSE WRITINGS ON INTEREST AND WHOSE HISTORY OF THE SUBJECT ARE CLASSIC, KINDLY READ AND CRITICIZED THE CHAPTER DEVOTED TO HIS THEORY OF INTEREST. AFTERWARD, IN THE THIRD EDITION OF HIS *POSITIVE THEORIE DES KAPITALES* AND THE *EXKURSE* THERETO, HE DEVOTED MORE THAN 100 PAGES TO DISCUSSIONS AND CRITICISMS, FAVORABLE AND UNFAVORABLE, OF *THE RATE OF INTEREST* AS IT FIRST APPEARED. I HAVE TAKEN ACCOUNT OF HIS CRITICISM IN CHAPTER XX.

IN PREPARING THIS BOOK I HAVE RECEIVED SUGGESTIONS AND ASSISTANCE FROM SO MANY ECONOMISTS AND OTHERS IN THE UNITED STATES AND ABROAD, THAT IT IS IMPRACTICABLE TO MENTION THEM ALL BY NAME. MY ASSOCIATES, DR. ROYAL MEEKER, DR. MAX SASULY, AND MR. BENJAMIN P. WHITAKER, HAVE CONTRIBUTED IN HELPFUL CRITICISM, AS WELL AS IN GATHERING MATERIAL, PREPARING THE MANUSCRIPT FOR THE PRINTER, AND READING THE PROOF. I AM ESPECIALLY INDEBTED TO MY BROTHER, MR. HERBERT W. FISHER, FOR HIS SUGGESTIONS AS TO STYLE AND THE MANNER OF PRESENTATION, AND TO PROFESSOR HARRY G. BROWN FOR HIS CRITICISM OF MY STATEMENT OF THE OPPORTUNITY PRINCIPLE. OTHERS WHO HAVE HELPED ME ESPECIALLY ARE: PROF. LIONEL D. EDIE, MR. C. O. HARDY, MR. R. G. HAWTRY, PROF. FRANK H. KNIGHT, PROF. J. S. LAWRENCE, PROF. ARTHUR W. MARGET, PROF. H. B. MEEK, PROF. WESLEY C. MITCHELL, MRS. CLARA ELIOT RAUP, PROF. HENRY SCHULTZ, PROF. HENRY R. SEAGER, MR. HENRY SIMONS, MR. CARL SNYDER, PROF. JACOB VINER.

I HAVE ALSO RECEIVED VALUABLE SUGGESTIONS FROM MEMBERS OF MY CLASS IN THE ECONOMICS OF DISTRIBUTION; NAMELY, HOWARD BEROLZHEIMER, A. G. BUEHLER, FRANCIS W. HOPKINS, RICHARD A. LESTER, DANIEL T. SELKO, ANDREW STEVENSON, JR., AND RONALD B. WELCH.

IRVING FISHER

YALE UNIVERSITY,
JANUARY, 1930

FOOTNOTES FOR PREFACE

1. THIS TERM, INVESTMENT OPPORTUNITY, SEEMS TO BE THE NEAREST EXPRESSION IN POPULAR LANGUAGE TO SUGGEST OR DENOTE THE TECHNICAL MAGNITUDE *R* EMPLOYED IN THIS BOOK. THE FULL EXPRESSION FOR *R* IS THE RATE OF RETURN OVER COST, AND BOTH COST AND RETURN ARE DIFFERENCES BETWEEN TWO OPTIONAL INCOME STREAMS. SO FAR AS I KNOW, NO OTHER WRITER ON INTEREST HAS MADE USE OF INCOME STREAMS AND THEIR DIFFERENCES, OR RATES OF RETURN OVER COST PER ANNUM. THE NEAREST APPROXIMATION TO THIS USAGE SEEMS TO BE IN THE WRITINGS OF PROFESSOR HERBERT J. DAVENPORT, PARTICULARLY HIS *ECONOMICS OF ENTREPRISE*, (MACMILLAN, NEW YORK, 1913) PAGES 368, 379, 381, 394, 395, 396, 410, 411.

SUGGESTIONS TO READERS

- 1.THE *GENERAL READER* WILL BE CHIEFLY INTERESTED IN PARTS I, II, AND IV.
- 2. *READERS WITH A DISTASTE FOR MATHEMATICS* WILL FIND THE ESSENTIAL THEORY STATED IN WORDS IN PART II.
- 3. *THOSE INTERESTED IN STATISTICAL ANALYSIS* SHOULD READ CHAPTER XIX.
- 4. THE APPENDIX TO CHAPTER XIX CONTAINS THE STATISTICAL TABLES USED IN THE ANALYSIS PRESENTED IN THE TEXT.
- 5. THE ANALYTICAL TABLE OF CONTENTS, THE INDEX, AND THE RUNNING PAGE HEADINGS HAVE BEEN CONSTRUCTED WITH ESPECIAL REFERENCE TO THE VARYING NEEDS OF DIFFERENT CLASSES OF READERS. THE BOOK PRESENTS A COMPLETE THEORY OF INTEREST, AND IT IS HOPED THAT THOSE WHO APPROACH IT FROM SPECIAL VIEWPOINTS MAY, IN THE END, READ IT ALL.

PART I. INTRODUCTION

CHAPTER I
INCOME AND CAPITAL[1]

§1. SUBJECTIVE, OR ENJOYMENT, INCOME

INCOME IS A SERIES OF EVENTS.[2]

ACCORDING TO THE MODERN THEORY OF RELATIVITY THE ELEMENTARY REALITY IS NOT MATTER, ELECTRICITY, SPACE, TIME, LIFE OR MIND, BUT EVENTS.

FOR EACH INDIVIDUAL ONLY THOSE EVENTS WHICH COME WITHIN THE PURVIEW OF HIS EXPERIENCE ARE OF DIRECT CONCERN. IT IS THESE EVENTS—THE PSYCHIC EXPERIENCES OF THE INDIVIDUAL MIND—WHICH CONSTITUTE ULTIMATE INCOME FOR THAT INDIVIDUAL. THE OUTSIDE EVENTS HAVE SIGNIFICANCE FOR THAT INDIVIDUAL ONLY IN SO FAR AS THEY ARE THE MEANS TO THESE INNER EVENTS OF THE MIND. THE HUMAN NERVOUS SYSTEM IS, LIKE A RADIO, A GREAT RECEIVING INSTRUMENT. OUR BRAINS SERVE TO TRANSFORM INTO THE STREAM OF OUR PSYCHIC LIFE THOSE OUTSIDE EVENTS, WHICH HAPPEN TO US AND STIMULATE OUR NERVOUS SYSTEM.

BUT THE HUMAN BODY IS NOT ORDINARILY REGARDED AS AN OWNED OBJECT, AND ONLY THOSE EVENTS IN CONSCIOUSNESS TRACEABLE TO OWNED OBJECTS OTHER THAN THE HUMAN BODY ARE GENERALLY ADMITTED TO BE PSYCHIC INCOME. HOWEVER, THE HUMAN MACHINE STILL PLAYS A RÔLE IN SO FAR AS, THROUGH ITS PURPOSEFUL ACTIVITIES, IT PRODUCES, OR HELPS PRODUCE, OTHER OWNED OBJECTS WHICH ARE MATERIAL SOURCES OF DESIRABLE EVENTS—FOOD, HOUSES, TOOLS, AND OTHER GOODS, WHICH IN THEIR TURN SET IN MOTION A CHAIN OF OPERATIONS WHOSE ULTIMATE EFFECT IS REGISTERED IN OUR STREAM OF CONSCIOUSNESS. THE IMPORTANT CONSIDERATION FROM THIS POINT OF VIEW IS THAT HUMAN BEINGS ARE EVER STRIVING TO CONTROL THE STREAM OF THEIR PSYCHIC LIFE BY APPROPRIATING AND UTILIZING THE MATERIALS AND FORCES OF NATURE.

IN MAN'S EARLY HISTORY HE HAD LITTLE COMMAND OVER HIS ENVIRONMENT. HE WAS LARGELY AT THE MERCY OF NATURAL FORCES—WIND AND LIGHTNING, RAIN AND SNOW, HEAT AND COLD. BUT TODAY MAN PROTECTS HIMSELF FROM THESE BY MEANS OF THOSE CONTRIVANCES CALLED HOUSES, CLOTHING, AND FURNACES. HE DIVERTS THE LIGHTNING BY MEANS OF LIGHTNING RODS. HE INCREASES HIS FOOD SUPPLY BY MEANS OF APPROPRIATED LAND, FARM BUILDINGS, PLOWS, AND OTHER IMPLEMENTS. HE THEN REFASHIONS THE FOOD BY MEANS OF MILLS, GRINDING MACHINERY, COOK-STOVES AND OTHER AGENCIES, AND BY THE LABOR OF HUMAN BODIES, INCLUDING HIS OWN.

NEITHER THESE INTERMEDIATE PROCESSES OF CREATION AND ALTERATION NOR THE MONEY TRANSACTIONS FOLLOWING THEM ARE OF SIGNIFICANCE EXCEPT AS THEY ARE THE NECESSARY OR HELPFUL PRELIMINARIES TO PSYCHIC INCOME—HUMAN ENJOYMENT. WE MUST BE CAREFUL LEST, IN FIXING OUR EYES ON SUCH PRELIMINARIES, ESPECIALLY MONEY TRANSACTIONS, WE OVERLOOK THE MUCH MORE IMPORTANT ENJOYMENT WHICH IT IS THEIR BUSINESS TO YIELD.

DIRECTORS AND MANAGERS PROVIDING INCOME FOR THOUSANDS OF PEOPLE SOMETIMES THINK OF THEIR CORPORATION MERELY AS A GREAT MONEY-MAKING MACHINE. IN THEIR EYES, ITS ONE PURPOSE IS TO EARN MONEY DIVIDENDS FOR THE STOCK-HOLDERS, MONEY INTEREST FOR THE BONDHOLDERS, MONEY WAGES AND MONEY SALARIES FOR THE EMPLOYEES. WHAT HAPPENS AFTER THESE PAYMENTS ARE MADE SEEMS TOO

PRIVATE A MATTER TO CONCERN THEM. YET THAT IS THE NUB OF THE WHOLE ARRANGEMENT. IT IS ONLY WHAT WE CARRY OUT OF THE MARKET PLACE INTO OUR HOMES AND PRIVATE LIVES WHICH REALLY COUNTS. MONEY IS OF NO USE TO US UNTIL IT IS SPENT. THE ULTIMATE WAGES ARE NOT PAID IN TERMS OF MONEY BUT IN THE ENJOYMENTS IT BUYS. THE DIVIDEND CHECK BECOMES INCOME IN THE ULTIMATE SENSE ONLY WHEN WE EAT THE FOOD, WEAR THE CLOTHES, OR RIDE IN THE AUTOMOBILE WHICH ARE BOUGHT WITH THE CHECK.

§2. OBJECTIVE, OR REAL, INCOME (OUR "LIVING")

ENJOYMENT INCOME IS A PSYCHOLOGICAL ENTITY AND CANNOT BE MEASURED DIRECTLY. WE CAN APPROXIMATE IT INDIRECTLY, HOWEVER, BY GOING ONE STEP BACK OF IT TO WHAT IS CALLED REAL INCOME. REAL WAGES, AND INDEED REAL INCOME IN GENERAL,CONSIST OF THOSE FINAL PHYSICAL EVENTS IN THE *OUTER* WORLD WHICH GIVE US OUR *INNER* ENJOYMENTS.

THIS REAL INCOME INCLUDES THE SHELTER OF A HOUSE, THE MUSIC OF A VICTROLA OR RADIO, THE USE OF CLOTHES, THE EATING OF FOOD, THE READING OF THE NEWSPAPER AND ALL THOSE OTHER INNUMERABLE EVENTS BY WHICH WE MAKE THE WORLD ABOUT US CONTRIBUTE TO OUR ENJOYMENTS. METAPHORICALLY WE SOMETIMES REFER TO THIS, OUR REAL INCOME, AS OUR "BREAD AND BUTTER."

THESE FINALS IN THE STREAM OF OUTER EVENTS ARE WHAT WE CALL OUR "LIVING," AS IMPLIED IN THE PHRASES COST OF LIVING AND EARNING A LIVING. THE FINAL OUTER EVENTS AND THE INNER EVENTS WHICH THEY ENTAIL RUN CLOSELY PARALLEL, OR, RATHER, THE INNER EVENTS GENERALLY FOLLOW CLOSELY IN TIME ON THE OUTER. THE ENJOYMENT OF MUSIC IS FELT ALMOST INSTANTANEOUSLY AS THE PIANO OR SINGER PRODUCES IT. THE ENJOYMENT OF FOOD IS EXPERIENCED WITH THE EATING OR SOON AFTER THE EATING.

THESE OUTER EVENTS, SUCH AS THE USE OF FOOD, OR CLOTHES, ETC., ARE LIKE THE RESULTANT INNER EVENTS IN NOT BEING VERY EASILY MEASURED. THEY OCCUR LARGELY IN THE PRIVACY OF THE HOME; THEY ARE OFTEN DIFFICULT TO EXPRESS IN ANY STANDARD UNITS. THEY HAVE NO COMMON DENOMINATOR. EVEN THE INDIVIDUAL WHO EXPERIENCES THEM CANNOT WEIGH AND MEASURE THEM DIRECTLY. ALL HE CAN DO IS TO MEASURE THE MONEY HE PAID TO GET THEM.

§3. COST OF LIVING, A MEASURE OF REAL INCOME

SO, JUST AS WE WENT BACK OF AN INDIVIDUAL'S ENJOYMENT INCOME TO HIS REAL INCOME, WE NOW GO BACK OF HIS REAL INCOME, OR HIS LIVING, TO HIS COST OF LIVING, THE MONEY MEASURE OF REAL INCOME. YOU CANNOT MEASURE IN DOLLARS EITHER THE INNER EVENT OF YOUR ENJOYMENT WHILE EATING YOUR DINNER OR THE OUTER EVENT OF EATING IT, BUT YOU CAN FIND OUT DEFINITELY HOW MUCH MONEY THAT DINNER COST YOU. IN THE SAME WAY, YOU CANNOT MEASURE YOUR ENJOYMENT AT MOVING PICTURE THEATER, BUT YOU DO KNOW WHAT YOU PAID FOR YOUR TICKET; YOU CANNOT MEASURE EXACTLY WHAT YOUR HOUSE SHELTER IS REALLY WORTH TO YOU, BUT YOU CAN TELL HOW MUCH YOU PAY FOR YOUR RENT, OR WHAT IS A FAIR EQUIVALENT FOR YOUR RENT IF YOU HAPPEN TO LIVE IN YOUR OWN HOUSE. YOU CANNOT MEASURE WHAT IT IS WORTH TO WEAR AN EVENING SUIT, BUT YOU CAN FIND OUT WHAT IT COSTS TO HIRE ONE, OR A FAIR EQUIVALENT OF ITS HIRE IF, PERCHANCE, THE SUIT BELONGS TO YOU. DEDUCING SUCH EQUIVALENTS IS AN ACCOUNTANT'S JOB.

THE TOTAL COST OF LIVING, IN THE SENSE OF MONEY PAYMENTS, IS A NEGATIVE ITEM, BEING OUTGO RATHER THAN INCOME; BUT IT IS OUR BEST PRACTICAL MEASURE OF THE POSITIVE ITEMS OF REAL INCOME FOR WHICH THOSE PAYMENTS ARE MADE. FOR FROM THIS TOTAL VALUATION OF POSITIVE REAL INCOME MAY BE SUBTRACTED THE TOTAL VALUATION OF THE PERSON'S LABOR PAIN DURING THE SAME PERIOD; IF WE WISH TO COMPARE A LABORER'S INCOME WITH THAT OF A MAN WHO DOES NO LABOR BUT LIVES ON HIS INCOME FROM CAPITAL (OTHER THAN HIMSELF), A "RENTIER."

ENJOYMENT INCOME, REAL INCOME, AND THE COST OF LIVING ARE MERELY THREE DIFFERENT STAGES OF INCOME. ALL THREE RUN CLOSELY PARALLEL TO EACH OTHER, ALTHOUGH THEY ARE NOT EXACTLY SYNCHRONOUS IN TIME. THESE DISCREPANCIES, AS HAS BEEN INTIMATED, ARE NEGLIGIBLE AS BETWEEN REAL AND ENJOYMENT INCOME. SO ALSO THE TIME ELAPSING BETWEEN THE COST OF LIVING AND THE LIVING IS USUALLY BRIEF. THERE IS A LITTLE DELAY BETWEEN THE SPENDING OF MONEY AT THE BOX OFFICE AND THE SEEING OF THE ENTERTAINMENT, OR BETWEEN PAYING BOARD OR RENT AND MAKING USE OF THE FOOD OR HOUSING FACILITIES. IN MANY CASES, THE MONEY PAYMENT FOLLOWS RATHER THAN PRECEDES THE ENJOYMENT.

§4. COST OF AN ARTICLE VS. COST OF ITS USE

THE ONLY TIME DISCREPANCY WORTH CAREFUL NOTING IS THAT WHICH OCCURS WHEN THE MONEY SPENT IS NOT SIMPLY FOR THE TEMPORARY USE OF SOME OBJECT BUT FOR THE WHOLE OBJECT, WHICH MEANS MERELY FOR ALL ITS POSSIBLE FUTURE USES. IF A HOUSE IS NOT RENTED BUT BOUGHT, WE DO NOT COUNT THE PURCHASE PRICE AS ALL SPENT FOR THIS YEAR'S SHELTER. WE EXPECT FROM IT MANY MORE YEARS OF USE. HENCE OUT OF THE ENTIRE PURCHASE PRICE, WE TRY TO COMPUTE A FAIR PORTION OF THE PURCHASE PRICE TO BE CHARGED UP TO THIS YEAR'S USE. IN LIKE MANNER, THE STATISTICIANS OF COST OF LIVING SHOULD DISTRIBUTE BY PERIODS THE COST OF USING A PERSON'S HOUSE FURNISHINGS, CLOTHING, MUSICAL INSTRUMENTS, AUTOMOBILES AND OTHER DURABLE GOODS, AND NOT CHARGE THE ENTIRE COST AGAINST THE INCOME OF THE YEAR OF PURCHASE. TO ANY GIVEN YEAR SHOULD BE CHARGED ONLY THAT YEAR'S UPKEEP AND REPLACEMENT, WHICH MEASURES, AT LEAST ROUGHLY, THE SERVICES RENDERED BY THE GOODS IN QUESTION DURING THAT PARTICULAR YEAR. THE TRUE REAL ANNUAL INCOME FROM SUCH GOODS IS THE EQUIVALENT APPROXIMATELY OF THE COST OF THE SERVICES GIVEN OFF BY THOSE GOODS EACH YEAR.

STRICTLY SPEAKING, THEN, IN MAKING UP OUR INCOME STATISTICS, WE SHOULD ALWAYS CALCULATE THE VALUE OF *SERVICES*, AND NEVER THE VALUE OF THE OBJECTS RENDERING THOSE SERVICES IT IS TRUE THAT, IN THE CASE OF SHORT-LIVED OBJECTS LIKE FOOD, WE DO NOT ORDINARILY NEED, IN PRACTICE, TO GO TO THE TROUBLE OF DISTINGUISHING THEIR TOTAL COST FROM THE COST OF THEIR USE. A LOAF OF BREAD IS WORTH TEN CENTS BECAUSE ITS USE IS WORTH TEN CENTS. WE CANNOT RENT FOOD; WE CAN ONLY BUY IT OUTRIGHT. YET THERE IS SOME DISCREPANCY IN TIME IN THE CASE OF FOODS THAT KEEP, SUCH AS FLOUR, PRESERVED FOODS AND CANNED GOODS. THESE WE MAY BUY IN ONE YEAR BUT NOT USE UNTIL A LATER YEAR, AND IN SUCH CASES THE MONEY GIVEN FOR THE FOOD MIGHT ALMOST BE SAID TO BE INVESTED RATHER THAN SPENT, LIKE THE MONEY GIVEN FOR A HOUSE. A MAN WHO BUYS A BASKET OF FRUIT AND EATS IT WITHIN AN HOUR IS

CERTAINLY SPENDING HIS MONEY FOR THE ENJOYMENT OF EATING THE FRUIT. BUT, IF HE BUYS A BARREL OF APPLES IN THE FALL TO BE EATEN DURING THE WINTER, IS HE SPENDING HIS MONEY OR IS HE INVESTING IT FOR A DEFERRED ENJOYMENT? THEORETICALLY, THE BARREL OF APPLES IS AN INVESTMENT COMPARABLE TO A HOUSE OR ANY OTHER DURABLE GOOD. PRACTICALLY IT IS CLASSED AS EXPENDITURE, ALTHOUGH IT IS A BORDER-LINE CASE.

SPENDING AND INVESTING DIFFER ONLY IN DEGREE, DEPENDING ON THE LENGTH OF TIME ELAPSING BETWEEN THE EXPENDITURE AND THE ENJOYMENT. TO SPEND IS TO PAY MONEY FOR ENJOYMENTS WHICH COME VERY SOON. TO INVEST IS TO PAY MONEY FOR ENJOYMENTS WHICH ARE DEFERRED TO A LATER TIME. WE SPEND MONEY FOR OUR DAILY BREAD AND BUTTER OR FOR A SEAT AT THE THEATER, BUT WE INVEST MONEY IN THE PURCHASE OF BONDS, FARMS, DWELLINGS, OR AUTOMOBILES, OR EVEN OF SUITS OF CLOTHES.

§5. MEASURING AT THE DOMESTIC THRESHOLD

IN PRACTICE, WE CAN ESTIMATE WITH FAIR ACCURACY IN ALL ORDINARY CASES HOW MUCH OF WHAT WE PAY IS FOR THIS YEAR'S USE. THAT IS TO SAY, WE CAN FIND OUT PRETTY NEARLY OUR COST OF LIVING FOR THE YEAR. WE NEED ONLY RECKON WHAT IS SPENT ON PERSONAL ARTICLES AND SERVICES—ON EVERYTHING WHICH ENTERS OUR DWELLINGS (OR ENTERS US), FOOD, DRINK, CLOTHES, FURNITURE, HOUSEHOLD RENT, FUEL AND LIGHT, AMUSEMENTS, AND SO ON, OUR "BREAD AND BUTTER"—EXCLUSIVE OF WHAT IS LEFT OVER FOR FUTURE YEARS, SUCH AS WHAT WE PAY FOR SECURITIES, MACHINERY, OR REAL ESTATE, OR WHAT WE PUT INTO THE SAVINGS BANK. THE DOMESTIC THRESHOLD IS, IN GENERAL, A PRETTY GOOD LINE OF DIVISION. THE COST OF ALMOST EVERY OBJECT WHICH CROSSES IT MEASURES A PORTION OF OUR REAL INCOME, AND FEW OTHER EXPENDITURES DO.

THUS, AT THE END OF PRODUCTION ECONOMICS, OR BUSINESS ECONOMICS, WE FIND HOME ECONOMICS IT IS THE HOUSEKEEPER, THE WOMAN WHO SPENDS, WHO TAKES THE FINAL STEPS THROUGH THE COST OF LIVING TOWARD GETTING THE REAL INCOME OF THE FAMILY, SO THAT THE FAMILY'S ENJOYMENT INCOME MAY FOLLOW.

§6. MONEY INCOME

WE HAVE JUST BEEN DEALING WITH MONEY PAYMENTS FOR CONSUMPTION GOODS, OR MONEY *OUTGO*. WE MAY NOW GO BACK ONE FURTHER STEP TO MONEY RECEIVED BY THE INDIVIDUAL SPENDER, OR MONEY INCOME. MONEY INCOME INCLUDES ALL MONEY *RECEIVED* WHICH IS NOT OBVIOUSLY, AND IN THE NATURE OF THE CASE, TO BE DEVOTED TO REINVESTMENT—OR, AS THE EXPRESSION IS, "EARMARKED" FOR REINVESTMENT. IN OTHER WORDS, ALL MONEY RECEIVED AND READILY AVAILABLE AND INTENDED TO BE USED FOR SPENDING IS MONEY INCOME. IT SOMETIMES DIFFERS FROM REAL INCOME CONSIDERABLY. FOR INSTANCE, IF YOU MORE THAN "EARN YOUR LIVING" OF $6,000 WITH A SALARY OF $10,000, YOU VOLUNTARILY PUT BY THE $4,000 REMAINING AS SAVINGS. THIS PART OF YOUR MONEY INCOME IS SAVED FROM BEING TURNED IMMEDIATELY INTO REAL INCOME. THAT IS, INSTEAD OF SPENDING ALL YOUR SALARY FOR THIS YEAR'S LIVING YOU INVEST $4,000 OF IT TO HELP TOWARD THE COST OF LIVING OF FUTURE YEARS. AND SO, THE $4,000 IS NOT ONLY CREDITED AS INCOME BUT DEBITED AS OUTGO. WITH IT YOU BUY DURABLE OBJECTS SUCH AS LAND OR BUILDINGS, OR PART RIGHTS IN THESE, SUCH AS STOCKS OR BONDS. YOUR MONEY INCOME IS IN THIS CASE YOUR SALARY (OR IT MAY BE DIVIDENDS, RENT, INTEREST, OR PROFITS) AND IT EXCEEDS REAL INCOME BY THE AMOUNT OF YOUR SAVINGS. ON THE OTHER HAND, YOU MAY BE LIVING BEYOND YOUR (MONEY) INCOME. THIS MEANS, EXPRESSED IN TERMS OF THE CONCEPTS HERE USED, THAT YOUR REAL INCOME FOR THE YEAR IS GREATER THAN YOUR MONEY INCOME.

THAT ALL ONE SPENDS ON HIS LIVING MEASURES REAL INCOME, EVEN WHEN HE "LIVES BEYOND HIS INCOME" (BEYOND HIS *MONEY* INCOME), MAY BE A HARD SAYING TO SOME WHO HAVE NEVER ATTEMPTED TO WORK OUT CONSISTENT DEFINITIONS OF ECONOMIC CONCEPTS WHICH WILL NOT ONLY SATISFY THE REQUIREMENTS OF ECONOMIC THEORY BUT WHICH WILL ALSO BRING THESE ECONOMIC CONCEPTS INTO CONFORMITY WITH THE THEORY AND PRACTICE OF ACCOUNTANCY. BUT A DEFINITION OF INCOME WHICH SATISFIES BOTH THEORY AND PRACTICE, IN BOTH ECONOMICS AND ACCOUNTANCY, *MUST* RECKON AS INCOME IN THE MOST BASIC SENSE ALL THOSE USES, SERVICES, OR LIVING FOR WHICH THE COST OF LIVING IS EXPENDED EVEN THOUGH SUCH EXPENDITURE MAY EXCEED THE MONEY INCOME.

THUS WE HAVE A PICTURE OF THREE SUCCESSIVE STAGES, OR ASPECTS, OF A MAN'S INCOME:

ENJOYMENT OR PSYCHIC INCOME, CONSISTING OF AGREEABLE SENSATIONS AND EXPERIENCES;

REAL INCOME *MEASURED* BY THE COST OF LIVING;

MONEY INCOME, CONSISTING OF THE MONEY RECEIVED BY A MAN FOR MEETING HIS COSTS OF LIVING;

THE LAST—MONEY INCOME—IS MOST COMMONLY CALLED INCOME; AND THE FIRST—ENJOYMENT INCOME—IS THE MOST FUNDAMENTAL. BUT, FOR ACCOUNTING PURPOSES, REAL INCOME, AS MEASURED BY THE COST OF LIVING, IS THE MOST PRACTICAL.[3]

TO RECAPITULATE, WE HAVE SEEN THAT THE ENJOYMENT INCOME IS A PSYCHOLOGICAL MATTER, AND HENCE CANNOT BE MEASURED DIRECTLY. SO WE LOOK TO REAL INCOME INSTEAD; BUT EVEN REAL INCOME IS A HETEROGENEOUS JUMBLE. IT INCLUDES QUARTS OF MILK, VISITS TO THE MOVING PICTURE HOUSE, ETC., AND IN THAT FORM CANNOT BE MEASURED EASILY OR AS A WHOLE. HERE IS WHERE THE COST OF LIVING COMES IN. IT IS THE PRACTICAL, HOMOGENEOUS[4] MEASURE OF REAL INCOME. AS THE COST OF LIVING IS EXPRESSED IN TERMS OF DOLLARS IT MAY, THEREFORE, BE TAKEN AS OUR BEST MEASURE OF INCOME *IN PLACE* OF ENJOYMENT INCOME, OR REAL INCOME. BETWEEN IT AND REAL INCOME THERE ARE NO IMPORTANT DISCREPANCIES AS THERE ARE BETWEEN MONEY INCOME AND REAL INCOME. MONEY INCOME PRACTICALLY NEVER CONFORMS EXACTLY TO REAL INCOME BECAUSE EITHER SAVINGS RAISE MONEY INCOME ABOVE REAL INCOME, OR DEFICITS PUSH MONEY INCOME BELOW REAL INCOME.

§7. CAPITAL VALUE

SAVINGS BRING US TO THE NATURE OF CAPITAL. CAPITAL, IN THE SENSE OF CAPITAL *VALUE*, IS SIMPLY FUTURE INCOME DISCOUNTED OR, IN OTHER WORDS, CAPITALIZED. THE VALUE OF ANY PROPERTY, OR RIGHTS TO WEALTH, IS ITS VALUE *AS A SOURCE OF INCOME* AND IS FOUND BY

DISCOUNTING THAT EXPECTED INCOME. WE MAY, IF WE SO CHOOSE, FOR LOGICAL CONVENIENCE, INCLUDE AS PROPERTY THE OWNERSHIP IN OURSELVES, OR WE MAY, CONFORMABLY TO CUSTOM, REGARD HUMAN BEINGS AS IN A SEPARATE CATEGORY.

I DEFINE WEALTH AS CONSISTING OF MATERIAL OBJECTS OWNED BY HUMAN BEINGS (INCLUDING, IF YOU PLEASE, HUMAN BEINGS THEMSELVES). THE OWNERSHIP MAY BE DIVIDED AND PARCELLED OUT AMONG DIFFERENT INDIVIDUALS IN THE FORM OF PARTNERSHIP RIGHTS, SHARES OF STOCK, BONDS, MORTGAGES, AND OTHER FORMS OF PROPERTY RIGHTS. IN WHATEVER WAYS THE OWNERSHIP BE DISTRIBUTED AND SYMBOLIZED IN DOCUMENTS, THE ENTIRE GROUP OF PROPERTY RIGHTS ARE MERELY MEANS TO AN END—INCOME. INCOME IS THE ALPHA AND OMEGA OF ECONOMICS.

§8. THE RATE OF INTEREST

THE BRIDGE OR LINK BETWEEN INCOME AND CAPITAL IS THE *RATE OF INTEREST*. WE MAY DEFINE THE *RATE OF INTEREST AS THE PER CENT OF PREMIUM* PAID ON MONEY AT ONE DATE IN TERMS OF MONEY TO BE IN HAND ONE YEAR LATER. THEORETICALLY, OF COURSE, WE MAY SUBSTITUTE FOR MONEY IN THIS STATEMENT WHEAT OR ANY OTHER SORT OF GOODS. THIS WILL BE DISCUSSED IN CHAPTER II. BUT PRACTICALLY, IT IS ONLY MONEY WHICH IS TRADED AS BETWEEN PRESENT AND FUTURE. HENCE, THE RATE OF INTEREST IS SOMETIMES CALLED THE PRICE OF MONEY; AND THE MARKET IN WHICH PRESENT AND FUTURE MONEY ARE TRADED FOR THAT PRICE, OR PREMIUM, IS CALLED THE MONEY MARKET. IF $100 TODAY WILL EXCHANGE FOR $105 TO BE RECEIVED ONE YEAR HENCE, THE PREMIUM ON PRESENT MONEY IN TERMS OF FUTURE MONEY IS $5 AND THIS, AS A PERCENTAGE OF THE $100, OR THE RATE OF INTEREST, IS FIVE PER CENT. THAT IS TO SAY, THE PRICE OF TODAY'S MONEY IN TERMS OF NEXT YEAR'S MONEY IS FIVE PER CENT ABOVE PAR. IT SHOULD ALWAYS BE REMEMBERED *THAT INTEREST AND THE RATE OF INTEREST ARE NOT IDENTICAL*. INTEREST IS COMPUTED BY MULTIPLYING CAPITAL VALUE BY THE RATE OF INTEREST.

THE AIM OF THIS BOOK IS TO SHOW HOW THE RATE OF INTEREST IS CAUSED OR DETERMINED. SOME WRITERS HAVE CHOSEN, FOR PURPOSES OF EXPOSITION, TO POSTULATE TWO QUESTIONS INVOLVED IN THE THEORY OF THE RATE OF INTEREST, VIZ., (1) WHY ANY RATE OF INTEREST EXISTS AND (2) HOW THE RATE OF INTEREST IS DETERMINED. THIS SECOND QUESTION, HOWEVER, EMBRACES ALSO THE FIRST, SINCE TO EXPLAIN HOW THE RATE OF INTEREST IS DETERMINED INVOLVES THE QUESTION OF WHETHER THE RATE CAN OR CANNOT BE ZERO, I.E., WHETHER A POSITIVE RATE OF INTEREST MUST NECESSARILY EXIST.

§9. DISCOUNTING IS FUNDAMENTAL

BUT ALTHOUGH THE RATE OF INTEREST MAY BE USED EITHER WAY—FOR COMPUTING FROM PRESENT TO FUTURE VALUES, OR FROM FUTURE TO PRESENT VALUES—THE LATTER PROCESS (DISCOUNTING) IS BY FAR THE MORE IMPORTANT OF THE TWO. ACCOUNTANTS, OF COURSE, ARE CONSTANTLY COMPUTING IN BOTH DIRECTIONS; FOR THEY HAVE TO DEAL WITH BOTH SETS OF PROBLEMS. BUT THE BASIC PROBLEM OF TIME VALUATION WHICH NATURE SETS US IS ALWAYS THAT OF TRANSLATING THE FUTURE INTO THE PRESENT, THAT IS, THE PROBLEM OF ASCERTAINING THE CAPITAL VALUE OF FUTURE INCOME. THE VALUE OF CAPITAL MUST BE COMPUTED FROM THE VALUE OF ITS ESTIMATED FUTURE NET INCOME, NOT *VICE VERSA*.

THIS STATEMENT MAY AT FIRST SEEM PUZZLING, FOR WE USUALLY THINK OF CAUSES AND EFFECTS AS RUNNING FORWARD NOT BACKWARD IN TIME. IT WOULD SEEM THEN THAT INCOME MUST BE DERIVED FROM CAPITAL; AND, IN A SENSE, THIS IS TRUE. INCOME *IS* DERIVED FROM CAPITAL *GOODS*. BUT THE *VALUE* OF THE INCOME IS NOT DERIVED FROM THE *VALUE* OF THE CAPITAL GOODS. ON THE CONTRARY, THE VALUE OF THE CAPITAL IS DERIVED FROM THE VALUE OF THE INCOME. VALUATION IS A HUMAN PROCESS IN WHICH FORESIGHT ENTERS. COMING EVENTS CAST THEIR SHADOWS BEFORE. OUR VALUATIONS ARE ALWAYS ANTICIPATIONS.

THESE RELATIONS ARE SHOWN IN THE FOLLOWING SCHEME IN WHICH THE ARROWS REPRESENT THE ORDER OF SEQUENCE—(1) FROM CAPITAL GOODS TO THEIR FUTURE SERVICES, THAT IS, INCOME; (2) FROM THESE SERVICES TO THEIR VALUE; AND (3) FROM THEIR VALUE BACK TO CAPITAL VALUE:

Capital goods → Flow of services (income)
↓
Capital value ← Income value

NOT UNTIL WE KNOW HOW MUCH INCOME AN ITEM OF CAPITAL WILL PROBABLY BRING US CAN WE SET ANY VALUATION ON THAT CAPITAL AT ALL. IT IS TRUE THAT THE WHEAT CROP DEPENDS ON THE LAND WHICH YIELDS IT. BUT THE VALUE OF THE CROP DOES NOT DEPEND ON THE VALUE OF THE LAND. ON THE CONTRARY, THE VALUE OF THE LAND DEPENDS ON THE EXPECTED VALUE OF ITS CROPS.

THE PRESENT WORTH OF ANY ARTICLE IS WHAT BUYERS ARE WILLING TO GIVE FOR IT AND SELLERS ARE READY TO TAKE FOR IT. IN ORDER THAT EACH MAN MAY LOGICALLY DECIDE WHAT HE IS WILLING TO GIVE OR TAKE, HE MUST HAVE: (1) SOME IDEA OF THE VALUE OF THE FUTURE BENEFITS WHICH THAT ARTICLE WILL YIELD, AND (2) SOME IDEA OF THE RATE OF INTEREST BY WHICH THESE FUTURE VALUES MAY BE TRANSLATED INTO PRESENT VALUES BY DISCOUNTING.

§10. COSTS, OR NEGATIVE INCOME

COST OF PRODUCTION OF DURABLE AGENTS OR CAPITAL GOODS HAS ITS INFLUENCE INCLUDED IN THE PRECEDING FORMULATION, SINCE ANY COST IS SIMPLY A NEGATIVE ITEM OF INCOME. FUTURE NEGATIVE ITEMS ARE TO BE DISCOUNTED EXACTLY AS FUTURE POSITIVE ITEMS. IT IS TO BE REMEMBERED THAT AT THE GIVEN POINT OF TIME WHEN THE VALUE IS BEING COMPUTED ONLY *FUTURE* COSTS CAN ENTER INTO THE VALUATION OF ANY GOOD. PAST COSTS HAVE NO *DIRECT* INFLUENCE ON VALUE. ONLY INDIRECTLY DO THEY ENTER TO THE EXTENT THAT THEY HAVE DETERMINED THE EXISTING SUPPLY OF GOODS AND HAVE THUS EITHER RAISED OR LOWERED THE VALUE OF THE SERVICES OF THESE GOODS.

IN THIS INDIRECT WAY, PAST COSTS CAN DETERMINE PRESENT VALUES TEMPORARILY AND UNTIL THE PRICES OF GOODS AVAILABLE ARE BROUGHT INTO CONFORMITY WITH THE PRESENT COSTS OF PRODUCTION THROUGH THE OPERATION OF SUPPLY AND DEMAND. FOR EXAMPLE,

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JOHN BURR WILLIAMS

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CHAPTER V

EVALUATION BY THE RULE OF PRESENT WORTH

I. FUTURE DIVIDENDS, COUPONS, AND PRINCIPAL

Now that we have disposed of the troublesome misconception that stock prices are somehow determined in accordance with a quantity theory of money, we are at last ready to take up the main thesis of this book.

Let us define the investment value of a stock as the present worth of all the dividends[1] to be paid upon it. Likewise let us define the investment value of a bond as the present worth of its future coupons and principal. In both cases, dividends, or coupons and principal, must be adjusted for expected changes in the purchasing power of money. The purchase of a stock or bond, like other transactions which give rise to the phenomenon of interest, represents the exchange of present goods for future goods — dividends, or coupons and principal, in this case being the claim on future goods. To appraise the investment value, then, it is necessary to estimate the future payments. The annuity of payments, adjusted for changes in the value of money itself, may then be discounted at the pure interest rate demanded by the investor. This definition of investment value can be expressed by the following equations:[2]

[1] Cf. Robert F. Wiese, "Investing for True Values," *Barron's*, September 8, 1930, p. 5: "*The proper price of any security, whether a stock or bond, is the sum of all future income payments discounted at the current rate of interest in order to arrive at the present value.*" See also Chapter I, § 2.

[2] *Note for the non-technical reader:* It is not necessary to master all of the algebra in the following chapters to understand the rest of this book, for the text between the equations has been so written as to summarize the argument and make it possible to take the derivation of the formulas for granted. The symbols used in the formulas are defined one by one when first introduced, but for

For stocks —

$$V_o = \sum_{t=1}^{t=\infty} \pi_t v^t = \pi_1 v + \pi_2 v^2 + \pi_3 v^3 + \cdots \qquad \text{(1a)}$$

where V_o = investment value at start

π_t = dividend in year t

$$v = \frac{1}{1+i}, \text{ by definition} \qquad \text{(2)}$$

i = interest rate sought by the investor

For bonds —

$$V_o = \sum_{t=1}^{t=n} \pi_t v^t + Cv^n \qquad \text{(1b)}$$

where π_t = coupon in year t

C = face value, or principal, of bond

n = number of years to maturity

---

easy reference they are reprinted with explanations in a systematic "Table of Symbols" at the end of the book.

The subscripts 1, 2, 3, etc., attached to the Greek letter π in the equations below signify the first, second, third, etc., value of the variable π. Thus π_1 is the amount of the dividend in the first year, π_2 in the second year, π_3 in the third, etc., and π_t in the tth year, where t means time.

The series of terms $\pi_1 v + \pi_2 v^2 + \pi_3 v^3 + \cdots$ is called an infinite series because there is no end to the number of terms. In this particular series each term is constructed according to the rule that the exponent of the factor v shall be the same as the subscript of the factor π, thus $\pi_3 v^3$, $\pi_t v^t$, etc. In certain special cases the sum of all the terms in an infinite series is a finite number and not infinity, even though the number of terms is infinite; under these circumstances, the series is said to be convergent. Suffice it to say that a series will often be convergent if each additional term is smaller than the preceding one; any further discussion of convergency would take us too far into higher mathematics.

Two ways of denoting an infinite series are as follows:

$$\pi_1 v + \pi_2 v^2 + \pi_3 v^3 + \cdots\cdots$$

and

$$\sum_{t=1}^{t=\infty} \pi_t v^t$$

The second notation, using the Greek letter Σ, means exactly the same as the first, but is briefer. This notation is read "Summation from t equals one to

The way in which dividends, or coupons and principal, should be adjusted for changes in the value of money in future years will be discussed later.[3]

2. FUTURE EARNINGS OF STOCKS

Most people will object at once to the foregoing formula for stocks by saying that it should use the present worth of future *earnings*, not future *dividends*.[4] But should not earnings and dividends both give the same answer under the implicit assumptions of our critics? If earnings not paid out in dividends are all successfully reinvested at compound interest for the benefit of the stockholder, as the critics imply, then these earnings should produce dividends later; if not, then they are money lost. Furthermore, if these reinvested earnings will produce dividends, then our formula will take account of them when it takes account of all future dividends; but if they will not, then our formula will rightly refrain from including them in any discounted annuity of benefits. (2)

Earnings are only a means to an end, and the means should not be mistaken for the end. Therefore we must say that a stock derives its value from its dividends, not its earnings. In short, a stock is worth only *what you can get out of it*. Even so spoke the old farmer to his son:

---

t equals infinity, of *pi* sub t, times v to the tth power." It should be noted that $\sum_{t=1}^{t=\infty}$ is not a factor to be multiplied by the other factors π_t and v^t, but is an operational sign applied to these two factors taken together.

If the series runs from $t=1$ to $t=n$, as in formula (1b) applying to bonds, the series is a finite series instead of an infinite series, because the number of terms is limited and is given in this case by the number of coupons payable during the life of the bond.

A series of the kind under discussion here, whether finite or infinite, is known as a geometric progression if π_t is constant.

[3] See Chapter VIII, § 2, and Chapter IX.

[4] See also Chapter XXII, "U. S. Steel," especially § 13.

A cow for her milk,
A hen for her eggs,
And a stock, by heck,
For her dividends.

An orchard for fruit
Bees for their honey,
And stocks, besides,
For their dividends.

The old man knew where milk and honey came from, but he made no such mistake as to tell his son to buy a cow for her cud or bees for their buzz.

In saying that dividends, not earnings, determine value, we seem to be reversing the usual rule that is drilled into every beginner's head when he starts to trade in the market; namely, that earnings, not dividends, make prices. The apparent contradiction is easily explained, however, for we are discussing permanent investment, not speculative trading, and dividends for years to come, not income for the moment only. Of course it is true that low earnings together with a high dividend for the time being should be looked at askance, but likewise it is true that these low earnings mean low dividends *in the long run*. On analysis, therefore, it will be seen that no contradiction really exists between our formula using dividends and the common precept regarding earnings.

How to estimate the future dividends for use in our formula is, of course, the difficulty. In later chapters ways of making an estimate will be given for such stocks as we now know how to deal with. In so doing, this book seeks to make its most important contribution to Investment Analysis.

3. PERSONAL VS. MARKET RATE OF INTEREST

In applying the foregoing formulas, each investor should use his own personal rate of interest. If one investor de-

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CAPITAL EQUIPMENT ANALYSIS: THE REQUIRED RATE OF PROFIT

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The interest in capital equipment analysis that has been evident in the business literature of the past five years is the product of numerous social, economic, and business developments of the postwar period. No conclusive listing of these developments can be attempted here. However, four should be mentioned which are of particular importance in this search for a more systematic method for discovering, evaluating, and selecting investment opportunities. These are: (1) the high level of capital outlays (in absolute terms); (2) the growth in the size of business firms; (3) the delegation of responsibility for initiating recommendations from top management to the profit center, which has been part of the general movement toward decentralization; and (4) the growing use of "scientific management" in the operations of the business firm.

These developments have motivated the current attempt to develop objective criteria whereby the executive committee in a decentralized firm can arrive at a capital budget. Since each of its profit centers submits capital proposals, the executive committee must screen these and establish an allocation and a level of capital outlays that is consistent with top management's criteria for rationing the firm's funds. Capital budgeting affords the promise that this screening process can be made amenable to some established criteria that are understandable to all the component parts of the firm. Consequently, capital budgeting appeals to top management, for, in the first place, each plant manager can see his proposal in the light of all competing proposals for the funds of the enterprise. This may not completely eliminate irritation among the various parts of the firm, but a rational capital budgeting program can go a long way toward maintaining initiative on the part of a plant manager, even though the executive committee may veto one or all of his proposals. In the second place, the use of a capital budgeting program serves to satisfy top management that each accepted proposal meets adequate predetermined standards and that the budget as a whole is part of a sound, long-run plan for the firm.

What specifically does a capital budgeting program entail? The focal points of capital budgeting are: (1) ascertaining the profit abilities of the array of capital outlay alternatives, and (2) determining the least profitability required to make an investment, i.e., a cut-off point. Capital budgeting also involves administrative procedures and organization designed to discover investment opportunities, process information, and carry out the budget; however, these latter aspects of the subject have been discussed in detail by means of case studies that have appeared in publications of the American Management Association and the

National Industrial Conference Board and in periodicals such as the *N.A.C.A. Bulletin*.[1] Hence, we will not concern ourselves with them here.

There are at least four methods for establishing an order-preference array of the capital expenditure suggestions. They are: (1) the still popular "payoff period"; (2) the average investment formula; (3) the present value formula with the rate of interest given; and (4) the present value formula used to find the rate of profit. It is not our intention in this paper to discuss these various methods specifically, since critical analyses of these alternatives are to be found in papers by Dean, by Lorie and Savage, and by Gordon in a recent issue of the *Journal of Business*,[2] which is devoted exclusively to the subject of capital budgeting.

However, it is of interest to note that in each of these methods the future revenue streams generated by the proposed outlays must be amenable to measurement if the method is to be operational. However, improvements in quality, more pleasant working conditions, strategic advantages of integration, and other types of benefits from a capital outlay are still recognized only in qualitative terms, and there is a considerable hiatus in the literature of capital budgeting with respect to the solution of this problem. Hence, in the absence of satisfactory methods for quantifying these types of benefits, the evaluation of alternative proposals is still characterized by intuitive judgments on the part of management, and a general quantitative solution to the capital budgeting problem is not now feasible. It appears to us that this problem affords one of the most promising opportunities for the application of the methods of management science. In fact, we anticipate that techniques for the quantification of the more important factors now treated qualitatively will soon be found.

Given the rate of profit on each capital outlay proposal, the size of the budget and its allocation are automatically determined with the establishment of the rate of profit required for the inclusion of a proposal in the budget. In the balance of this paper, a method for determining this quantity is proposed and its use in capital budgeting is analyzed.

II

We state that the objective of a firm is the maximization of the value of the stockholders' equity. While there may be legitimate differences of opinion as to whether this is the sole motivation of management, we certainly feel that there can be no quarrel with the statement that it is a dominant variable in manage-

[1] American Management Association, *Tested Approaches to Capital Equipment Replacement*, Special Report No. 1, 1954; American Management Association, *Capital Equipment Replacement*; *AMA Special Conference*, May 3–4, 1954 (New York, 1954, American Management Association, 105 pp.); J. H. Watson, III, National Industrial Conference Board, *Controlling Capital Expenditures*, Studies in Business Policy, No. 62, April, 1953; C. I. Fellers, "Problems of Capital Expenditure Budgeting", *N.A.C.A. Bulletin*, 26 (May, 1955), 918–24; E. N. Martin, "Equipment Replacement Policy and Application", *N.A.C.A. Bulletin*, 35 (February, 1954), 715–30.

[2] *Journal of Business*, Vol. XXVIII, No. 3 (October, 1955).

ment's decisions. It has been shown by Lutz and Lutz in their *Theory of the Investment of the Firm*[3] and by others[4] that this objective is realized in capital budgeting when the budget is set so as to equate the marginal return on investment with the rate of return at which the corporation's stock is selling in the market. The logic and operation of this criterion will be discussed later. Now, we only wish to note the role assigned in capital budgeting to the rate of profit that is required by the market.

At the present time, the dividend yield (the current dividend divided by the price) and the earnings yield (the current income per share divided by the price) are used to measure the rate of profit at which a share is selling. However, both these yields fail to recognize that a share's payments can be expected to grow, and the earnings yield fails to recognize that the corporation's earnings per share are not the payments made to the stockholder.

The practical significance of these failures is evidenced by the qualifications with which these two rate-of-profit measures are used by investment analysts. In the comparative analysis of common stocks for the purpose of arriving at buy or sell recommendations, the conclusions indicated by the dividend and/or the earnings yield are invariably qualified by the presence or absence of the prospect of growth. If it is necessary to qualify a share's yield as a measure of the rate of profit one might expect to earn by buying the share, then it must follow that current yield, whether income or dividend, is inadequate for the purposes of capital budgeting, which is also concerned with the future. In short, it appears to us that the prospective growth in a share's revenue stream should be reflected in a measure of the rate of profit at which the share is selling. Otherwise, its usefulness as the required rate of profit in capital budgeting is questionable.

In his *Theory of Investment Value*[5], a classic on the subject, J. B. Williams tackled this problem of growth. However, the models he developed were arbitrary and complicated so that the problem of growth remained among the phenomena dealt with qualitatively. It is our belief that the following proposal for a definition of the rate of profit that takes cognizance of prospective growth has merit.

The accepted definition of the rate of profit on an asset is the rate of discount that equates the asset's expected future payments with its price. Let P_0 = a share's price at $t = 0$, let D_t = the dividend expected at time t, and let k = the rate of profit. Then, the rate of profit on a share of stock is the value of k that satisfies

$$P_0 = \sum_{t=1}^{\infty} \frac{D_t}{(1+k)^t}. \tag{1}$$

[3] Friedrich and Vera Lutz, *The Theory of Investment of the Firm* (Princeton, N. J., 1951, Princeton University Press, 253 pp.), 41–43.

[4] Joel Dean, *Capital Budgeting: Top Management Policy on Plant, Equipment, and Product Development* (New York, 1951, Columbia University Press, 174 pp.); Roland P. Soule, "Trends in the Cost of Capital", *Harvard Business Review*, 31 (March, April, 1953), 33–47.

[5] J. B. Williams, *The Theory of Investment Value*, (Cambridge, Massachusetts, 1938, Harvard University Press), 87–96.

It is mathematically convenient to assume that the dividend is paid and discounted continuously at the annual rates D_t and k, in which case

$$P_0 = \int_0^\infty D_t e^{-kt}\, dt. \tag{2}$$

Since P_0 is known, estimating the rate of profit at which a share of stock is selling requires the determination of D_t, $t = 1, 2, \cdots, \infty$.

At the outset it should be made clear that our objective is not to find the rate of profit that *will actually be earned* by buying a share of stock. This requires knowledge of the dividends that will be paid in the future, the price at which the share will be sold, and when it will be sold. Unfortunately, such information is not available to us. The rate of profit of interest here is a relation between the present known price and the *expected future dividends*. The latter will vary among individuals with the information they have on a host of variables and with their personality. Therefore, by expected future dividends we mean an estimate that (1) is derivable from known data in an objective manner, (2) is derived by methods that appear reasonable, i.e., not in conflict with common sense knowledge of corporation financial behavior, and (3) can be used to arrive at a manageable measure of the rate of profit implicit in the expectation.

We arrive at D_t by means of two assumptions. One, a corporation is expected to retain a fraction b of its income after taxes; and two, a corporation is expected to earn a return of r on the book value of its common equity. Let Y_t equal a corporation's income per share of common after taxes at time t. Then the expected dividend at time t is

$$D_t = (1 - b)Y_t \tag{3}$$

The income per share at time t is the income at $(t - 1)$ plus r percent of the income at $(t - 1)$ retained, or

$$Y_t = Y_{t-1} + rbY_{t-1} \tag{4}$$

Equation (4) is simply a compound interest expression so that, if Y_t grows continuously at the rate $g = br$,

$$Y_t = Y_0 e^{gt}. \tag{5}$$

From Equations (3) and (5)

$$D_t = D_0 e^{gt}. \tag{6}$$

Substituting this expression for D_t in Equation (2) and integrating, yields

$$\begin{aligned} P_0 &= \int_0^\infty D_0 e^{gt} e^{-kt}\, dt \\ &= D_0 \int_0^\infty e^{-t(k-g)}\, dt \qquad (7) \\ &= \frac{D_0}{k - g}. \end{aligned}$$

The condition for a solution is $k > g$, a condition that is easily satisfied, for otherwise, P_0 would be infinite or negative.

Solving Equation (7) for k we find that

$$k = \frac{D_0}{P_0} + g. \tag{8}$$

Translated, this means that the rate of profit at which a share of common stock is selling is equal to the current dividend, divided by the current price (the dividend yield), plus the rate at which the dividend is expected to grow. Since there are other possible empirical definitions of the market rate of profit on a share of stock, we will refer to k as the growth rate of profit.

III

Let us now review and evaluate the rationale of the model we have just established. Estimating the rate of profit on a share of stock involves estimating the future dividend stream that it provides, and the fundamental difference between this model and the dividend yield is the assumption of growth. The latter, as can be seen, assumes that the dividend will remain constant. Since growth is generally recognized as a factor in the value of a share and since it is used to explain differences in dividend yield among shares, its explicit recognition appears desirable. Future dividends are uncertain, but the problem cannot be avoided by ignoring it. To assume a constant rate of growth and estimate it to be equal to the current rate appears to be a better alternative.

Under this model the dividend will grow at the rate br, which is the product of the fraction of income retained and the rate of return earned on net worth. It is mathematically true that the dividend will grow at this rate if the corporation retains b and earns r. While we can be most certain that the dividend will not grow uniformly and continuously at some rate, unless we believe that an alternative method for estimating the future dividend stream is superior, the restriction of the model to the assumption that it will grow uniformly at some rate is no handicap. Furthermore, the future is discounted; hence, an error in the estimated dividend for a year in the distant future results in a considerably smaller error in k than an error in estimating the dividend in a near year.

It should be noted that this measure of the rate of profit is suspect, when *both* income and dividend are zero, and it may also be questioned when either falls to very low (or negative) values. In such cases, the model yields a lower rate of profit than one might believe that the market requires on a corporation in such difficulties. It is evident that the dividend and the income yields are even more suspect under these conditions and, hence, are subject to the same limitations.

There are other approaches to the estimation of future dividends than the extrapolation of the current dividend on the basis of the growth rate implicit in b and r. In particular, one can arrive at g directly by taking some average of the past rate of growth in a corporation's dividend. Whether or not this or some other measure of the expected future dividends is superior to the one presented earlier will depend on their relative usefulness in such purposes as the analysis of variation in prices among shares and the preferences of those who want an objective measure of a share's rate of profit.

So far, we have compared the growth rate of profit with the income and dividend yields on theoretical grounds. Let us now consider how they differ in practice, using the same measurement rules for the variables in each case. The numerical difference between the growth rate of profit and the dividend yield is simply the growth rate. However, the income yield, which is the measure of the rate of profit commonly recommended for capital budgeting, differs from the growth rate of profit in a more complex manner, and to establish this difference we first note that

$$b = \frac{Y - D}{Y} \text{ and } r = \frac{Y}{B} \tag{9}$$

where B = the net worth or book value per share. The growth rate of profit, therefore, may be written as

$$k = \frac{D}{P} + br = \frac{D}{P} + \frac{Y - D}{B}. \tag{10}$$

Next, the income yield can be decomposed as follows:

$$y = \frac{Y}{P} = \frac{D}{P} + \frac{Y - D}{P}. \tag{11}$$

We see then that y and k will be equal when book and market values are equal. It can be argued that the income yield overstates a share's payment stream by assuming that each payment is equal to the income per share and understates the payment stream by assuming that it will not grow. Hence, in this special case where book and market values are equal, the two errors exactly compensate each other.

Commonly market and book values differ, and y will be above k when market is below book, and it will be below k when market is above book. Hence, a share of IBM, for example, that is priced far above book had had an earnings yield of two to three percent in 1955. We know that the market requires a higher rate of profit on a common stock, even on IBM, and its growth rate of profit, k, is more in accord with the value suggested by common sense. Conversely, when U. S. Steel was selling at one-half of book value in 1950, the high income yield grossly overstated the rate of profit that the market was, in fact, requiring on the stock.

Furthermore, the growth rate of profit will fluctuate in a narrower range than the earnings yield. For instance, during the last few years, income, dividends, and book value have gone up more or less together, but market price has gone up at a considerably higher rate. Consequently, the growth rate of profit, dependent in part on book value, has fallen less than the earnings yield. Conversely, in a declining market k would rise less rapidly than y.

There is a widespread feeling that many accounting figures, particularly book value per share, are insensitive to the realities of the world, and some may feel that the comparative stability of k is merely a consequence of the limitations of accounting data. This is not true! The behavior of k is not a consequence of the supposed lack of realism in accounting data. Rather, book value appears in the model because it, and not market value, is used to measure the rate of return the corporation earns on investment, which, we have seen, is the rate of return that enters into the determination of the rate at which the dividend will grow. The comparative stability of k follows from the simple fact that, when a revenue stream is expected to grow, a change in the required rate of profit will give rise to a more than proportional change in the asset's price. Conversely, a change in the price reflects a less than proportional change in the rate of profit.

IV

Given the rate of profit expected on each item in the schedule of available investment opportunities and given the rate of profit at which the corporation's stock is selling, what should the capital budget be? As stated earlier, the accepted theory is that the budget should be set so as to equate the marginal return on investment with the rate of profit at which the stock is selling. The reasoning is, if the market requires, let us say, a 10 percent return on investment in the corporation's stock, and if the corporation can earn 15 percent on additional investment, obtaining the funds and making the investment will increase the earnings per share. As the earnings and the dividend per share increase or as the market becomes persuaded that they will increase, the price of the stock will rise. The objective, it will be recalled, is the maximization of the value of the stockholder's equity.

The conclusion drawn implicitly assumes that the corporation can sell additional shares at or above the prevailing market, or if a new issue depresses the market, the fall will be slight, and the price will soon rise above the previous level. However, some other consideration may argue against a new stock issue; for example, the management may be concerned with dilution of control, or the costs of floating a new issue may be very high, or a new issue may be expected to depress the price severely and indefinitely for reasons not recognized in the theory. Hence, it does not automatically follow that a new issue should be floated when a firm's demand for funds exceeds, according to the above criterion, those that are internally available.

In determining whether the required rate of profit is above or below r', the marginal return on investment, one can use y, the earnings yield, or k, the growth rate of profit as the required rate of profit. If y and k differ and if the reasoning in support of k presented earlier is valid, using y to estimate the direction in which a new issue will change the price of the stock may result in a wrong conclusion.

In arriving at the optimum size of a stock issue, the objective is to equate r' and y or k, depending on which is used. Internal data may be used to estimate the marginal efficiency of capital schedule. If the required rate of profit is considered a constant, its definition, $y = Y/P$ or $k = D/P + br$, provides its value. However, the required rate of profit may vary with the size of the stock issue or with the variables that may change as a consequence of the issue. In this event,

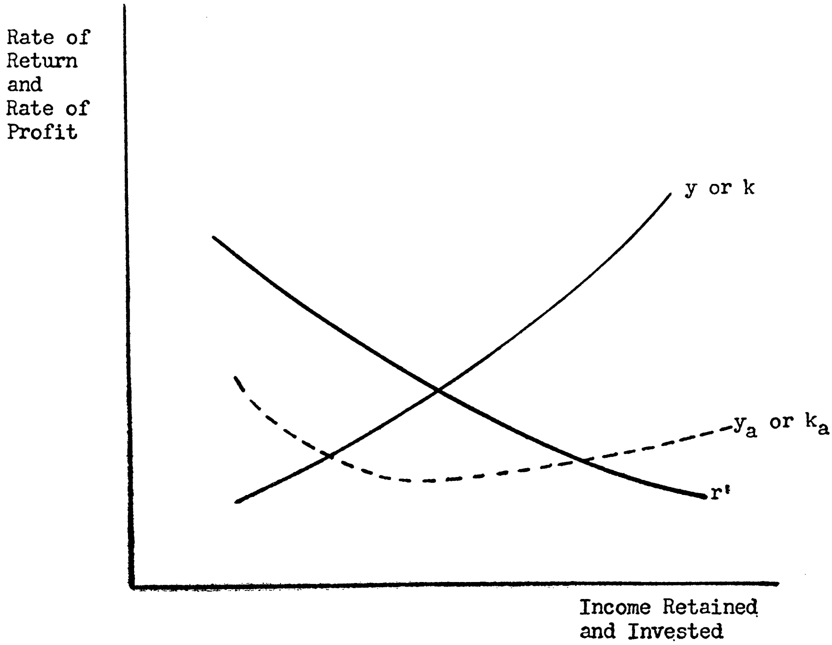


Fig. 1

finding the optimum size of a stock issue requires a model that predicts the variation in the required rate of profit with the relevant variables.

Borrowing is an alternative source of funds for investment. However, an analysis of this alternative requires the measurement of both (1) the variation in risk with debt, and (2) the difference between the rate of profit and the rate of interest needed to cover a given increase in risk. This has not been done as yet, which may explain the widespread practice of arbitrarily establishing a "satisfactory" financial structure and only borrowing to the extent allowed by it.

It has been stated by Dean[6] and Terborgh[7] that the long-term ceiling on a firm's capital outlays is the amount of its internally available funds. However, the share of its income a corporation retains is not beyond the control of its management; and, among the things we want from a capital budgeting model is guidance on whether the share of a corporation's income that is retained for investment should be raised or lowered.

Proceeding along traditional lines, the problem may be posed as follows. A firm estimates its earnings and depreciation allowances for the coming year and deducts the planned dividend to arrive at a preliminary figure for the capital budget. The marginal rate of return on investment in excess of this amount may be above or below the required rate of profit. We infer from theory that the two rates should be equated by (1) raising the budget and reducing the dividend

[6] Dean, *op. cit.*, 53–55.

[7] George Willard Terborgh, *Dynamic Equipment Policy* (New York, 1949, McGraw-Hill, 290 pp.), 228–29.

when the marginal return on investment is above the required rate of return, and (2) raising the dividend and reducing the budget when the reverse holds. The conditions under which this process yields an equilibrium are illustrated in Figure 1. The marginal return on investment, r', should fall as the budget is increased, and the required rate of profit, y or k, should increase or it should fall at a lower rate than r'. The latter case is illustrated by the line y_a or k_a.

Changing the dividend so as to equate r' and say y should maximize the price of the stock. For instance, if r' is above y, the company can earn a higher return on investment than stockholders require, and a dollar used this way is worth more to the stockholders than the dollar distributed in dividends. In other words, the price should go up by more than the income retained.

There are, of course, a number of problems connected with the use of this model for arriving at the optimum dividend rate. First, there is the question whether y or k should be used to measure the required rate of profit. Second, there is no question that the required rate of profit varies with the dividend rate. Hence, the current rate of profit given by the definition does not tell what profit rate will be required with a different dividend rate. This requires a model which predicts the variation in y or k with the dividend rate and other variables. Third, there is a very nasty problem of the short and the long run. It is widely believed, though the evidence has limitations, that the price of a share of stock varies with the dividend rate, in which case a corporation should distribute all of its income. However, it is quite possible that a change in the dividend gives rise to the expectation that earnings and future dividends are changing in the same direction. Further, in the short run, the market is not likely to be informed on a firm's marginal efficiency of capital schedule. For these and other reasons, it is likely that the dividend rate should not be made to vary with short-run changes in the marginal efficiency of capital, and more sophisticated methods than those now in use are needed to establish the variation in price or required rate of profit with the dividend rate.

V

The major points developed in this paper may be summarized as follows. We presented a definition of the rate of profit required by the market on a share of common stock, and we noted some of its advantages. It is theoretically superior to the income and dividend yields because it recognizes that the revenue stream provided by a share can be expected to grow. Furthermore, its empirical characteristics are also superior to those of the income and dividend yields since its value is generally in closer agreement with common sense notions concerning the prevailing rate of profit on a share of stock and since its value fluctuates in a narrower range over time. We next examined some of the problems involved in using this definition of the rate of profit and the earnings yield in capital budgeting models. Finally, we saw that, before capital budgeting theory can be made a reliable guide to action, we must improve our techniques for estimating the future revenue on a capital outlay proposal, and we must learn a good deal more about how the rate of profit the market requires on a share of stock varies with the dividend, the growth rate, and other variables that may influence it.

Chapter 4

Overview of Cost of Equity Capital Models

There are many methods for calculating the equity cost of capital. Chapter 3 discusses the buildup method for estimating the equity cost of capital. Other popular methods of calculation include the capital asset pricing model (CAPM), the discounted cash flow (DCF) method, arbitrage pricing theory (APT), and the Fama-French three factor model..

The Capital Asset Pricing Model

The capital asset pricing model (CAPM) is a simple and elegant model that describes the expected (future) rate of return on any security or portfolio of securities. It is among the most widely used techniques to estimate the cost of equity. The CAPM resulted from the efforts of three recipients of the Nobel Memorial Prize in Economic Science: Harry M. Markowitz, James Tobin, and William F. Sharpe. The Nobel committee cited the contributions to the CAPM of Tobin and Markowitz when awarding the prizes to both men. Sharpe's work on the model was the primary reason for which he won the Nobel Prize.

Systematic Risk

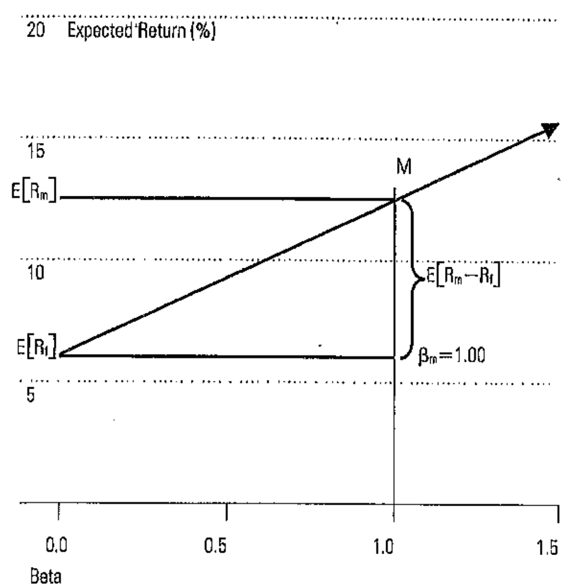
The principal insight of the CAPM is that the expected return on an asset is related to its risk; that is, risk-taking is rewarded. The model assumes that there is a riskless rate of return that can be earned on a hypothetical investment with returns that do not vary. A risky investment (one with returns that vary from one period to the next) will provide the investor with a reward in the form of a risk premium—an expected return higher than the riskless rate. For a particular risky investment, the CAPM indicates that the size of the risk premium is proportionate, in a linear fashion, to the amount of systematic risk taken.

The CAPM breaks up the total risk (the variability of returns) of an investment into two parts: systematic risk and unsystematic risk. Systematic risk is unavoidable and pervades (to a greater or lesser degree) every asset in the real economy and every claim (such as a stock) on those assets. Systematic risk generally springs from external, macroeconomic factors that affect all companies in a particular fashion, albeit with different magnitudes. The CAPM concludes that taking systematic risk is rewarded with a risk premium. The size of the risk premium is proportionate to the degree of co-movement of the security or portfolio (called beta) with the market portfolio consisting of all risky assets.

In contrast, unsystematic risk is that portion of total risk that can be avoided through diversification. The CAPM concludes that unsystematic risk is not rewarded with a risk premium. For example, the possibility that a firm will lose market share to a competitor is a source of unsystematic risk for its stock (see Chapter 6 for additional information on beta and systematic risk).

The security market line represents the relationship between expected return and systematic risk. This linear relationship forms the security market line, which is depicted in Graph 4-1.

Graph 4-1: The Security Market Line



The riskless asset forms the y-intercept of the security market line and represents the expected return on the asset with no systematic risk (beta equal to zero). The market portfolio by definition has a beta of one. Drawing a line that passes through the riskless asset and the market portfolio forms the security market line. Theoretically, to be fairly priced, every stock or portfolio of stocks should fall on the line.[1]

Corporate Finance

A Focused Approach

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9.7 Bond-Yield-Plus-Risk-Premium Approach

Some analysts use a subjective, ad hoc procedure to estimate a firm's cost of common equity: They simply add a judgmental risk premium of 3 to 5 percentage points to the interest rate on the firm's own long-term debt. It is logical to think that firms with risky, low-rated, and consequently high-interest-rate debt will also have risky, high-cost equity, and the procedure of basing the cost of equity on a readily observable debt cost utilizes this logic. In this approach,

$$r_s = \text{Bond yield} + \text{Bond risk premium} \quad (9\text{-}8)$$

The bonds of NCC have a yield of 11.0%. If its bond risk premium is estimated as 3.7%, its estimated cost of equity is 14.7%:

$$r_s = 11.0\% + 3.7\% = 14.7\%$$

Because the 3.7% risk premium is a judgmental estimate, the estimated value of r_s is also judgmental. Empirical work suggests that the risk premium over a firm's own bond yield has generally ranged from 3 to 5 percentage points, with recent values close to 3%. With such a large range, this method is not likely to produce a precise cost of equity. However, it can get us "into the right ballpark."

SELF-TEST

What is the reasoning behind the bond-yield-plus-risk-premium approach?

A company's bond yield is 7%. If the appropriate bond risk premium is 3.5%, what is r_s, based on the bond-yield-plus-risk-premium approach? *(10.5%)*

9.8 Comparison of the CAPM, DCF, and Bond-Yield-Plus-Risk-Premium Methods

We have discussed three methods for estimating the required return on common stock. For NCC, the CAPM estimate is 14.6%, the DCF constant growth estimate is 14.5%, and the bond-yield-plus-risk-premium is 14.7%. The overall average of these three methods is (14.6% + 14.5% + 14.7%)/3 = 14.6%. These results are unusually consistent, so it would make little difference which one we used. However, if the methods produced widely varied estimates, then a financial analyst would have to use his or her judgment as to the relative merits of each estimate and then choose the estimate that seemed most reasonable under the circumstances.

Recent surveys found that the CAPM approach is by far the most widely used method. Although most firms use more than one method, almost 74% of respondents in one survey, and 85% in the other, used the CAPM.[17] This is in sharp contrast to a 1982 survey, which found that only 30% of respondents used the CAPM.[18] Approximately 16% now use the DCF approach, down from 31% in 1982. The bond-yield-plus-risk-premium is used primarily by companies that are not publicly traded.

[17]See John R. Graham and Campbell Harvey, "The Theory and Practice of Corporate Finance: Evidence from the Field," *Journal of Financial Economics*, 2001, pp. 187–243, and the paper cited in footnote 9. Interestingly, a growing number of firms (about 34%) also are using CAPM-type models with more than one factor. Of these firms, over 40% include factors for interest-rate risk, foreign exchange risk, and business cycle risk (proxied by gross domestic product). More than 20% of these firms include a factor for inflation, size, and exposure to particular commodity prices. Less than 20% of these firms make adjustments due to distress factors, book-to-market ratios, or momentum factors.

[18]See Lawrence J. Gitman and Vincent Mercurio, "Cost of Capital Techniques Used by Major U.S. Firms: Survey Analysis of *Fortune's* 1000," *Financial Management*, 1982, pp. 21–29.

Appendix 5-B
Risk-Free Rate Proxies

There are two possibilities for proxying investors' expectations of the risk-free rate expected to prevail in one year: actual and forecast interest rates. Each offers distinct advantages and limitations. At the conceptual level, given that ratemaking is a forward-looking process, interest rate forecasts are preferable. Moreover, the conceptual models used in the determination of the cost of equity, such as the CAPM, are prospective in nature and require expectational inputs.

At the practical level, however, the question arises as to what is the most reliable proxy for interest rate investor expectations. There are four potential sources of investor interest rate expectations: actual interest rates, yields on long-term interest rate futures contracts, forward rates implied in the term structure of interest rates, and institutional interest rate forecasts such as those contained in *Consensus Forecasts* from Consensus Economics Inc. or Blue Chip Forecast.

There is extensive literature concerning the prediction of interest rates. From this evidence, it appears that the no-change model of interest rates frequently provides the most accurate forecasts of future interest rates while at other times, the experts are more accurate. Naive extrapolations of current interest rates frequently outperform published forecasts. The literature suggests that on balance, the bond market is very efficient in that it is difficult to consistently forecast interest rates with greater accuracy than a no-change model. The latter model provides similar and, in some cases, superior accuracy than professional forecasts.

The no-change model is consistent with the notion that actual interest rates are the best estimators of future interest rates if interest rates follow a random walk process. Moreover, actual interest rates are easily observable and available and provide the regulator with a simple, reliable, administratively expedient, and non-controversial input to the CAPM.

The use of yields on outstanding long-term Treasury bond futures contracts is another source of investor interest rate expectations. The term structure of yields on financial futures contracts extending out one to two years reveals investor expectations as to the expected future course of interest rates. An ascending price structure reveals an expectation of falling interest rates, and conversely.

Forward rates present another source of investor interest rate expectations. Forward contracts and futures contracts are very close substitutes. Empirical

Using Analysts' Growth Forecasts to Estimate Shareholder Required Rates of Return

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I. Introduction

Shareholder required rates of return play key roles in establishing economic criteria for resource allocation in many corporate and regulatory decisions. Theory dictates that such returns should be forward-looking return requirements that take into account the risk of the specific equity investment.

Estimation of such returns, however, presents numerous and difficult problems. Although theory clearly calls for a forward-looking required return, investigators, lacking a superior alternative, often resort to averages of historical realizations. One primary example is the determination of equity required return as a "least risk" rate plus a risk premium where an equity risk premium is calculated as an average of past differences between equity returns and returns on debt instruments. The historical studies of Ibbotson *et al.* [9] have been used frequently to implement this approach.[1] Use of such historical risk premia assumes that past realizations are a good surrogate for future expectations and that risk premia are roughly constant over time. Additionally, the choice of a time period over which to average data under such a procedure is essentially arbitrary. Carleton and Lakonishok [3] demonstrate empirically some of the problems with such historical premia when they are disaggregated for different time periods or groups of firms.

Recently Brigham, Shome, and Vinson [2] surveyed work on developing *ex ante* equity risk premia with particular emphasis on regulated utilities. They presented their own risk premia estimates, which make use of financial analysts' forecasts as surrogates for investor expectations.

The current paper follows an approach similar to Brigham *et al.* and derives equity required returns and risk premia using publicly available expectational

Thanks go to Ed Bachmann, Rich Harjes, and Hamid Mehran for computational assistance and to Bill Carleton, Pete Crawford, and Steve Osborn for many discussions. I gratefully acknowledge financial support from the UNC Business Foundation and the Pogue Foundation and thank Bell Atlantic for supplying data for this project. Finally, I thank colleagues at UNC for their helpful comments.

[1]Many leading texts in financial management use such historical risk premia to estimate a market return. See for example, Brealey and Myers [1]. Often a market risk premium is adjusted for the observed relative risk of a stock.

data. The estimation makes use of dividend growth models but incorporates expected rather than historical growth rates. A consensus forecast of financial analysts is used as a proxy for investor expectations. While Brigham *et al.* focus on utility securities, this paper also provides estimates of risk premia for a broad market index. Equity risk premia for both the market and for utilities are shown to vary over time with changes in the perceived riskiness of corporate activity relative to U.S. government bonds. In addition, the estimated risk premia at any given time are shown to vary across groups of stocks. The paper also provides results using the dispersion of analysts' forecasts as an *ex ante* proxy for equity risk.

Section II discusses related literature on financial analysts' forecasts (FAF) and the estimation of required returns using such forecasts. In Section III models and data are discussed. Following a comparison of the results to those of earlier studies (including historical risk premia), the estimates are subjected to economic tests of both their time-series and their cross-sectional characteristics in Section V. Finally, conclusions are offered.

II. Background and Literature Review

In finance, it is often convenient to use the notion of a shareholder's required rate of return. Such a rate (k) is the minimum level of expected return necessary to compensate the investor for bearing risks and receiving dollars in the future rather than in the present. In general, k will depend on returns available on alternative investments (*e.g.*, bonds or other equities) and the riskiness of the stock. To isolate the effects of risk it is often useful (both theoretically and empirically) to work in terms of a risk premium (rp), defined as

$$rp = k - i, \qquad (1)$$

where i = required return for a zero risk investment. Theoretically, i is a risk free rate, though empirically its proxy (*e.g.*, yield to maturity on a government bond) is only a "least risk" alternative that is itself subject to risk.[2] While models such as the capital asset pricing model offer explicit methods for varying risk premia across securities, they provide little practical advice on establishing some benchmark market risk premium. Other models, such as the dividend growth model (hereafter referred to as the discounted cash flow, or DCF, model), can be used to provide direct estimates of k, and hence implied values of rp, but are silent on how rp ought to vary across firms. In this paper DCF models are used to establish risk premia both for the market and for utility stocks. Since the DCF analysis uses a consensus measure of FAF of earnings as a proxy for investor expectations, a brief review of research on FAF is appropriate.

A. Literature on FAF

Much of the burgeoning literature on properties of FAF is surveyed by Givoly and Lakonishok [8]. Of primary importance for this work is the relationship between FAF and investor expectations that determine stock prices. Such forecast data are readily available. That they are used by investors is evidenced by the commercial viability of services that provide such forecasts and by the results of studies of investors' behavior (Touche, Ross and Company [16], Stanley, Lewellen and Schlarbaum [15]). Moreover, a growing body of knowledge shows that analysts' earnings forecasts are indeed reflected in stock prices. Such studies typically employ a consensus measure of FAF calculated as a simple average[3] of forecasts by individual analysts. Elton, Gruber, and Gultekin [5] show that stock prices react more to changes in analysts' forecasts of earnings than they do to changes in earnings themselves, suggesting the usefulness of FAF as a surrogate for market expectations. In an extensive NBER study using analysts' earnings forecasts, Cragg and Malkiel [4, p. 165] conclude "the expectations formed by Wall Street professionals get quickly and thoroughly impounded into the prices of securities. Implicitly, we have found that the evaluations of companies that analysts make are the sorts of ones on which market valuation is based." Updating Cragg and Malkiel's work, Vander Weide and Carleton [17] recently compare consensus FAF of earnings growth to 41 different historical growth measures.[4] They con-

[2]In this development the effects of tax codes and inflation on required returns are ignored.

[3]Mayshar [14] discusses the problems of explaining equilibrium prices of securities when there is divergence of opinion among investors. One issue is whether it is the expectation of the marginal investor or the average investor that determines security prices. Mayshar shows that, in general given divergence of opinion and trading costs, not all investors trade in all assets and that equilibrium prices and the identity of investors trading in each asset are jointly determined. In this sense, equilibrium prices can be considered as "determined simultaneously by the average and marginal investors."

[4]Both Cragg and Malkiel [4] and Vander Weide and Carleton [17] show that an average measure of analysts' forecasts of growth in earnings is powerful in explaining cross-sectional variation in price earnings ratios of stocks.

clude that "there is overwhelming evidence that the consensus analysts' forecast of future growth is superior to historically-oriented growth measures in predicting the firm's stock price . . . consistent with the hypothesis that investors use analysts' forecasts, rather than historically-oriented growth calculations, in making stock buy and sell decisions." [17, p. 15].

B. Use of FAF to Estimate Equity Required Returns

Given the demonstrated relationship of FAF to equity prices and the direct theoretical appeal of expectational data, it is no surprise that FAF have been used in conjunction with DCF models to estimate equity return requirements. Typically such approaches have estimated an *ex ante* risk premium (rp) calculated as the difference between required return and a least risk rate as shown in Equation (1).

Malkiel [13] estimated such risk premia for the Dow Jones Industrial Index using a nonconstant growth version of the DCF model. Initial years of growth were based on Value Line's five-year earnings growth forecasts with subsequent growth approaching a long-run real national growth rate of 4%. More recently, Brigham, Vinson, and Shome [2] used a two stage DCF growth model to estimate *ex ante* risk premia for electric utilities and the Dow Jones Industrial Index. For the period 1966–1984, they report annual risk premia for both Dow Jones Industrial and Electric Indices using Value Line's forecasts. Beginning in 1980 they report monthly risk premia for electric utilities with the source of FAF varying over time; starting with Value Line, adding Merrill Lynch and Salomon Brothers in 1981 and finally, in mid-1983, adding IBES data. IBES (Institutional Broker's Estimate System) is a collection of analysts' forecasts and is discussed in the next section. The resultant risk premia vary over time. In addition, Brigham *et al.* present evidence that their estimated risk premia vary cross-sectionally with a stock's risk (as proxied by bond rating) and over time with the level of interest rates. FAF also have been used in conjunction with DCF models by a number of expert witnesses in rate of return determination for regulated utilities. Recently, the Federal Communications Commission [6] tentatively endorsed the use of consensus FAF in DCF determinations of required return on equity.[5]

This paper adds to earlier work in a number of important respects. First, while Malkiel and Brigham *et al.* focus on electric utilities or the Dow Jones Industrial Index, this paper estimates risk premia for a broadly defined market index — the Standard and Poor's 500. Thus, the results are directly comparable to historical "market" risk premia typically estimated on a similar sample of stocks. Second, the study uses a large sample of FAF (beginning in 1982 when the necessary data first became available). This provides the ability to use a consensus measure of expectations as would be suggested by financial theory. Third, the results show that the derived risk premia change over time and that these changes are related to proxies for risk, which would be expected to be associated with equity risk premia. Although such changes have been noted by earlier studies (*e.g.*, Brigham *et al.*), there is little work explaining the patterns of change. Finally, the paper shows the usefulness of the dispersion of FAF as a proxy for risk. Such a measure is a direct expectational measure of risk and does not rely on assumptions of risk stability over time as do most operational methods of deriving risk surrogates.

III. Models and Data

A. Model for Estimation

The DCF model states that the current market price is the present value of expected future cash flows from ownership. The simplest and most commonly used version estimates shareholders' required rate of return, k, as the sum of dividend yield and expected growth in dividends, or

$$k = (D_1/P_0) + g, \tag{2}$$

where D_1 = dividend per share expected to be received at time one, P_0 = current price per share (time 0), and g = expected growth rate in dividends per share. The limitations of this model are well known, and it is straightforward to derive expressions for k based on more general specifications of the DCF model.[6] The primary difficulty in using the DCF model is obtaining an estimate of g, since it should reflect market expecta-

[5]In response to the FCC's *Notice of Proposed Rulemaking* [6] to determine authorized rates of return, AT&T used an approach driven by FAF growth estimates from IBES. Also see, for example, W.T. Carleton, *Testimony before the Vermont Public Service Board*, Docket No. 4865 (January 1984) and R.S. Harris, *Testimony filed with the Delaware Public Service Commission*, Docket 84–33 (November 1984). In its *Supplemental Notice* [6], the FCC tentatively endorsed substantial reliance on FAF for use in DCF determination of cost of equity.

[6]As stated, Equation (2) requires expectations of either an infinite horizon of dividend growth at rate g or a finite horizon of dividend growth at rate g and special assumptions about the price of the stock at the end of that horizon. Essentially, the assumption must ensure that the stock price grows at a compound rate of g over the finite horizon.

tions of future performance. Without a ready source for measuring such expectations, application of the DCF model is fraught with difficulties even if the simple version shown in Equation (2) fits the equity investment in question. This paper uses published FAF of long-run growth in earnings as a proxy for g.

B. Data

Many analysts publish forecasts of corporate earnings. Such forecasts are widely disseminated and are the subject of considerable interest both to investors and researchers (see Givoly and Lakonishok [8]). In recent years, this interest has led to a viable market for services that collect and disseminate such FAF. FAF for this research come from IBES (Institutional Broker's Estimate System), which is a product of Lynch, Jones, and Ryan, a major brokerage firm. Data in IBES represent a compilation of earnings per share (EPS) estimates of about 2000 individual analysts from 100 brokerage firms on over 2000 corporations. IBES data are provided to clients in a number of forms, including on-line data bases provided by vendors. The client base, which currently numbers more than 300, includes most large institutional investors such as pension funds, banks, and insurance companies. Representative of industry practice, IBES contains estimates of (i) EPS for the upcoming fiscal year, (ii) EPS for the subsequent year, and (iii) a projected five-year growth rate in EPS. Each item is available at monthly intervals.

IBES collection procedures are designed to obtain timely forecasts made on a consistent basis. IBES requests "normalized" five-year growth rates from analysts. Such normalization is designed to remove short-term distortions that might stem from using an unusually high or low earnings year as a base. These growth and other earnings forecasts are updated when analysts formally change their stated predictions. IBES does, however, verify prior forecasts monthly to make sure that analysts still hold to them. Despite these procedures, there remain potential difficulties in using IBES data to the extent that some analysts fail to normalize growth projections or fail to continually review and revise their earnings estimates. To control for some of these potential difficulties, this analysis uses averages of analysts' forecasts for a wide range of companies over an extended number of months.

In this research, the mean value of individual analyst's forecasts of five-year growth rate in EPS will be used as a proxy for g in the DCF model.[7] The five-year horizon is the longest horizon over which such forecasts are available from IBES and often is the longest horizon used by analysts. One could make alternate assumptions about growth after five years and use a more general version of a DCF model, but unfortunately, there is no source for obtaining market estimates of this expected growth. As a result, the current analysis applies the five-year growth rate as a proxy for g in Equation (2). Given no objective basis for predicting a change in growth (see Footnote 6), this avoids the introduction of *ad hoc* assumptions about future growth. Importantly, however, the approach is applied to portfolios of stocks rather than to individual securities, since future growth patterns may be expected to have drastic changes for some specific securities. Stock prices were obtained from Chase Econometrics and dividend and other firm-specific information from COMPUSTAT. Interest rates (both government and corporate) were gathered from Federal Reserve Bulletins and from Moody's Bond Record. Exhibit 1 describes key variables used in the study. Data collected cover all dividend paying stocks in the Standard and Poor's 500 stock (SP500) index plus approximately

Exhibit 1. Variable Definitions

k	=	equity required rate of return
P_0	=	average daily price per share*
D_1	=	expected dividend per share measured as current indicated annual dividend from COMPUSTAT multiplied by $(1+g)$†
g	=	average financial analysts' forecasts of five-year growth rate in earnings per share (from IBES)
σ_g	=	cross-sectional standard deviation of analysts' forecasts of growth in earnings per share (from IBES)
N_g	=	number of analysts' forecasts of g (from IBES)
i_{20}	=	yield to maturity on 20-year U.S. government obligations. Source: Federal Reserve Bulletin, constant maturity series
i_c	=	yield to maturity on long-term corporate bonds: Moody's average
i_u	=	yield to maturity on long-term public utility bonds: Moody's average
rp	=	equity risk premium calculated as $rp = k - i_{20}$

*In results reported P_0 is the average daily price for a stock from the beginning of the month up to and including the date of publication of monthly IBES data (typically half a month). Almost identical results were found using the average price for the entire month.

†See Footnote 8 at the end of the paper for a discussion of the $(1+g)$ adjustment.

[7]While the model calls for expected growth in dividends, no source of data on such projections is readily available. In addition, in the long run, dividend growth is sustainable only via growth in earnings. As long as payout ratios are not expected to change, the two growth rates will be the same. Vander Weide and Carleton [17] also use the IBES growth rate in earnings per share.

150 additional stocks of regulated companies. Since five-year growth rates were first available from IBES in January 1982, the analysis covers the 36-month period 1982–1984. On average, each company in SP500 had approximately nine individual forecasts of g per month, with some companies having 20 or more forecasts of g. As a result, well over 100,000 FAF (company-months) were employed in the analysis.

IV. Construction of Risk Premia and Required Rates of Return

For each month, a "market" required rate of return was calculated using each dividend paying stock in the SP500 index for which data were available. The DCF model in Equation (2) was applied to each stock and the results weighted by market value of equity to produce the market required return.[8] The return was converted to a risk premium by subtracting i_{20}, the yield to maturity on 20-year U.S. government bonds.[9] The procedure was repeated for the Standard and Poor's Utility Index (SPUT) of 40 stocks. Exhibit 2 reports the results by quarter.

Exhibit 2. Required Rates of Return and Risk Premia

		SP500		SPUT	
	Bond Yield*	Required† Return	Risk‡ Premium	Required† Return	Risk‡ Premium
1982					
Quarter 1	14.27	20.81	6.54	18.83	4.56
Quarter 2	13.74	20.68	6.94	18.51	4.77
Quarter 3	12.94	20.23	7.29	18.55	5.61
Quarter 4	10.72	18.58	7.86	17.20	6.48
Average	12.92	20.08	7.16	18.28	5.36
1983					
Quarter 1	10.87	18.07	7.20	16.71	5.84
Quarter 2	10.80	17.76	6.96	16.52	5.72
Quarter 3	11.79	17.90	6.11	16.39	4.60
Quarter 4	11.90	17.81	5.91	16.00	4.10
Average	11.34	17.88	6.54	16.41	5.07
1984					
Quarter 1	12.09	17.22	5.13	16.48	4.39
Quarter 2	13.21	17.42	4.21	16.99	3.78
Quarter 3	12.83	17.34	4.51	16.62	3.79
Quarter 4	11.78	17.05	5.27	15.18	4.04
Average	12.48	17.26	4.78	16.48	4.00
Average 1982–1984	12.25	18.41	6.16	17.06	4.81

*i_{20} = Yield on U.S. Treasury obligation, 20 year constant maturity.
†Monthly required return (k) calculated as value weighted average. Quarterly values are simple averages of monthly figures.
‡Risk premium calculated as k − i_{20}.

The results appear quite plausible. The estimated risk premia are positive, consistent with equity owners demanding a risk premium over and above returns available on debt securities. Also, as would be expected for less risky stocks, the utility risk premia consistently fall below those estimated for stocks in general. Exhibit 2 shows that estimated risk premia change over time, suggesting changes in the market's perception of the incremental risk of investing in equity rather than debt securities. Such changes will be examined in a subsequent section.

For comparative purposes, Exhibit 3 provides results of related studies. The long-run differential return between stocks and long-term government bonds (Panel A) has been about 6.4% per year (on a geometric basis). It is comforting to note that this is very close to the 6.16% average annual risk premia estimated in Exhibit 2. Note, however, that such risk premia appear to change over time. Panels B and C show some of Brigham *et al.*'s risk premium estimates. Unfortunate-

[8]The construction of D_1 is controversial since dividends are paid quarterly and may be expected to change during the year; whereas, Equation (2), as is typical, is being applied to annual data. Both the quarterly payment of dividends (due to investors' reinvestment income before year's end, see Linke, and Zumwalt [11]) and any growth during the year require an upward adjustment of the current annual rate of dividends to construct D_1. If quarterly dividends grew at a constant rate, both factors could be accommodated straightforwardly by applying Equation (2) to quarterly data (with a quarterly growth rate) and then annualizing the estimated quarterly required return. Unfortunately, with lumpy changes in dividends, the precise nature of the adjustment depends, on both an individual company's pattern of growth during the calendar year and an individual company's required return (and hence reinvestment income in that risk class).

In this work, D_1 is calculated as $D_0(1+g)$. The full g adjustment is a crude approximation to adjust for both growth and reinvestment income. For example, if one expected dividends to have been raised, on average, six months ago, a "½ g" adjustment would allow for growth, the remaining "½ g" would be justified on the basis of reinvestment income. Any precise accounting for both reinvestment income and growth would require tracking each company's dividend change history and making explicit judgments about the quarter of the next change. Since no organized "market" forecasts of such a detailed nature exist, such a procedure is not possible. To get a feel for the magnitudes involved, the average dividend yield (D_1/P_0) and growth (market value weighted 1982–1984) for the SP500 were 5.8% and 12.5%. Comparable figures for the SP utility index were 10.4% and 6.7%. As a result, a "full g" adjustment on average increases the required return by 60–70 basis points (relative to no g adjustment) for both indices.

[9]Brigham, Shome, and Vinson [2] also use this interest rate to create equity risk premia. The results were robust to changes in weighting. For the SP500, equal weighting (rather than value weighting) increased the 1982–1984 risk premium by two basis points while for the SPUT equal weighting resulted in a 21 basis point increase. As a further test, the SP500 stocks were ranked on g and the upper and lower deciles deleted. The resulting risk premium (1982–84 average) was 5.94%. A similar procedure used to rank dividend yield produced an SP500 risk premium of 6.18%.

Exhibit 3. Results of Related Studies: Historical Returns and Estimated Risk Premia

			Geometric	Arithmetic
A. Historical Return Realizations (1926–1980)*				
Common Stocks			9.4%	11.7%
Long-Term Government Bonds			3.0%	3.1%
U.S. Treasury Bills			2.8%	2.8%

	Dow Jones Industrials		Dow Jones Electrics	
	Average	Range	Average	Range
B. DCF risk premia using one analyst†				
1966–1970	5.45	4.97–6.81	3.91	3.46–4.13
1971–1975	5.51	4.95–6.92	5.95	4.52–8.72
1976–1980	6.23	5.09–6.88	5.82	5.55–6.21
1981	5.38		5.62	
1982	5.30		3.70	
1983	5.87		5.64	
1984	3.75		4.06	
Average 1982–1984	4.97		4.47	

	Electric Utilities
C. DCF risk premia using three analysts‡	
1981	3.73
1982	4.52
1983	5.17
1984 (through June)	5.01

*Ibbotson, Sinquefield, and Siegel [9].
†Analyst is Value Line. Data are annual estimates using two-stage growth DCF model. Source: Brigham, Shome, and Vinson [2].
‡Analysts are Value Line, Merrill Lynch and Salomon Brothers. Data are averages of monthly values from Brigham, Shome, and Vinson [2].

Exhibit 4. Risk Premia by Moody's Bond Ratings*

Electric Utilities: SIC's 4911 and 4931	Aaa	Aa	A	Baa
Risk Premia				
Risk Premium (Expectational g)	3.60	4.33	4.81	4.90
Risk Premium (Historical g†)	6.10	3.28	3.09	5.24
Financial Data				
Debt Ratio‡	0.46	0.48	0.50	0.51
Beta§	0.58	0.61	0.62	0.61
Variability¶				
Operating Cash Flow	0.009	0.016	0.022	0.059
Equity Cash Flow	0.006	0.013	0.019	0.024
Standard Deviation** of Analysts' Forecasts	1.00	1.26	1.33	1.79

*Moody's ratings as of January 1984 from *Moody's Bond Record*, February 1984. The number of companies by rating is Aaa (2), Aa (22), A (32), Baa (22). Risk premia are averages of monthly values, January 1982–September 1983.
†Historical Growth is past five-year earnings growth, based on 20 quarters of past data. Source: IBES.
‡Debt Ratio = Long-Term Debt ÷ Total Capital, average 1978–1982 from COMPUSTAT.
§Beta from *Value Line*, January 29, 1982.
¶Measure of variability around trend growth: variance of residuals of regressions on quarterly COMPUSTAT data (1978–1982). Regressions are log of variable regressed on time and seasonal dummies.
**This is the average value of the standard deviation around the mean long-term growth forecast. Such standard deviations are reported for each company in each month. Note it is *not* the cross-sectional standard deviation of growth rates among companies.

ly, their work does not include a broad market index directly comparable to the SP500. Rather, they use the Dow Jones Industrial Index based on 30 large industrial concerns. Though the SPUT includes a broader set of utilities than the electrics covered by Brigham *et al.*, their average risk premium estimates are also in the 4 to 5% range for the early 1980s.

While the estimates in Exhibit 2 are quite plausible, the question still remains as to whether they satisfy economic criteria one would expect of risk premia. In the following section, the estimated risk premia are subjected to a series of tests to see if they vary both cross-sectionally and over time with changes in risk. The tests are ultimately joint tests of the estimates as useful risk premia, the measured proxies for risk and the validity of the economic hypothesis. Nonetheless, if the tests using the risk premia have results conforming to theoretical expectation, the comfort level in using them is increased accordingly.

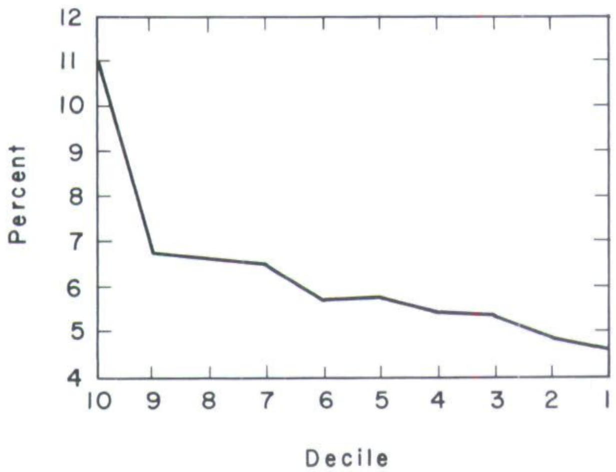
V. Characteristics of Risk Premia

A. Cross-Sectional Tests

Brigham *et al.* show that risk premia (IBES estimates for first half of 1984) for electric utilities are lower the higher the bond rating of the company, confirming the expected tradeoff between risk and return. A similar experiment for electrics, using the current data stretching back to January 1982, confirmed this relationship for a longer time period. Exhibit 4 reports selected results of that analysis. As a contrast, Exhibit 4 also shows the results of using historical growth rates (rather than FAF) in a DCF model. Risk premia derived from historical growth are actually higher for companies with very safe debt, suggesting the clear inferiority of historical to expectational growth rates. With the exception of beta, which is roughly constant across groups, other measures of risk noted in Exhibit 4 confirm the risk differentials associated with bond rating groups.

A further test of the cross-sectional variation in risk premia was performed by dividing the universe of

Exhibit 5. Equity Risk Premia: Deciles Based on Standard Deviation of Financial Analysts Forecasts* (Companies with at least three analysts)



*Risk premia were calculated as equally weighted averages for each decile (10 = highest dispersion) for each of three months: January 1982, December 1982, and September 1983 (approximately 50 companies per decile). These premia were then averaged across deciles. A similar downward pattern was evident in each month.

stocks (industrial plus utility) according to the dispersion of analysts' forecasts, σ_g. This cross-sectional measure of analysts' disagreement should be positively related to the uncertainty of future growth prospects and hence to the riskiness of equity investment. Elsewhere, Malkiel [12] has discussed the rationale and usefulness of such dispersion as an *ex ante* measure of risk. Malkiel argues that σ_g may be a proxy for systematic risk and shows that it bears a closer empirical relationship to expected return than does beta or other risk measures. Most of Malkiel's work is, however, based on data from the 1960s. Exhibit 5 reports risk premia by decile based on σ_g for companies having at least three analysts' forecasts. The three months were chosen as representative. The results show a consistent positive relationship between risk premia and dispersion of analysts' forecasts.

The results in Exhibits 4 and 5 show that the estimated risk premia conform to theoretical relationships between risk and required return that are expected when investors are risk averse. This strengthens the case for using such risk premia, and provides encouragement for further study of their structure.[10]

B. Time Series Tests

A potential benefit of using *ex ante* risk premia is the estimation of changes in risk premia over time. Brigham *et al.* [2] note such changes for utility stocks and relate them to changes in interest rates. They conclude that prior to 1980 utility risk premia increased with the level of interest rates, but that this pattern reversed thereafter, resulting in an inverse correlation between risk premia and interest rates. They explain this turnaround as the outcome of changes in bond markets and adaptation of utilities and their regulators to an inflationary environment. Brigham *et al.* do not, however, analyze changing risk premia for stocks in general. Furthermore, they do not provide direct empirical proxies for changes in equity risks that would explain changes in equity risk premia over time.[11]

C. Changes in Risk Premia

One would expect changes in measured equity risk premia to be related to changes in perceived riskiness. First, with changes in the economy and financial markets, equity investments may be perceived to change in risk. Second, since government bonds are risky investments themselves, their perceived riskiness may change. For example, the large increase in interest rate volatility in the last decade has undoubtedly made fixed income investments more risky holdings than they were in a world of relatively stable rates. Measured equity risk premia (relative to government bonds) could thus be reduced due to increases in perceived riskiness of bonds, even if equities displayed no shifts in risk.

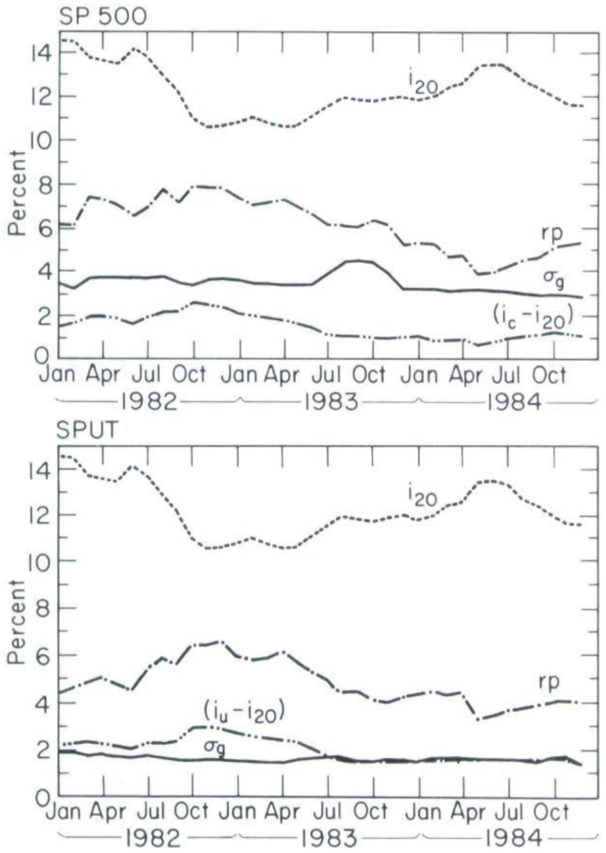
One measure of risk, the standard deviation of FAF, σ_g, was shown previously to be related to cross-sectional differences in risk premia. To test its usefulness as a time series measure of risk, the average value of σ_g was calculated each month for the SP500 index and the SPUT index. The results are graphed in Exhibit 6.[12]

[10]Such *ex ante* required returns offer a useful alternative to *ex post* data typically used in tests of asset pricing models. See Friend, Westerfield, and Granito [7] for a test of the CAPM using survey data rather than *ex post* holding period returns.

[11]In addition, Brigham *et al.* do not report on their treatment of serial correlation in reported regression results, making it more difficult to interpret their findings. As an example, monthly data are used for the 1980–1984 period in a time series regression of a risk premium on the level of interest rates. Similar regressions using data in this paper (1982–1984 monthly data) showed significant positive autocorrelation with Durbin Watson Statistics well below 1.0.

[12]The average values of σ_g are the market value weighted averages of the σ_g for individual stocks. If one looked at a direct estimate of g made by individual analysts for the index, one would expect to find a lower amount of dispersion because some of the differences on individual securities would cancel out. Such data are not available. One would suspect, however, that the calculated average would move up and down in tandem with this unobservable measure of dispersion.

Exhibit 6. Equity Risk Premia, Interest Rates and Risk



Another possible time series proxy for equity risk is the set of yield spreads between corporate and government bonds. As the perceived riskiness of corporate activity increases, the difference between yields on corporate bonds and government bonds should increase. One would expect the sources of increased riskiness to corporate bonds to also increase risks to shareholders.[13] Exhibit 6 graphs two series of yield spreads. The first is the difference between the yield on Moody's corporate average series and the yield on 20-year U.S. Treasury obligations. This series includes debt of both industrial and utility companies and thus would be appropriate as a risk proxy for a broad market index such as the SP500. The second is the spread between the yields on Moody's public utility series and 20-year U.S. Treasury bonds. This series should reflect relative risks of utility stocks as proxied by SPUT.[14]

Exhibit 7 reports results of analyzing the relationship between risk premia, interest rates, and proxies for risk for both the SP500 and SPUT. All regressions are corrected for serial correlation.[15] For stocks in general, Panel A shows that risk premia are negatively related to the level of interest rates — as proxied by i_{20}. Such a negative relationship may result from increases in the perceived riskiness of investment in government debt at high levels of interest rates. A direct measure of uncertainty about investments in government bonds would be necessary to test this hypothesis directly.

The results also show the significant positive relationship between the two proxies for risk and the estimated risk premia. For example, regression 4 of Panel A shows that the equity premium on the SP500 increases with the dispersion of FAF (σ_g) and the yield spread between corporate and government bonds ($i_c - i_{20}$). Evidently, these two risk measures capture somewhat different dimensions of risk, both of which appear important in explaining risk premia on stocks in general. The simple correlation coefficient between the two risk measures is 0.19 and is insignificantly different from zero. The addition of the yield spread risk proxy also dramatically lowers the magnitude of the coefficient on government bond yields, as can be seen by comparing Equations 1 and 3 of Panel A. Apparently, a large part of the effect of changes in government bond rates on equity risk premia may be explained through the narrowing of the yield spread between corporate and government bonds. This suggests that such increases in government yields may often be associated with a reduction in the *difference* in risk between investment in government bonds and in corporate activity.

Panel B shows that utility risk premia are also inversely related to the level of interest rates as was found by Brigham *et al.* [2]. Unlike the results for stocks in general, however, changes in the dispersion of FAF over time are not significantly related to changes in these utility risk premia. This may be be-

[13]Of course, counterexamples could be constructed but one would expect an overall positive correlation across companies. Additionally, the cross-sectional relationship between bond ratings and equity risk premia reported earlier in the paper supports the link between corporate debt risks and risks on equity.

[14]Note that these two series reflect both changes in the ratings of corporate bonds as well as yield spreads for a given bond rating. The two series proved better in explaining equity risk premia than use of two comparable series for AA-rated debt.

[15]Ordinary least squares regressions showed severe positive autocorrelation in many cases with Durbin Watson Statistics typically below one. Estimation used the Prais-Winsten method. See Johnston [10], pp. 321–325.

Exhibit 7. Changes in Equity Risk Premia Over Time — Entries are Coefficient (t-value)

Regression	Intercept	i_{20}	σ_g	$i_c - i_{20}$	R^2
A. SP500: Dependent Variable is Equity Risk Premium*					
1.	0.140	−0.632			0.43
	(8.15)†	(−4.95)†			
2.	0.118	−0.660	0.754		0.58
	(7.10)†	(−5.93)†	(3.32)†		
3.	0.069	−0.235		1.448	0.57
	(3.44)†	(−1.76)		(4.18)†	
4.	0.030	−0.177	0.855	1.645	0.79
	(2.17)†	(−2.07)†	(4.68)†	(7.63)†	

Regression	Intercept	i_{20}	σ_g	$i_u - i_{20}$	R^2
B. SPUT: Dependent Variable is Equity Risk Premium*					
1.	0.110	−0.510			0.37
	(7.35)†	(−4.41)†			
2.	0.101	−0.543	0.805		0.41
	(6.28)†	(−4.68)†	(1.42)		
3.	0.051	−0.259		1.432	0.80
	(5.54)†	(−4.05)†		(8.87)†	
4.	0.049	−0.287	0.387	1.391	0.80
	(5.15)†	(−3.87)†	(0.75)	(8.14)†	

*All variables are defined in Exhibit 1 and graphed in Exhibit 6. Regressions were estimated for the 36 month period January 1982–December 1984 and were corrected for serial correlation using the Prais-Winsten method. For purposes of this regression variables are expressed in decimal form, *e.g.*, 14% = 0.14.

†Significantly different from zero at 0.05 level using two-tailed test.

cause of lower variability over time in the dispersion of FAF for utility stocks as compared to equities in general. The yield spread between utility and government bonds is significantly positively related to utility equity risk premia. And, as in the case of stocks in general, introduction of this spread substantially reduces the independent effect of interest rate levels on equity risk premia.

Given the short time series (36 months), tests for the stability of the relationships found in Exhibit 7 present difficulties. As a check, the relationships were reestimated dividing the data into two 18-month periods. For stocks in general (SP500), coefficients on σ_g and $(i_c - i_{20})$ were positive in all regressions and significantly so, except in the case of $(i_c - i_{20})$ for the second 18-month period. The coefficient of i_{20} was significantly negative in both periods. This confirms the general findings for the SP500 in Panel A of Exhibit 7. For utility stocks, results for the subperiods also matched the entire period results. The coefficients of $(i_u - i_{20})$ were significantly positive in both subperiods while those of σ_g were insignificantly different from zero. The level of interest rates (i_{20}) had a significant negative effect in both subperiods.

In summary, the estimated risk premia change over time and the patterns of such change are directly related to changes in proxies for the risks of equity investments. Risk premia for both stocks in general and utilities are inversely related to the level of government interest rates but positively related to the bond yield spreads which proxy for the incremental risk of investing in equities rather than government bonds. For stocks in general, risk premia also increase over time with increases in the general level of disagreement about future corporate performance.

VI. Conclusions

Notions of shareholder required rates of return and risk premia are based in theory on investors' expectations about the future. Research has demonstrated the usefulness of financial analysts' forecasts for such expectations. When such forecasts are used to derive equity risk premia, the results are quite encouraging. In addition to meeting the theoretical requirement of using expectational data, the procedure produces estimates of reasonable magnitude that behave as economic theory would predict. Both over time and across stocks, the risk premia vary directly with the perceived riskiness of equity investment.

The approach offers a straightforward and powerful aid in establishing required rates of return either for corporate investment decisions or in the regulatory arena. Since data are readily available on a wide range of equities, an investigator can analyze various proxy groups (*e.g.*, portfolios of utility stocks) appropriate for a particular decision. An additional advantage of the estimated risk premia is that they allow analysis of changes in equity return requirements over time. Tracking such changes is important for managers facing changing economic climates.

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7

Estimating Shareholder Risk Premia Using Analysts' Growth Forecasts

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■ One of the most widely used concepts in finance is that shareholders require a risk premium over bond yields to bear the additional risks of equity investments. While models such as the two-parameter capital asset pricing model (CAPM) or arbitrage pricing theory offer explicit methods for varying risk premia across securities, the models are invariably linked to some underlying market (or factor-specific) risk premium. Unfortunately, the theoretical models provide limited practical advice on establishing empirical estimates of such a benchmark market risk premium. As a result, the typical advice to practitioners is to estimate the market risk premium based on historical realizations of share and bond returns (see Brealey and Myers [3]).

In this paper, we present estimates of shareholder required rates of return and risk premia which are derived using forward-looking analysts' growth forecasts. We update, through 1991, earlier work which, due to data availability, was restricted to the period 1982-1984 (Harris [12]). Using stronger tests, we also reexamine the efficacy of using such an expectational approach as an alternative to the use of historical averages. Using the S&P 500 as a proxy for the market portfolio, we find an average market risk premium (1982-1991) of 6.47% above yields on long-term U.S. government bonds and 5.13% above yields on corporate bonds. We also find that required returns for individual stocks vary directly with their risk (as proxied by beta) and that the market risk premium varies over time. In particular, the equity market premium over government bond yields is higher in low interest rate environments and when there is a larger spread between corporate and government bond yields. These findings show that, in addition to fitting the theoretical requirement of being forward-looking, the utilization of analysts' forecasts in estimating return requirements provides reasonable empirical results that can be useful in practical applications.

Section I provides background on the estimation of equity required returns and a brief discussion of related

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literature on financial analysts' forecasts (FAF). In Section II, models and data are discussed. Following a comparison of the results to historical risk premia, the estimates are subjected to economic tests of both their time-series and cross-sectional characteristics in Section III. Finally, conclusions are offered in Section IV.

I. Background and Literature Review

In establishing economic criteria for resource allocation, it is often convenient to use the notion of a shareholder's required rate of return. Such a rate (k) is the minimum level of expected return necessary to compensate the investor for bearing risks and receiving dollars in the future rather than in the present. In general, k will depend on returns available on alternative investments (e.g., bonds or other equities) and the riskiness of the stock. To isolate the effects of risk, it is useful to work in terms of a risk premium (rp), defined as

$$rp = k - i, \tag{1}$$

where i = required return for a zero risk investment.[1]

Lacking a superior alternative, investigators often use averages of historical realizations to estimate a benchmark "market" risk premium which then may be adjusted for the relative risk of individual stocks (e.g., using the CAPM or a variant). The historical studies of Ibbotson Associates [13] have been used frequently to implement this approach.[2] This historical approach requires the assumptions that past realizations are a good surrogate for future expectations and, as typically applied, that risk premia are constant over time. Carleton and Lakonishok [5] demonstrate empirically some of the problems with such historical premia when they are disaggregated for different time periods or groups of firms.

As an alternative to historical estimates, the current paper derives estimates of k, and hence, implied values of rp, using publicly available expectational data. This expectational approach employs the dividend growth model (hereafter referred to as the discounted cash flow or DCF model) in which a consensus measure of financial analysts' forecasts (FAF) of earnings is used as a proxy for investor expectations. Earlier works by Malkiel [17], Brigham, Vinson, and Shome [4], and Harris [12] have used FAF in DCF models, and this approach has been employed in regulatory settings (see Harris [12]) and suggested by consultants as an alternative to use of historical data (e.g., Ibbotson Associates [13, pp. 127, 128]). Unfortunately, the published studies use data extending to 1984 at the latest. Our paper draws on this earlier work but extends it through 1991.[3] Our work is closest to that done by Harris [12], who reviews literature showing a strong link between equity prices and FAF and supporting the use of FAF as a proxy for investor expectations. Using data from 1982 to 1984, Harris' results suggest that this expectational approach to estimating equity risk premia is an encouraging alternative to the use of historical averages. He also demonstrates that such risk premia vary both cross-sectionally with the riskiness of individual stocks and over time with financial market conditions.

II. Models and Data

A. Model for Estimation

The simplest and most commonly used version of the DCF model to estimate shareholders' required rate of return, k, is shown in Equation (2):

$$k = \left(\frac{D_1}{P_0}\right) + g, \tag{2}$$

where D_1 = dividend per share expected to be received at time one, P_0 = current price per share (time 0), and g = expected growth rate in dividends per share. The limitations of this model are well known, and it is straightforward to derive expressions for k based on more general specifications of the DCF model.[4] The primary difficulty in using the DCF model is obtaining an estimate of g, since it should reflect market expectations of future perfor-

[1]Theoretically, i is a risk-free rate, though empirically its proxy (e.g., yield to maturity on a government bond) is only a "least risk" alternative that is itself subject to risk. In this development, the effects of tax codes on required returns are ignored.

[2]Many leading texts in financial management use such historical risk premia to estimate a market return. See, for example, Brealey and Myers [3]. Often a market risk premium is adjusted for the observed relative risk of a stock.

[3]See Harris [12] for a discussion of the earlier work and a detailed discussion of the approach employed here.

[4]As stated, Equation (2) requires expectations of either an infinite horizon of dividend growth at a rate g or a finite horizon of dividend growth at rate g and special assumptions about the price of the stock at the end of that horizon. Essentially, the assumption must ensure that the stock price grows at a compound rate of g over the finite horizon. One could alternatively estimate a nonconstant growth model, although the proxies for multistage growth rates are even more difficult to obtain than single stage growth estimates. Marston, Harris, and Crawford [19] examine publicly available data from 1982-1985 and find that plausible measures of risk are more closely related to expected returns derived from a constant growth model than to those derived from multistage growth models. These findings illustrate empirical difficulties in finding empirical proxies for multistage growth models for large samples.

mance. Without a ready source for measuring such expectations, application of the DCF model is fraught with difficulties. This paper uses published FAF of long-run growth in earnings as a proxy for g.

B. Data

FAF for this research come from IBES (Institutional Broker's Estimate System), which is a product of Lynch, Jones, and Ryan, a major brokerage firm.[5] Representative of industry practice, IBES contains estimates of (*i*) EPS for the upcoming fiscal years (up to five separate years), and (*ii*) a five-year growth rate in EPS. Each item is available at monthly intervals.

The mean value of individual analysts' forecasts of five-year growth rate in EPS will be used as a proxy for g in the DCF model.[6] The five-year horizon is the longest horizon over which such forecasts are available from IBES and often is the longest horizon used by analysts. IBES requests "normalized" five-year growth rates from analysts in order to remove short-term distortions that might stem from using an unusually high or low earnings year as a base.

Dividend and other firm-specific information come from COMPUSTAT. Interest rates (both government and corporate) are gathered from Federal Reserve Bulletins and *Moody's Bond Record*. Exhibit 1 describes key variables used in the study. Data collected cover all dividend paying stocks in the Standard & Poor's 500 stock (S&P 500) index, plus approximately 100 additional stocks of regulated companies. Since five-year growth rates are first available from IBES beginning in 1982, the analysis covers the 113-month period from January 1982 to May 1991.

III. Risk Premia and Required Rates of Return

A. Construction of Risk Premia

For each month, a "market" required rate of return is calculated using each dividend paying stock in the S&P 500 index for which data are available. The DCF model in

Exhibit 1. Variable Definitions

For equity

k	=	Equity required rate of return.
P_0	=	Average daily price per share.
D_1	=	Expected dividend per share measured as current indicated annual dividend from COMPUSTAT multiplied by $(1 + g)$.[a]
g	=	Average financial analysts' forecast of five-year growth rate in earnings per share (from IBES).
i_{lt}	=	Yield to maturity on long-term U.S. government obligations (source: Federal Reserve Bulletin, constant maturity series).
i_c	=	Yield to maturity on long-term corporate bonds: Moody's average.[b]
rp	=	Equity risk premium calculated as $rp = k - i$.
β	=	beta, calculated from CRSP monthly data over 60 months.

Notes:
[a]See footnote 7 for a discussion of the $(1 + g)$ adjustment.
[b]The average corporate bond yield across bond rating categories as reported by Moody's. See *Moody's Bond Survey* for a brief description and the latest published list of bonds included in the bond rating categories.

Equation (2) is applied to each stock and the results weighted by market value of equity to produce the market required return.[7] The return is converted to a risk premium

[5]Harris [12] provides a discussion of IBES data and its limitations. In more recent years, IBES has begun collecting forecasts for each of the next five years. Since this work was completed, the FAF used here have become available from IBES Inc., now a subsidiary of CitiBank.
[6]While the model calls for expected growth in dividends, no source of data on such projections is readily available. In addition, in the long run, dividend growth is sustainable only via growth in earnings. As long as payout ratios are not expected to change, the two growth rates will be the same.

[7]The construction of D_1 is controversial since dividends are paid quarterly and may be expected to change during the year; whereas, Equation (2), as is typical, is being applied to annual data. Both the quarterly payment of dividends (due to investors' reinvestment income before year's end, see Linke and Zumwalt [15]) and any growth during the year require an upward adjustment of the current annual rate of dividends to construct D_1. If quarterly dividends grow at a constant rate, both factors could be accommodated straightforwardly by applying Equation (2) to quarterly data with a quarterly growth rate and then annualizing the estimated quarterly required return. Unfortunately, with lumpy changes in dividends, the precise nature of the adjustment depends on both an individual company's pattern of growth during the calendar year and an individual company's required return (and hence reinvestment income in the risk class).
In this work, D_1 is calculated as $D_0 (1 + g)$. The full g adjustment is a crude approximation to adjust for both growth and reinvestment income. For example, if one expected dividends to have been raised, on average, six months ago, a "1/2 g" adjustment would allow for growth, and the remaining "1/2 g" would be justified on the basis of reinvestment income. Any precise accounting for both reinvestment income and growth would require tracking each company's dividend change history and making explicit judgments about the quarter of the next change. Since no organized "market" forecast of such a detailed nature exists, such a procedure is not possible. To get a feel for the magnitudes involved, during the sample period the dividend yield (D_1/P_0) and growth (market value weighted) for the S&P 500 were typically 4% to 6% and 11% to 13%, respectively. As a result, a "full g" adjustment on average increases the required return by 60 to 70 basis points (relative to no g adjustment).

Exhibit 2. Bond Market Yields, Equity Required Return, and Equity Risk Premium,[a] 1982-1991

Year	Bond Market Yields[b] (1) U.S. Gov't	Bond Market Yields[b] (2) Moody's Corporates	Equity Market Required Return[c] (3) S&P 500	Equity Risk Premium U.S. Gov't (3) - (1)	Equity Risk Premium Moody's Corporates (3) - (2)
1982	12.92	14.94	20.08	7.16	5.14
1983	11.34	12.78	17.89	6.55	5.11
1984	12.48	13.49	17.26	4.78	3.77
1985	10.97	12.05	16.32	5.37	4.28
1986	7.85	9.71	15.09	7.24	5.38
1987	8.58	9.84	14.71	6.13	4.86
1988	8.96	10.18	15.37	6.41	5.19
1989	8.46	9.66	15.06	6.60	5.40
1990	8.61	9.77	15.69	7.08	5.92
1991[d]	8.21	9.41	15.61	7.40	6.20
Average[e]	9.84	11.18	16.31	6.47	5.13

Notes:
[a]Values are averages of monthly figures in percent.
[b]Yields to maturity.
[c]Required return on value weighted S&P 500 index using Equation (1).
[d]Figures for 1991 are through May.
[e]Months weighted equally.

over government bonds by subtracting i_{lt}, the yield to maturity on long-term government bonds. A risk premium over corporate bond yields is also constructed by subtracting i_c, the yield on long-term corporate bonds. Exhibit 2 reports the results by year (averages of monthly data).

The results are quite consistent with the patterns reported earlier (i.e., Harris [12]). The estimated risk premia in Exhibit 2 are positive, consistent with equity owners demanding additional rewards over and above returns on debt securities. The average expectational risk premium (1982 to 1991) over government bonds is 6.47%, only slightly higher than the 6.16% average for 1982 to 1984 reported earlier (Harris [12]). Furthermore, Exhibit 2 shows the estimated risk premia change over time, suggesting changes in the market's perception of the incremental risk of investing in equity rather than debt securities.

For comparison purposes, Exhibit 3 contains historical returns and risk premia. The average expectational risk premium reported in Exhibit 2 falls roughly midway between the arithmetic (7.5%) and geometric (5.7%) long-term differentials between returns on stocks and long-term government bonds. Note, however, that the expectational risk premia appear to change over time. In the following sections, we examine the estimated risk premia to see if they vary cross-sectionally with the risk of individual stocks and over time with financial market conditions.

B. Cross-Sectional Tests

Earlier, Harris [12] conducted crude tests of whether expectational equity risk premia varied with risk proxied by bond ratings and the dispersion of analysts' forecasts and found that required returns increased with higher risk. Here we examine the link between these premia and beta, perhaps the most commonly used measure of risk for equities.[8] In keeping with traditional work in this area, we adopt the methodology introduced by Fama and Macbeth [9] but replace realized returns with expected returns from Equation (2) as the variable to be explained. For this portion of our tests, we restrict our sample to 1982-1987

[8]For other efforts using expectational data in the context of the two-parameter CAPM, see Friend, Westerfield, and Granito [10], Cragg and Malkiel [7], Marston, Crawford, and Harris [19], Marston and Harris [20], and Linke, Kannan, Whitford, and Zumwalt [16]. For a more complete treatment of the subject, see Marston and Harris [20] from which we draw some of these results. Marston and Harris also investigate the role of unsystematic risk and the difference in estimates found when using expected versus realized returns.

Exhibit 3. Average Historical Returns on Bonds, Stocks, Bills, and Inflation in the U.S., 1926-1989

Historical Return Realizations	Geometric	Arithmetic
Common stock	10.3%	12.4%
Long-term government bonds	4.6%	4.9%
Long-term corporate bonds	5.2%	5.5%
Treasury bills	3.6%	3.7%
Inflation rate	3.1%	3.2%

Source: Ibbotson Associates, Inc., *1990 Stocks, Bonds, Bills and Inflation*, 1990 Yearbook.

and in any month include firms that have at least three forecasts of earnings growth to reduce measurement error associated with individual forecasts.[9] This restricted sample still consists of, on average, 399 firms for each of the 72 months (or 28,744 company months).

For a given company in a given month, beta is estimated via the market model (using ordinary least squares) on the prior 60 months of return data taken from CRSP. Beta estimates are updated monthly and are calculated against an equally weighted index of all NYSE securities. For each month, we aggregate firms into 20 portfolios (consisting of approximately 20 securities each). The advantage of grouped data is the reduction in potential measurement error inherent in independent variables at the company level. Portfolios are formed based on a ranking of beta estimated from a prior time period (t = -61 to t = -120). Portfolio expected returns and beta are calculated as the simple averages for the individual securities.

Using these data, we estimate the following model for each of the 72 months:

$$R_p = \alpha_0 + \alpha_1 \beta_p + u_p, \quad p = 1...20, \qquad (3)$$

where:

R_p = Expected return for portfolio p in the given month,

β_p = Portfolio beta, estimated over 60 prior months, and

u_p = A random error term with mean zero.

As a result of estimating regression (3) for each month, 72 estimates of each coefficient (α_0 and α_1) are obtained. Using realized returns as the dependent variable, the traditional approach (e.g., Fama and Macbeth [9]) is to assume that realized returns are a fair game. Given this assumption, the mean of the 72 values of each coefficient is an unbiased estimate of the mean over that same time period if one could have actually used expected returns as the dependent variable. Note that if expected returns are used as the dependent variable the fair-game assumption is not required. Making the additional assumption that the true value of the coefficient is constant over the 72 months, a test of whether the mean coefficient is different from zero is performed using a t-statistic where the denominator is the standard error of the 72 values of the coefficient. This is the technique employed by Fama and Macbeth [9]. If one assumes the CAPM is correct, the coefficient α_1 is an empirical estimate of the market risk premium, which should be positive.

To test the sensitivity of the results, we also repeat our procedures using individual security returns rather than portfolios. To account, at least in part, for differences in precision of coefficient estimates in different months we also report results in which monthly parameter estimates are weighted inversely by the standard error of the coefficient estimate rather than being weighted equally (following Chan, Hamao, and Lakonishok [6]).

Exhibit 4 shows that there is a significant positive link between expectational required returns and beta. For instance, in Panel A, the mean coefficient of 2.78 on beta is significantly different from zero at better than the 0.001 level (t = 35.31), and each of the 72 monthly coefficients going into this average is positive (as shown by that 100% positive figure). Using individual stock returns, the significant positive link between beta and expected return remains, though it is smaller in magnitude than for portfolios.[10] Comparison of Panels A and B shows that the results are not sensitive to the weighting of monthly coefficients.

While the findings in Exhibit 4 suggest a strong positive link between beta and risk premia (a result often not supported when realized returns are used as a proxy for expectations; e.g., see Tinic and West [22]), the results do not support the predictions of a simple CAPM. In particular, the intercept is higher than a proxy for the risk-free rate over the sample period and the coefficient of beta is well below estimates of a market risk premium obtained from either expectational (Exhibit 2) or historical data (Exhibit

[9]Firms for which the standard deviation of individual FAF exceeded 20 in any month were excluded since we suspect some of these involve errors in data entry. This screen eliminated very few companies in any month. The 1982-1987 period was chosen due to the availability of data on betas.

[10]The smaller coefficients on beta using individual stock portfolio returns are likely due in part to the higher measurement error in measuring individual stock versus portfolio betas.

Exhibit 4. Mean Values of Monthly Parameter Estimates for the Relationship Between Required Returns and Beta for Both Portfolios and Individual Securities (Figures in Parentheses are *t* Values and Percent Positive), 1982-1987

	Intercept	B	Adjusted $R^{2\,c}$	F^c
Panel A. Equal Weighting[a]				
Portfolio returns	14.06 (54.02, 100)	2.78 (35.31, 100)	0.503	25.4
Security returns	14.77 (58.10, 100)	1.91 (16.50, 99)	0.080	39.0
Panel B. Weighted by Standard Errors[b]				
Portfolio returns	13.86 (215.6, 100)	2.67 (35.80, 100)	0.503	25.4
Security returns	14.63 (398.9, 100)	1.92 (47.3, 99)	0.080	39.0

[a]Equally weighted average of monthly parameters estimated using cross-sectional data for each of the 72 months, January 1982 - December 1987.
[b]In obtaining the reported means, estimates of the monthly intercept and slope coefficients are weighted inversely by the standard error of the estimate from the cross-sectional regression for that month.
[c]Values are averages for the 72 monthly regressions.

3).[11] Nonetheless, the results show that the estimated risk premia conform to the general theoretical relationship between risk and required return that is expected when investors are risk-averse.

C. Time Series Tests — Changes in Market Risk Premia

A potential benefit of using ex ante risk premia is the estimation of changes in market risk premia over time. With changes in the economy and financial markets, equity investments may be perceived to change in risk. For instance, investor sentiment about future business conditions likely affects attitudes about the riskiness of equity investments compared to investments in the bond markets. Moreover, since bonds are risky investments themselves, equity risk premia (relative to bonds) could change due to changes in perceived riskiness of bonds, even if equities displayed no shifts in risk. For example, during the high interest rate period of the early 1980s, the high level of interest rate volatility made fixed income investments more risky holdings than they were in a world of relatively stable rates.

[11]Estimation difficulties confound precise interpretation of the intercept as the risk-free rate and the coefficient on beta as the market risk premium (see Miller and Scholes [21], and Black, Jensen, and Scholes [2]). The higher than expected intercept and lower than expected slope coefficient on beta are consistent with the prior studies of Black, Jensen, and Scholes [2], and Fama and MacBeth [9] using historical returns. Such results are consistent with Black's [1] zero beta model, although alternative explanations for these findings exist as well (as noted by Black, Jensen, and Scholes [2]).

Studying changes in risk premia for utility stocks, Brigham, et al [4] conclude that, prior to 1980, utility risk premia increased with the level of interest rates, but that this pattern reversed thereafter, resulting in an inverse correlation between risk premia and interest rates. Studying risk premia for both utilities and the equity market generally, Harris [12] also reports that risk premia appear to change over time. Specifically, he finds that equity risk premia decreased with the level of government interest rates, increased with the increases in the spread between corporate and government bond yields, and increased with increases in the dispersion of analysts' forecasts. Harris' study is, however, restricted to the 36-month period, 1982 to 1984.

Exhibit 5 reports results of analyzing the relationship between equity risk premia, interest rates, and yield spreads between corporate and government bonds. Following Harris [12], these bond yield spreads are used as a time series proxy for equity risk. As the perceived riskiness of corporate activity increases, the difference between yields on corporate bonds and government bonds should increase. One would expect the sources of increased riskiness to corporate bonds to also increase risks to shareholders. All regressions in Exhibit 5 are corrected for serial correlation.[12]

[12]Ordinary least squares regressions showed severe positive autocorrelation in many cases, with Durbin Watson statistics typically below one. Estimation used the Prais-Winsten method. See Johnston [14, pp. 321-325].

Exhibit 5. Changes in Equity Risk Premia Over Time — Entries are Coefficient (*t*-value); Dependent Variable is Equity Risk Premium

Time period	Intercept	i_{lt}	$i_c - i_{lt}$	R^2
A. May 1991-1992	0.131 (19.82)	-0.651 (-11.16)		0.53
	0.092 (14.26)	-0.363 (-6.74)	0.666 (5.48)	0.54
B. 1982-1984	0.140 (8.15)	-0.637 (-5.00)		0.43
	0.064 (3.25)	-0.203 (-1.63)	1.549 (4.84)	0.60
C. 1985-1987	0.131 (7.73)	-0.739 (-9.67)		0.74
	0.110 (12.53)	-0.561 (-7.30)	0.317 (1.87)	0.77
D. 1988-1991	0.136 (16.23)	-0.793 (-8.29)		0.68
	0.130 (8.71)	-0.738 (-4.96)	0.098 (0.40)	0.68

Note: All variables are defined in Exhibit 1. Regressions were estimated using monthly data and were corrected for serial correlation using the Prais-Winsten method. For purposes of this regression, variables are expressed in decimal form, e.g., 14% = 0.14.

For the entire sample period, Panel A shows that risk premia are negatively related to the level of interest rates — as proxied by yields on government bonds, i_{lt}. This negative relationship is also true for each of the subperiods displayed in Panels B through D. Such a negative relationship may result from increases in the perceived riskiness of investment in government debt at high levels of interest rates. A direct measure of uncertainty about investments in government bonds would be necessary to test this hypothesis directly.

For the entire 1982 to 1991 period, the addition of the yield spread risk proxy to the regressions dramatically lowers the magnitude of the coefficient on government bond yields, as can be seen by comparing Equations 1 and 2 of Panel A. Furthermore, the coefficient of the yield spread (0.666) is itself significantly positive. This pattern suggests that a reduction in the risk differential between investment in government bonds and in corporate activity is translated into a lower equity market risk premium. Further examination of Panels B through D, however, suggests that the yield spread variable is much more important in explaining changes in equity risk premia in the early portion of the 1980s than in the 1988 to 1991 period.

In summary, market equity risk premia change over time and appear inversely related to the level of government interest rates but positively related to the bond yield spread, which proxies for the incremental risk of investing in equities as opposed to government bonds.

IV. Conclusions

Shareholder required rates of return and risk premia are based on theories about investors' expectations for the future. In practice, however, risk premia are often estimated using averages of historical returns. This paper applies an alternate approach to estimating risk premia that employs publicly available expectational data. At least for the decade studied (1982 to 1991), the resultant average market equity risk premium over government bonds is comparable in magnitude to long-term differences (1926 to 1989) in historical returns between stocks and bonds. There is strong evidence, however, that market risk premia change over time and, as a result, use of a constant historical average risk premium is not likely to mirror changes in investor return requirements. The results also show that the expectational risk premia vary cross-sectionally with the relative risk (beta) of individual stocks.

The approach offers a straightforward and powerful aid in establishing required rates of return either for corporate investment decisions or in the regulatory arena. Since data are readily available on a wide range of equities, an investigator can analyze various proxy groups (e.g., portfolios of utility stocks) appropriate for a particular decision as well as analyze changes in equity return requirements over time.

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An empirical study of ex ante risk premiums for the electric utility industry

by Farris M. Maddox, Donna T. Pippert, Rodney N. Sullivan

Several studies published in recent years support an inverse relationship between utility equity risk premiums and interest rates during the first half of the 1980s. Our study provides a more current examination of this relationship. Our findings support the conclusion that equity risk premiums for utility stocks continue to vary inversely with interest rates. Further, the inverse relationship between interest rates and risk premiums appears stable over the sample period; however, market behavior at certain points in the sample period appears to reflect changes in the market's evaluation of the relative risk of Treasury bonds and utility stocks. For instance, significant differences in the level of the risk premium were observed during certain periods, irrespective of the level of interest rates. Considering the dynamic nature of risk premiums, we discuss how the study may be applicable for estimating the cost of equity for utilities.

Section I provides background information and a literature review. Section II describes the research methodology and the data. Section III provides the empirical results. Section IV furnishes an example to illustrate the model's usefulness. Section V furnishes conclusions.

I. Background and Literature Review

The determination of an appropriate cost of equity is a controversial issue in utility rate proceedings. Bond yields provide a readily observable, definitive measure of the market's required return on that investment; however, such a measure is not readily available for stocks. The indefinite life and uncertainty of a firm's future earnings make it necessary to employ theoretical models to arrive at an estimate of the cost of equity. All theoretical models have strengths and weaknesses, and the focus in utility rate proceedings is often on what is wrong with a particular approach rather than what is right. However, the nebulous nature of the true cost of equity provides no definitive way to assess the superiority of one method's results over another's. Consequently, several cost of equity models are typically used to develop a final estimate.

The risk premium method is an alternative approach to the prevalent discounted cash flow (DCF) model in estimating the cost of equity. A fundamental tenet of financial theory is that riskier investments should command a higher expected return than less risky investments. The risk premium may be defined as the difference, or spread, between expected returns on alternative investments. Financial textbooks usually illustrate risk premiums based on a theoretical risk-free rate and the rate for alternative-risk investments along the security market line.

A widespread application of the risk premium method is based on an average of the realized spreads between total returns on equity and debt investments over some historical period. A refinement of this approach is to calculate the average spread between realized equity total returns and bond yields, in order to obtain a forward-looking measure of the required return on debt. Either type of average risk premium is then added to the current cost of debt to obtain a current cost of equity estimate. The assumption implicit in such approaches is that a constant risk premium is embodied in the current cost of equity. A corollary assumption is that the constant risk premium embodied in expected returns is equal to the average of risk premiums measured from realized returns. In actuality, the time period over which past returns are measured can result in significantly different risk premiums. However, many practitioners of this method argue that if the market risk premium is constant, then it is best approximated by realized returns over very long periods of time. These factors underlie the weaknesses of an ex post risk premium approach. Still, this method has cognitive appeal due to the almost tangible dimension added by the measurement of risk premiums from observed returns. There is also great practical appeal to this approach because it is easy to implement by using readily accessible data from sources like Ibbotson Associates (1993), which provide a regularly updated and consistently available compilation of various risk premiums based on holding periods beginning in 1926.

In recent years, an alternative risk premium model has been proposed. It relies on the expected cost of equity, rather than realized returns, as the appropriate basis for measuring risk premiums. Several studies empirically support the hypothesis that risk premiums, as measured by the expected cost of equity, are not constant but, instead, vary inversely with interest rates (Brigham, Shome, and Vinson, 1985; Harris, 1986; Harris and Marston, 1992; and Shome and Smith, 1988). Generally, studies supporting an ex ante risk premium approach are based on data from as early as the mid-1960s through the mid-1980s. The measurement of the ex ante risk premium holds conceptual appeal because it is consistent with the valuation of equity investments based on expected returns. However, a practical concern is the reliability of a risk premium measure that must be based upon an estimate of the cost of equity obtained by some other method, such as a DCF model. If problems exist in the formulation of the model used to estimate the cost of equity, those problems are transferred to the risk premium estimate.

An ex ante risk premium study by Brigham et al. (1985) supported the existence of an inverse relationship between interest rates and utility stock risk premiums from 1980 through the first half of 1984. To determine these risk premiums, they employed a two-stage DCF model to obtain monthly cost of equity estimates for utility stocks. Risk premium measures for each month were then derived by deducting an appropriate Treasury bond yield each month. They found that, prior to 1980, the relationship between equity risk premiums and interest rates had been positive. Shome and Smith (1988) obtained similar results, finding an inverse relationship between interest rates and electric utility risk premiums that continued through 1985. Both studies discussed factors that reduced the impact of regulatory lag on utility stocks from the late 1970s into the early 1980s. Both studies concluded that reduced regulatory lag contributed to shifting the relative risk relationship between debt and utility stocks from positive to negative.

These studies were by and large an outgrowth of the market climate of the early 1980s. During that time, the risk of debt instruments rose in both an absolute sense and compared to stocks. This environment led many to conclude that the risk premium had narrowed and some to even argue it was negative.

Shome and Smith (1988) note that while stocks and bonds are both considered to be hedges against anticipated inflation, common stocks are considered to offer a partial hedge against unanticipated inflation. Therefore, during periods of greater inflation uncertainty, Smith and Shome argue that it would seem reasonable that equity risk premiums would decline as interest rates rise (see Gordon and Halpern, 1976). Stated another way, the risk and required return of the less complete hedge (i.e., debt) would increase at a relatively greater rate than the more complete hedge (i.e., equity), thereby reducing the risk premium during periods of higher uncertainty. However, Carleton, Chambers, and Lakonishok (1983) furnish empirical evidence that risk premiums for utility stocks tend to rise with inflation and interest rates if regulatory lag severely hampers earnings and prevents dividends from keeping pace with inflation.

Harris (1986) also finds an inverse relationship between interest rates and ex ante risk premium measures during the early to mid- 1980s, based on utility and broader stock market indices. In a more recent study, Harris and Marston (1992) find an inverse relationship between interest rates and ex ante risk premiums for stocks in the S&P 500, based on data from 1982 to 1991. Blanchard (1993) studied real, rather than nominal, risk premiums between 1926 and 1993. Blanchard hypothesized that the persistence of relatively high risk premiums from the late 1930s through the 1940s could have been due to the market's reaction to the high stock market volatility in the late 1920s and early 1930s. Blanchard also suggested that changes in inflation had a more temporal impact on the relative risk of debt and equity. He concluded that there was a declining trend in real risk premiums for the broad market since the 1950s, to a current level of about 2% to 3%. He also concluded that inflation contributed to a transitory increase above the trend in the 1970s and to a transitory decrease below the trend in the 1980s. However, Blanchard finds that real risk premiums were negative throughout much of the 1980s, which leads to the question as to whether the method he used to measure risk premiums is consistent with the basic risk/return tenet of financial theory.

Any forward-looking cost of capital calculation already embodies tax effects since investors price securities on the basis of after-tax returns. Besides, a very large proportion of trading is conducted by tax-exempt financial institutions (pension funds, mutual funds, 401K, etc.) for whom tax issues are largely immaterial.

The existence of a negative risk premium is highly unlikely, as it is at serious odds with the basic tenets of finance, economics, and law. Using proper definitions for expected rates of return of equity and debt, the preponderance of the evidence indicates that the negative risk premium does not exist. Several risk premium studies cited in this chapter have found positive risk premiums well in excess of 5% over the last decade. Risk premiums do narrow during unusually turbulent and volatile interest rate environments, but then return to normal levels. They are most unlikely to ever become negative.

4.7 Risk Premium Determinants

Fundamentally, the primary determinant of expected returns is risk. To wit, the various paradigms of financial theory, including the Capital Asset Pricing Model and the Arbitrage Pricing Model covered in subsequent chapters, posit fundamental relationships between return and risk. There are also secondary influences on the relative magnitude of the risk premium, however, including the level of interest rates, default risk, and taxes.

Interest Rates

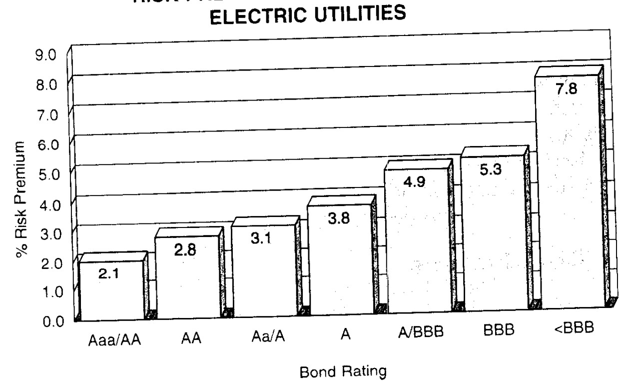
Published studies by Brigham, Shome, and Vinson (1985), Harris (1986), Harris and Marston (1992, 1993), Carleton, Chambers, and Lakonishok (1983), Morin, (2005), and McShane (2005), and others demonstrate that, beginning in 1980, risk premiums varied inversely with the level of interest rates—rising when rates fell and declining when interest rates rose. The reason for this relationship is that when interest rates rise, bondholders suffer a capital loss. This is referred to as interest rate risk. Stockholders, on the other hand, are more concerned with the firm's earning power. So, if bondholders' fear of interest rate risk exceeds shareholders' fear of loss of earning power, the risk differential will narrow and hence the risk premium will shrink. This is particularly true in high inflation environments. Interest rates rise as a result of accelerating inflation, and the interest rate risk of bonds intensifies more than the earnings risk of common stocks, which are partially hedged from the ravages of inflation. This phenomenon has been termed as a "lock-in" premium. Conversely in low interest rate environments, when bondholders' interest rate fears subside and shareholders' fears of loss of earning power dominate, the risk differential will widen and hence the risk premium will increase.

Harris (1986) showed that for every 100 basis point change in government bond yields, the equity risk premium for utilities changes 51 basis points in the opposite direction, for a net change in the cost of equity of 49 basis points. For example, a 100 basis point decline in government bond yields would lead to a 51 basis point increase in the equity risk premium and therefore an overall decrease in the cost of equity of 49 basis points, a result almost identical to the estimate reported in Morin (2005). As discussed earlier, similar results were uncovered by McShane (2005), who examined the statistical relationship between DCF-derived risk premiums and interest rates using a sample of natural gas distribution utilities.

The gist of the empirical research on this subject is that the cost of equity has changed only half as much as interest rates have changed in the past. The knowledge that risk premiums vary inversely to the level of interest rates can be used to adjust historical risk premiums to better reflect current market conditions. Thus, when interest rates are unusually high (low), the appropriate current risk premium is somewhat below (above) that long-run average. The empirical research cited above provides guidance as to the magnitude of the adjustment.

Risk premiums also tend to fluctuate with changes in investor risk aversion. Such changes can be tracked by observing the yield spreads between different bond rating categories over time. Brigham, Shome, and Vinson (1985) examined the relationship between risk premium and bond rating and found, unsurprisingly, that the risk premiums are higher for lower rated firms than for higher rated firms. Figure 4-5 shows the results graphically.

FIGURE 4-5
RISK PREMIUMS VS BOND RATINGS
ELECTRIC UTILITIES



Source: Brigham, Shome, and Vinson (1985).

Taxes

Significant changes in the relative taxation of returns received from stocks and bonds can also influence risk premiums. Measured risk premiums will in fact incorporate investor adjustments to relative taxation rates, since it is pre-tax risk premiums that are measured from capital market data rather than post-tax quantities.

Some analysts have therefore argued that there should be an adjustment for taxation differentials between securities and investors. This presents a gargantuan practical problem, however. If a regulatory commission were to seek to enable the utility to compensate investors for their after-tax returns, there could be as many returns as there are tax bracket variations, and they would defy analysis. It is impractical to determine the constellation of tax brackets for all the company's shareholders, and to determine the identity and tax bracket of the marginal price-setting investor. This argument ignores the fact that several institutional investors are not taxable, such as pension funds, and they engage in very large amounts of trading on security markets. Taxable retail investors are relatively inactive traders when compared to large non-taxable investors who have a substantial influence on capital markets.

Fundamentally, the core determinant of expected returns is not taxability, it is risk. Taxable investors will examine the risk-return tradeoff offered by various securities first, and as a secondary matter, the taxability issue.

Not only is it unrealistic to attempt to target tax clienteles in issuing securities but this presents investors with a serious practical dilemma. If a utility could target non-taxable investors only for bonds, it would follow that a coupon considerably less than the current return on common equity would be acceptable, since the bonds have much lower risk. But when the buyer of such bonds decided to sell securities, he or she would confront a serious dilemma because the taxable would-be buyers would require vastly higher returns (would be willing to pay a much lower price). The seller would face a large capital loss on resale, or would be forced to sell the bonds to other non-taxable investors. But the latter would have no incentive to trade with the seller, because they would have the opportunity of purchasing many other alternative securities providing a higher yield.

4.8 Conclusions

The risk premium method is conceptually sound and firmly rooted in the conceptual framework of Capital Market Theory, which is the subject of the next chapter. Data requirements to implement the method are not prohibitive. The methodology is responsive to changes in capital market conditions and provides a timely signaling device for current interest rate trends in contrast to the DCF method, which may be sluggish in detecting changes in return requirements, especially when based on historical data.

One advantage of risk premium over DCF is that the former is a period-by-period (time-series) study of the cost of equity over the cost of debt, in contrast to the latter which is a point-in-time cross-sectional estimate. In other words, the risk premium approach takes a broader time-series perspective rather than a snapshot point-in-time viewpoint, and is therefore less vulnerable to the vagaries of any one particular capital market environment. A prospective risk premium test relies on a succession of DCF observations over long periods, and is not as vulnerable to a given capital market environment as a spot DCF test.

Of course, the estimation of the appropriate risk premium for either the equity market as a whole or for a specific utility company, is not an exact science. Therefore, it is necessary to evaluate a broad spectrum of data and apply alternative risk premium estimation approaches in order to derive a fair and reasonable estimate of the required equity risk premium. Equal emphasis should be accorded to risk premium results based on history and those based on prospective data. Each proxy for expected risk premium brings information to the judgment process from a different light. Neither proxy is without blemish, each has advantages and shortcomings. Historical risk premiums over long periods are available and verifiable, but may no longer be applicable if structural shifts have occurred. Prospective risk premiums may be more relevant since they encompass both history and current changes, but are nevertheless imperfect proxies and are subject to measurement error and to the vagaries of the DCF input proxies.

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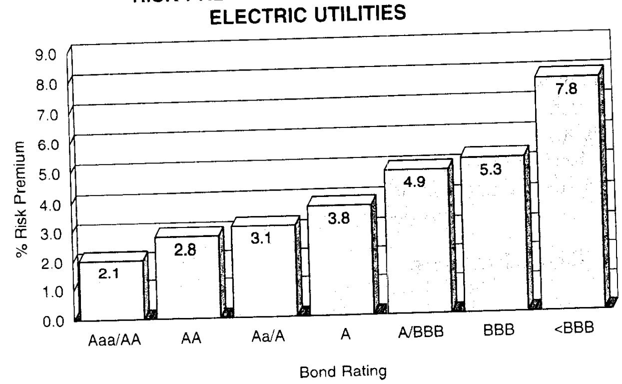

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The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks
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THE EFFECT OF THE FIRM'S CAPITAL STRUCTURE ON THE SYSTEMATIC RISK OF COMMON STOCKS

ROBERT S. HAMADA*

I. INTRODUCTION

ONLY RECENTLY has there been an interest in relating the issues historically associated with corporation finance to those historically associated with investment and portfolio analyses. In fact, rigorous theoretical attempts in this direction were made only since the capital asset pricing model of Sharpe [13], Lintner [6], and Mossin [11], itself an extension of the Markowitz [7] portfolio theory. This study is one of the first empirical works consciously attempting to show and test the relationships between the two fields. In addition, differences in the observed systematic or nondiversifiable risk of common stocks, β, have never really been analyzed before by investigating some of the underlying differences in the firms.

In the capital asset pricing model, it was demonstrated that the efficient set of portfolios to any individual investor will always be some combination of lending at the risk-free rate and the "market portfolio," or borrowing at the risk-free rate and the "market portfolio." At the same time, the Modigliani and Miller (MM) propositions [9, 10] on the effect of corporate leverage are well known to the students of corporation finance. In order for their propositions to hold, personal leverage is required to be a perfect substitute for corporate leverage. If this is true, then corporate borrowing could substitute for personal borrowing in the capital asset pricing model as well.

Both in the pricing model and the MM theory, borrowing, from whatever source, while maintaining a fixed amount of equity, increases the risk to the investor. Therefore, in the mean-standard deviation version of the capital asset pricing model, the covariance of the asset's rate of return with the market portfolio's rate of return (which measures the nondiversifiable risk of the asset—the proxy β will be used to measure this) should be greater for the stock of a firm with a higher debt-equity ratio than for the stock of another firm in the same risk-class with a lower debt-equity ratio.[1]

This study, then, has a number of purposes. First, we shall attempt to link empirically corporation finance issues with portfolio and security analyses through the effect of a firm's leverage on the systematic risk of its common

* Graduate School of Business, University of Chicago, currently visiting at the Graduate School of Business Administration, University of Washington. The research assistance of Christine Thomas and Leon Tsao is gratefully acknowledged. This paper has benefited from the comments made at the Finance Workshop at the University of Chicago, and especially those made by Eugene Fama. Remaining errors are due solely to the author.

1. This very quick summary of the theoretical relationship between what is known as corporation finance and the modern investment and portfolio analyses centered around the capital asset pricing model is more thoroughly presented in [5], along with the necessary assumptions required for this relationship.

stock. Then, we shall attempt to test the MM theory, or at least provide another piece of evidence on this long-standing controversial issue. This test will not rely on an explicit valuation model, such as the MM study of the electric utility industry [8] and the Brown study of the railroad industry [2]. A procedure using systematic risk measures (β s) has been worked out in this paper for this purpose.

If the MM theory is validated by this procedure, then the final purpose of this study is to demonstrate a method for estimating the cost of capital of individual firms to be used by them for scale-changing or nondiversifying investment projects. The primary component of any firm's cost of capital is the capitalization rate for the firm if the firm had no debt and preferred stock in its capital structure. Since most firms do have fixed commitment obligations, this capitalization rate (we shall call it $E(R_A)$; MM denote it ρ^τ) is unobservable. But if the MM theory and the capital asset pricing model are correct, then it is possible to estimate $E(R_A)$ from the systematic risk approach for individual firms, even if these firms are members of a one-firm risk-class.[2]

With this statement of the purposes for this study, we shall, in Section II, discuss the alternative general procedures that are possible for estimating the effect of leverage on systematic risk and select the most feasible ones. The results are presented in Section III. And finally, tests of the MM versus the traditional theories of corporation finance are presented in Section IV.

II. Some Possible Procedures and the Selected Estimating Relationships

There are at least four general procedures that can be used to estimate the effect of the firm's capital structure on the systematic risk of common stocks. The first is the MM valuation model approach. By estimating ρ^τ with an explicit valuation model as they have for the electric utility industry, it is possible to relate this ρ^τ with the use of the capital asset pricing model to a nonleveraged systematic risk measure, ${}_A\beta$. Then the difference between the observed common stock's systematic risk (which we shall denote ${}_B\beta$) and ${}_A\beta$ would be due solely to leverage. But the difficulties of this approach for all firms are many.

The MM valuation model approach requires the specification, in advance, of risk-classes. All firms in a risk-class are then assumed to have the same ρ^τ—the capitalization rate for an all-common equity firm. Unfortunately, there must be enough firms in a risk-class so that a cross-section analysis will yield statistically significant coefficients. There may not be many more risk-classes (with enough observations) now that the electric utility and railroad industries have been studied. In addition, the MM approach requires estimating expected asset earnings and estimating the capitalized growth potential implicit in stock prices. If it is possible to consider growth and expected earnings without having

2. It is, in fact, this last purpose of making applicable and practical some of the implications of the capital asset pricing model for corporation finance issues that provided the initial motivation for this paper. In this context, if one is familiar with the fair rate of return literature for regulated utilities, for example, an industry where debt is so prevalent, adjusting correctly for leverage is not frequently done and can be very critical.

to specify their exact magnitude at a specific point in time, considerable difficulty and possible measurement errors will be avoided.

The second approach is to run a regression between the observed systematic risk of a stock and a number of accounting and leverage variables in an attempt to explain this observed systematic risk. Unfortunately, without a theory, we do not know which variables to include and which variables to exclude and whether the relationship is linear, multiplicative, exponential, curvilinear, etc. Therefore, this method will also not be used.

A third approach is to measure the systematic risk before and after a new debt issue. The difference can then be attributed to the debt issue directly. An attractive feature of this procedure is that a good estimate of the market value of the incremental debt issue can be obtained. A number of disadvantages, unfortunately, are associated with this direct approach. The difference in the systematic risk may be due not only to the additional debt, but also to the reason the debt was issued. It may be used to finance a new investment project, in which case the project's characteristics will also be reflected in the new systematic risk measure. In addition, the new debt issue may have been anticipated by the market if the firm had some long-run target leverage ratio which this issue will help maintain; conversely, the market may not fully consider the new debt issue if it believes the increase in leverage is only temporary. For these reasons, this seemingly attractive procedure will not be employed.

The last approach, which will be used in this study, is to assume the validity of the MM theory from the outset. Then the observed rate of return of a stock can be adjusted to what *it would have been* over the same time period had the firm no debt and preferred stock in its capital structure. The difference between the observed systematic risk, ${}_B\beta$, and the systematic risk for this adjusted rate of return time series, ${}_A\beta$, can be attributed to leverage, if the MM theory is correct. The final step, then, is to test the MM theory.

To discuss this more specifically, consider the following relationship for the dollar return to the common shareholder from period t − 1 to t:

$$(X - I)_t(1 - \tau)_t - p_t + \Delta G_t = d_t + cg_t \qquad (1)$$

where X_t represents earnings before taxes, interest, and preferred dividends and is assumed to be unaffected by fixed commitment obligations; I_t represents interest and other fixed charges paid during the period; τ is the corporation income tax rate; p_t is the preferred dividends paid; ΔG_t represents the change in capitalized growth over the period; and d_t and cg_t are common shareholder dividends and capital gains during the period, respectively.

Equation (1) relates the corporation finance types of variables with the market holding period return important to the investors. The first term on the left-hand-side of (1) is profits after taxes and after interest which is the earnings the common and preferred shareholders receive on their investment for the period. Subtracting out p_t leaves us with the earnings the common shareholder would receive from currently-held assets.

To this must be added any change in capitalized growth since we are trying to explain the common shareholder's market holding period dollar return. ΔG_t

must be added for growth firms to the current period's profits from existing assets since capitalized growth opportunities of the firm—future earnings from new assets over and above the firm's cost of capital which are already reflected in the stock price at $(t-1)$—should change over the period and would accrue to the common shareholder. Assuming shareholders at the start of the period estimated these growth opportunities on average correctly, the expected value of ΔG_t would not be zero, but should be positive. For example, consider growth opportunities five years from now which yield more than the going rate of return and are reflected in today's stock price. These growth opportunities will become one year closer to fruition at time t than at time $t-1$ so that their present value would become larger. ΔG_t then represents this increase in the present value of these future opportunities simply because it is now four years away rather than five.[3]

Since the systematic risk of a common stock is:

$$_B\beta = \frac{\text{cov}\,(R_{B_t}, R_{M_t})}{\sigma^2(R_{M_t})} \tag{2}$$

where R_{Bt} is the common shareholder's rate of return and R_{Mt} is the rate of return on the market portfolio, then substitution of (1) into (2) yields:

$$_B\beta = \frac{\text{cov}\left[\dfrac{(X-I)(1-\tau)_t - p_t + \Delta G_t}{S_{B_{t-1}}}, R_{M_t}\right]}{\sigma^2(R_{M_t})} \tag{2a}$$

where $S_{B_{t-1}}$ denotes the market value of the common stock at the beginning of the period.

The systematic risk for the same firm over the same period *if* there were no debt and preferred stock in its capital structure is:

$$_A\beta = \frac{\text{cov}(R_{A_t}, R_{M_t})}{\sigma^2(R_{M_t})}$$

$$= \frac{\text{cov}\left[\dfrac{X(1-\tau)_t + \Delta G_t}{S_{A_{t-1}}}, R_{M_t}\right]}{\sigma^2(R_{M_t})} \tag{3}$$

where R_{A_t} and $S_{A_{t-1}}$ represent the rate of return and the market value, respectively, to the common shareholder if the firm had no debt and preferred stock. From (3), we can obtain:

$$_A\beta S_{A_{t-1}} = \frac{\text{cov}\,[X(1-\tau)_t + \Delta G_t, R_{M_t}]}{\sigma^2(R_{M_t})} \tag{3a}$$

3. Continual awareness of the difficulties of estimating capitalized growth, or changes in growth, especially in conjunction with leverage considerations, for purposes such as valuation or cost of capital is a characteristic common to students of corporation finance. This is the reason for the emphasis on growth in this paper and for presenting a method to neutralize for differences in growth when comparing rates of return.

Next, by expanding and rearranging (2a), we have:

$$_B\beta S_{B_{t-1}} = \frac{\text{cov}\,[X(1-\tau)_t + \Delta G_t, R_{M_t}]}{\sigma^2(R_{M_t})} - \frac{\text{cov}\,[I(1-\tau)_t, R_{M_t}]}{\sigma^2(R_{M_t})} - \frac{\text{cov}\,(p_t, R_{M_t})}{\sigma^2(R_{M_t})} \tag{2b}$$

If we assume as an empirical approximation that interest and preferred dividends have negligible covariance with the market, at least relative to the (pure equity) common stock's covariance, then substitution of the LHS of (3a) into the RHS of (2b) yields:[4]

$$_B\beta S_{B_{t-1}} = {}_A\beta S_{A_{t-1}} \tag{4}$$

or

$$_A\beta = \left(\frac{S_B}{S_A}\right)_{t-1} {}_B\beta \tag{4a}$$

Because $S_{A_{t-1}}$, the market value of common stock *if* the firm had no debt and preferred stock, is not observable since most firms do have debt and/or preferred stock, a theory is required in order to measure what this quantity *would have been* at $t-1$. The MM theory [10] will be employed for this purpose, that is:

$$S_{A_{t-1}} = (V - \tau D)_{t-1}. \tag{5}$$

Equation (5) indicates that if the Federal government tax subsidy for debt financing, τD, where D is the market value of debt, is subtracted from the observed market value of the firm, V_{t-1} (where V_{t-1} is the sum of S_B, D and the observed market value of preferred), then the market value of an unleveraged firm is obtained. Underlying (5) is the assumption that the firm is near its target leverage ratio so that no more or no less debt subsidy is capitalized already into the observed stock price. The conditions under which this MM relationship hold are discussed carefully in [4].

It is at this point that problems in obtaining satisfactory estimates of $_A\beta$ develop, since (4) theoretically holds only for the next period. As a practical matter, the accepted, and seemingly acceptable, method of obtaining estimates of a stock's systematic risk, $_B\beta$, is to run a least squares regression between a stock's and market portfolio's *historical* rates of return. Using past data for $_B\beta$, it is not clear which *period's* ratio of market values to apply in (4a) to estimate the firm's systematic risk, $_A\beta$. There would be no problem if the market value ratios of debt to equity and preferred stock to equity remained relatively stable over the past for each firm, but a cursory look at these data reveals that this is not true for the large majority of firms in our sample. Should we use the market value ratio required in (4a) that was observed at the start of our regression period, at the end of our regression period, or some kind of average over the period? In addition, since these different observed ratios will give us different estimates for $_A\beta$, it is not clear, without some criterion, how we should select from among the various estimates.

4. This general method of arriving at (4) was suggested by the comments of William Sharpe, one of the discussants of this paper at the annual meeting. A much more cumbersome and less general derivation of (4) was in the earlier version.

It is for this purpose—to obtain a standard—that a more cumbersome and more data demanding approach to obtain estimates of ${}_A\beta$ is suggested. Given the large fluctuations in market leverage ratios, intuitively it would appear that the firm's risk is more stable than the common stock's risk. In that event, a leverage-free rate of return time series for each firm should be derived and the market model applied to this time series directly. In this manner, the beta coefficient would give us a *direct* estimate of ${}_A\beta$ which can then be used as a criterion to determine if any of the market value ratios discussed above can be applied to (4a) successfully.

For this purpose, the "would-have-been" rate of return for the common stock if the firm had no debt and preferred is:

$$R_{A_t} = \frac{X_t(1-\tau)_t + \Delta G_t}{S_{A_{t-1}}}. \tag{6}$$

The numerator of (6) can be rearranged to be:

$$X_t(1-\tau)_t + \Delta G_t \equiv [(X-I)_t(1-\tau)_t - p_t + \Delta G_t] + p_t + I_t(1-\tau)_t.$$

Substituting (1):

$$X_t(1-\tau)_t + \Delta G_t = [d_t + cg_t] + p_t + I_t(1-\tau)_t.$$

Therefore, (6) can be written as:

$$R_{A_t} = \frac{d_t + cg_t + p_t + I_t(1-\tau)_t}{S_{A_{t-1}}}. \tag{7}$$

Since $S_{A_{t-1}}$ is unobservable for the firms with leverage, the MM theory, equation (5), will be employed; then:

$$R_{A_t} = \frac{d_t + cg_t + p_t + I_t(1-\tau)_t}{(V-\tau D)_{t-1}}. \tag{8}$$

The observed rate of return on the common stock is, of course:

$$R_{B_t} = \frac{(X-I)_t(1-\tau)_t - p_t + \Delta G_t}{S_{B_{t-1}}} = \frac{d_t + cg_t}{S_{B_{t-1}}}. \tag{9}$$

Equation (8) is the rate of return to the common shareholder of the same firm and over the same period of time as (9). However, in (8) there are the underlying assumptions that the firm never had any debt and preferred stock and that the MM theory is correct; (9) incorporates the exact amount of debt and preferred stock that the firm actually did have over this time period and no leverage assumption is being made. Both (8) and (9) are now in forms where they can be measured with available data. One can note that it is unnecessary to estimate the change in growth, or earnings from current assets, since these should be captured in the market holding period return, $d_t + cg_t$.

Using CRSP data for (9) and both CRSP and Compustat data for the components of (8), a time series of yearly R_{At} and R_{Bt} for $t = 1948\text{-}1967$ were derived for 304 different firms. These 304 firms represent an exhaustive sample of the firms with complete data on both tapes for all the years.

A number of "market model" [1, 12] variants were then applied to these data. For each of the 304 firms, the following regressions were run:

$$R_{Ait} = {}_A\alpha_i + {}_A\beta_i R_{Mt} + {}_A\epsilon_{it} \quad (10a)$$

$$R_{Bit} = {}_B\alpha_i + {}_B\beta_i R_{Mt} + {}_B\epsilon_{it} \quad (10b)$$

$$\ln(1 + R_{Ait}) = {}_{AC}\alpha_i + {}_{AC}\beta_i \ln(1 + R_{M_t}) + {}_{AC}\epsilon_{it} \quad (10c)$$

$$\ln(1 + R_{Bit}) = {}_{BC}\alpha_i + {}_{BC}\beta_i \ln(1 + R_{M_t}) + {}_{BC}\epsilon_{it} \quad (10d)$$

$$i = 1, 2, \ldots, 304$$
$$t = 1948\text{-}1967$$

where R_{Mt} is the observed NYSE arithmetic stock market rate of return with dividends reinvested, α_i and β_i are constants for each firm-regression, and the usual conditions are assumed for the properties of the disturbance terms, ϵ_{it}. Equations (10c) and (10d) are the continuously-compounded rate of return versions of (10a) and (10b), respectively.[5]

III. The Results

An abbreviated table of the regression results for each of the four variants, equations (10a)-(10d), summarized across the 304 firms is shown in Table 1.

The first column designated "mean" is the average of the statistic (indicated by the rows) over all 304 firms. Therefore, the mean ${}_A\hat{\alpha}$ of 0.0221 is the intercept term of equation (10a) averaged over 304 different firm-regressions. The second and third columns give the deviation measures indicated, of the 304 point estimates of, say, ${}_A\hat{\alpha}$. The mean standard error of estimate in the last column is the average over 304 firms of the individual standard errors of estimate.

The major conclusion drawn from Table 1 is the following mean β comparisons:

$${}_B\hat{\beta} > {}_A\hat{\beta}, \text{ i.e., } 0.9190 > 0.7030$$
$${}_{BC}\hat{\beta} > {}_{AC}\hat{\beta}, \text{ i.e., } 0.9183 > 0.7263.$$

The directional results of these betas, assuming the validity of the MM theory, are not imperceptible and clearly are not negligible differences from the investor's point of view. This is obtained in spite of all the measurement and data problems associated with estimating a time series of the RHS of (8) for

5. Because the R_{M_t} used in equations (10) is defined as the observed stock market return, and since adjusting for capital structure is the major purpose of this exercise, it was decided that the same four regressions should be replicated on a leverage-adjusted stock market rate of return. The major reason for this additional adjustment is the belief that the rates of return over time and their relationship with the market are more stable when we can abstract from all changes in leverage and get at the underlying risk of all firms.

For the 221 firms (out of the total 304) whose fiscal years coincide with the calendar year, average values for the components of the RHS of (8) were obtained for each year so that R_{M_t} could be adjusted in the same way as for the individual firms—a yearly time series of stock market rates of return, if all the firms on the NYSE had no debt and no preferred in their capital structure, was derived. The results, when using this adjusted market portfolio rate of return time series, were not very different from the results of equations (10), and so will not be reported here separately.

TABLE 1
SUMMARY RESULTS OVER 304 FIRMS OF EQUATIONS (10a)-(10d)

	Mean	Mean Absolute Deviation*	Standard Deviation	Mean Standard Error of Estimate
${}_A\hat{\alpha}$	0.0221	0.0431	0.0537	0.0558
${}_A\hat{\beta}$	0.7030	0.2660	0.3485	0.2130
${}_A\hat{R}^2$	0.3799	0.1577	0.1896	
${}_A\hat{\rho}$	0.0314			
${}_B\hat{\alpha}$	0.0187	0.0571	0.0714	0.0720
${}_B\hat{\beta}$	0.9190	0.3550	0.4478	0.2746
${}_B\hat{R}^2$	0.3864	0.1578	0.1905	
${}_B\hat{\rho}$	0.0281			
${}_{AC}\hat{\alpha}$	0.0058	0.0427	0.0535	0.0461
${}_{AC}\hat{\beta}$	0.7263	0.2700	0.3442	0.2081
${}_{AC}\hat{R}^2$	0.3933	0.1586	0.1909	
${}_{AC}\hat{\rho}$	0.0268			
${}_{BC}\hat{\alpha}$	−0.0052	0.0580	0.0729	0.0574
${}_{BC}\hat{\beta}$	0.9183	0.3426	0.4216	0.2591
${}_{BC}\hat{R}^2$	0.4012	0.1602	0.1922	
${}_{BC}\hat{\rho}$	0.0262			

* Defined as: $\frac{\sum_{i=1}^{N} |x_i - \bar{x}|}{N}$, where N = 304. $\hat{\rho}$ = first order serial correlation coefficient.

each firm. One of the reasons for the "traditional" theory position on leverage is precisely this point—that small and reasonable amounts of leverage cannot be discerned by the market. In fact, if the MM theory is correct, leverage has explained as much as, roughly, 21 to 24 per cent of the value of the mean β.

We can also note that if the covariance between the asset and market rates of return, as well as the market variance, was constant over time, then the systematic risk from the market model is related to the expected rate of return by the capital asset pricing model. That is:

$$E(R_{A_t}) = R_{F_t} + {}_A\beta[E(R_{M_t}) - R_{F_t}] \quad (11a)$$

$$E(R_{B_t}) = R_{F_t} + {}_B\beta[E(R_{M_t}) - R_{F_t}] \quad (11b)$$

Equation (11a) indicates the relationship between the expected rate of return for the common stock shareholder of a debt-free and preferred-free firm, to the systematic risk, ${}_A\beta$, as obtained in regressions (10a) or (10c). The LHS of (11a) is the important $\rho\tau$ for the MM cost of capital. The MM theory [9, 10] also predicts that shareholder expected yield must be higher (for the same real firm) when the firm has debt than when it does not. Financial risk is greater, therefore, shareholders require more expected return. Thus, $E(R_{Bt})$ must be greater than $E(R_{At})$. In order for this MM prediction to be true, from (11a) and (11b) it can be observed that ${}_B\beta$ must be greater than ${}_A\beta$, which is what we obtained.

Using the results underlying Table 1, namely the firm and stock betas, as the criterion for selecting among the possible observed market value ratios that can be used, if any, for (4), the following cross-section regressions were run:

$$({}_{B}\beta)_i = a_1 + b_1 \left(\frac{S_A}{S_B} {}_{A}\beta \right)_i + u_{1i} \qquad i = 1, 2, \ldots, 102 \qquad (12a)$$

$$({}_{BC}\beta)_i = a_2 + b_2 \left(\frac{S_A}{S_B} {}_{AC}\beta \right)_i + u_{2i} \qquad i = 1, 2, \ldots, 102 \qquad (12b)$$

$$({}_{A}\beta)_i = a_3 + b_3 \left(\frac{S_B}{S_A} {}_{B}\beta \right)_i + u_{3i} \qquad i = 1, 2, \ldots, 102 \qquad (13a)$$

$$({}_{AC}\beta)_i = a_4 + b_4 \left(\frac{S_B}{S_A} {}_{BC}\beta \right)_i + u_{4i} \qquad i = 1, 2, \ldots, 102 \qquad (13b)$$

Because the preferred stock market values were not as reliable as debt, only the 102 firms (out of 304) that did not have preferred in any of the years were used. The test for the adequacy of this alternative approach, equation (4), to adjust the systematic risk of common stocks for the underlying firm's capital structure, is whether the intercept term, a, is equal to zero, and the slope coefficient, b, is equal to one in the above regressions (as well as, of course, a high R^2)—these requirements are implied by (4). The results of this test would also indicate whether future "market model" studies that only use common stock rates of return without adjusting, or even noting, for the firm's debt-equity ratio will be adequate. The total firm's systematic risk may be stable (as long as the firm stays in the same risk-class), whereas the common stock's systematic risk may not be stable merely because of unanticipated capital structure changes—the data underlying Table 3 indicate that there were very few firms which did not have major changes in their capital structure over the twenty years studied.

The results of these regressions, when using the average S_A and average S_B over the twenty years for each firm, are shown in the first column panel of Table 2. These regressions were then replicated twice, first using the December 31, 1947 values of S_{A_i} and S_{B_i} instead of the twenty-year average for each firm, and then substituting the December 31, 1966 values of S_{A_i} and S_{B_i} for the 1947 values. These results are in the second and third panels of Table 2.[6]

From the first panel of Table 2, it appears that this alternative approach via (4a) for adjusting the systematic risk for the firm's leverage is quite

6. The point should be made that we are not merely regressing a variable on itself in (12) and (13). (12a) and (12b) can be interpreted as correlating the ${}_{B}\beta_i$ obtained from (10b) and (10d)—the LHS variable in (12a) and (12b)—against the ${}_{B}\beta_i$ obtained from rearranging (4)—the RHS variable in (12a) and (12b)—to determine whether the use of (4) is as good a means of obtaining ${}_{B}\beta_i$ as the direct way via the equations (10). We would be regressing a variable on itself only if the ${}_{A}\beta_i$ were calculated using (4a), and then the ${}_{A}\beta_i$ thus obtained, inserted into (12a) and (12b).

Instead, we are obtaining ${}_{A}\beta_i$ using the MM model in *each* of the twenty years so that a leverage-adjusted 20 year time series of R_{A_i} is derived. Of course, if there were no data nor measurement problems, and if the debt-to-equity ratio were perfectly stable over this twenty year period for each firm, then we should obtain perfect correlation in (12a) and (12b), with a = 0 and b = 1, as (4) would be an identity.

TABLE 2
RESULTS FOR THE EQUATIONS (12a), (12b), (13a), AND (13b)*

	Using 20-Year Average for $\left(\frac{S_A}{S_B}\right)_i$			Using 1947 Value for $\left(\frac{S_A}{S_B}\right)_i$			Using 1966 Value for $\left(\frac{S_A}{S_B}\right)_i$		
	a	b	R^2	a	b	R^2	a	b	R^2
Eq. (12a)	−0.022 (0.021)	1.062 (0.021)	0.962	0.150 (0.048)	0.842 (0.045)	0.781	0.085 (0.041)	0.905 (0.038)	0.849
	constant suppressed	1.042 (0.009)	0.962	constant suppressed	0.966 (0.021)	0.781	constant suppressed	0.976 (0.017)	0.849
Eq. (12b)	−0.003 (0.013)	1.016 (0.013)	0.984	0.159 (0.047)	0.816 (0.044)	0.773	0.124 (0.037)	0.843 (0.034)	0.859
	constant suppressed	1.014 (0.005)	0.984	constant suppressed	0.952 (0.019)	0.773	constant suppressed	0.947 (0.015)	0.859

	Using 20-Year Average for $\left(\frac{S_B}{S_A}\right)_i$			Using 1947 Value for $\left(\frac{S_B}{S_A}\right)_i$			Using 1966 Value for $\left(\frac{S_B}{S_A}\right)_i$		
	a	b	R^2	a	b	R^2	a	b	R^2
Eq. (13a)	0.030 (0.016)	0.931 (0.017)	0.969	0.112 (0.028)	0.843 (0.030)	0.888	0.080 (0.027)	0.898 (0.030)	0.902
	constant suppressed	0.960 (0.007)	0.969	constant suppressed	0.948 (0.015)	0.888	constant suppressed	0.976 (0.014)	0.902
Eq. (13b)	0.007 (0.010)	0.979 (0.011)	0.988	0.119 (0.026)	0.852 (0.028)	0.902	0.063 (0.026)	0.942 (0.029)	0.911
	constant suppressed	1.004 (0.012)	0.911	constant suppressed	0.967 (0.013)	0.902	constant suppressed	1.005 (0.012)	0.911

* Standard error in parentheses.

satisfactory (at least with respect to our sample of firms and years) only if long-run averages of S_A and S_B are used. The second and third panels indicate that the equations (8) and (10) procedure is markedly superior when only one year's market value ratio is used as the adjustment factor. The annual debt-to-equity ratio is much too unstable for this latter procedure.

Thus, when forecasting systematic risk is the primary objective—for example, for portfolio decisions or for estimating the firm's cost of capital to apply to prospective projects—a long-run forecasted leverage adjustment is required. Assuming the firm's risk is more stable than the common stock's risk,[7] and if there is some reason to believe that a better forecast of the firm's future leverage can be obtained than using simply a past year's (or an average of past years') leverage, it should be possible to improve the usual extrapolation forecast of a stock's systematic risk by forecasting the total firm's systematic risk first, and then using the independent leverage estimate as an adjustment.

IV. Tests of the MM vs. Traditional Theories of Corporation Finance

To determine if the difference, ${}_B\beta - {}_A\beta$, found in this study is indeed the correct effect of leverage, some confirmation of the MM theory (since it was assumed to be correct up to this point) from the systematic risk approach is needed. Since a direct test by this approach seems impossible, an indirect, inferential test is suggested.

The MM theory [9, 10] predicts that for firms in the same risk-class, the capitalization rate if all the firms were financed with only common equity, $E(R_A)$, would be the same—regardless of the actual amount of debt and preferred each individual firm had. This would imply, from (11a), that if $E(R_A)$ must be the same for all firms in a risk-class, so must ${}_A\beta$. And if these firms had different ratios of fixed commitment obligations to common equity, this difference in financial risk would cause their observed ${}_B\beta$s to be different.

The major competing theory of corporation finance is what is now known as the "traditional theory," which has contrary implications. This theory predicts that the capitalization rate for common equity, $E(R_B)$, (sometimes called the required or expected stock yield, or expected earnings-price ratio) is constant, as debt is increased, up to some critical leverage point (this point being a function of gambler's ruin and bankruptcy costs).[8] The clear implication of this constant, horizontal, equity yield (or their initial downward sloping cost of capital curve) is that changes in market or covariability risk are assumed not to be discernible to the shareholders as debt is increased. Then the traditional theory is saying that the ${}_B\beta$s, a measure of this covariability risk, would be the same for all firms in a given risk-class irregardless of differences in leverage, as long as the critical leverage point is not reached.

Since there will always be unavoidable errors in estimating the β's of indi-

7. A faint, but possible, empirical indication of this point may be obtained from Table 1. The ratio of the mean point estimate to the mean standard error of estimate is less for the firm β than for the stock β in both the discrete and continuously compounded cases.

8. This interpretation of the traditional theory can be found in [9, especially their figure 2, page 275, and their equation (13) and footnote 24 where reference is made to Durand and Graham and Dodd].

TABLE 3
INDUSTRY MARKET VALUE RATIOS OF PREFERRED STOCK (P) AND DEBT (D) TO COMMON STOCK (S)

Industry Number	Industry	Number of Firms		P/S		D/S		$\frac{P+D}{S}$	
20	Food and Kindred Products	30	Mean*	0.22		0.81		1.04	
			ROM**	0.00	1.18	0.00	3.55	0.00	4.13
			ROCR***	0.00	2.52	0.00	8.10	0.00	10.01
28	Chemicals and Allied Products	30	Mean	0.07		0.25		0.33	
			ROM	0.00	0.51	0.00	0.90	0.00	1.20
			ROCR	0.00	1.54	0.00	2.07	0.00	2.92
29	Petroleum and Coal Products	18	Mean	0.06		0.22		0.27	
			ROM	0.00	0.26	0.00	0.55	0.03	0.57
			ROCR	0.00	0.83	0.00	1.54	0.00	2.30
33	Primary Metals	21	Mean	0.14		0.54		0.68	
			ROM	0.00	1.31	0.00	1.95	0.00	3.04
			ROCR	0.00	4.69	0.00	6.20	0.00	7.49
35	Machinery, except Electrical	28	Mean	0.07		0.33		0.40	
			ROM	0.00	0.49	0.00	1.92	0.00	2.32
			ROCR	0.00	1.28	0.00	6.92	0.00	7.62

TABLE 3 (*Continued*)

Industry Number	Industry	Number of Firms		P/S			D/S			$\frac{P+D}{S}$		
36	Electrical Machinery & Equipment	13	Mean		0.06			0.35			0.41	
			ROM	0.00		0.29	0.00		1.31	0.01		1.33
			ROCR	0.00		1.13	0.00		2.53	0.00		2.53
37	Transportation Equipment	24	Mean		0.08			0.38			0.47	
			ROM	0.00		0.54	0.00		0.93	0.00		1.32
			ROCR	0.00		2.33	0.00		3.76	0.00		6.09
49	Utilities	27	Mean		0.25			1.03			1.28	
			ROM	0.00		0.53	0.49		2.64	0.52		3.12
			ROCR	0.00		3.12	0.12		16.40	0.12		19.52
53	Dep't Stores, Order Houses & Vending Mach. Operators	17	Mean		0.13			0.49			0.62	
			ROM	0.00		0.38	0.01		1.52	0.01		1.87
			ROCR	0.00		1.09	0.00		3.19	0.00		3.66

* "Mean" refers to the average ratio over 20 years and over all firms in the industry.
** "Range of Means" (ROM) refers to the lowest firm's mean (over 20 years) ratio and the highest firm's mean (over 20 years) ratio in the industry.
*** "Range of Company Ranges" (ROCR) refers to the lowest and highest ratio in the industry, regardless of the year.

vidual firms and in specifying a risk-class, we would not expect to find a set of firms with identical systematic risk. But by specifying reasonable a priori risk-classes, if the individual firms had closer or less scattered $_{A}\beta$s than $_{B}\beta$s, then this would support the MM theory and contradict the traditional theory. If, instead, the $_{B}\beta$s were not discernibly more diverse than the $_{A}\beta$s, and the leverage ratio differed considerably among firms, then this would indicate support for the traditional theory.[9]

In order to test this implication, risk-classes must be first specified. The SEC two-digit industry classification was used for this purpose. Requiring enough firms for statistical reasons in any given industry, nine risk-classes were specified that had at least 13 firms; these nine classes are listed in Table 3 with their various leverage ratios.[10] It is clear from this table that our first requirement is met—that there is a considerable range of leverage ratios among firms in a risk-class and also over the twenty-year period.

Three tests will be performed to distinguish between the MM and traditional theories. The first is simply to calculate the standard deviation of the unbiased β estimates in a risk-class. The second is a chi-square test of the distribution of β's in an industry compared to the distribution of the β's in the total sample. Finally, an analysis of variance test on the estimated variance of the β's between industries, as opposed to within industries, is performed. In all tests, only the point estimate of β (which should be unbiased) for each stock and firm is used.[11]

The first test is reported in Table 4. If we compare the standard deviation of $_{AC}\beta$ with the standard deviation of $_{BC}\beta$ by industries (or risk-classes), we can note that $\sigma(_{AC}\beta)$ is less than $\sigma(_{BC}\beta)$ for eight out of the nine classes. The probability of obtaining this is only 0.0195, given a 50% probability that $\sigma(_{AC}\beta)$ can be larger or smaller than $\sigma(_{BC}\beta)$. These results indicate that the systematic risk of the firms in a given risk-class, if they were all financed only with common equity, is much less diverse than their observed stock's systematic risk. This supports the MM theory, at least in contrast to the traditional theory.[12]

9. The traditional theory also implies that $E(R_A)$ is equal to $E(R_B)$ for all firms. Unfortunately, we do not have a functional relationship between these traditional theory capitalization rates and the measured βs of this study. Clearly, since the $_{A}\beta$s were obtained assuming the validity of the MM theory, they would not be applicable for the traditional theory. In fact, no relationship between the $_{A}\beta$ and $_{B}\beta$ for a given firm, or for firms in a given risk-class, can be specified as was done for the capitalization rates.

10. The tenth largest industry had only eight firms. For our purpose of testing the uniformity of firm βs relative to stock βs within a risk-class, the use of the two-digit industry classification as a proxy does not seem as critical as, for instance, its use for the purpose of performing an MM valuation model study [8] wherein the ρ^{τ} must be pre-specified to be exactly the same for all firms in the industry.

11. Since these βs are estimated in the market model regressions with error, precise testing should incorporate the errors in the β estimation. Unfortunately, to do this is extremely difficult and more importantly, requires the normality assumption for the market model disturbance term. Since there is considerable evidence that is contrary to this required assumption [see 3], our tests will ignore the β measurement error entirely. But ignoring this is partially corrected in our first and third tests since means and variances of these point estimate βs must be calculated, and this procedure will "average out" the individual measurement errors by the factor 1/N.

12. Of course, there could always be another theory, as yet not formulated, which could be even

TABLE 4
MEAN AND STANDARD DEVIATION OF INDUSTRY β'S

Industry Number	Industry	Number of Firms		$_A\beta$	$_B\beta$	$_{AC}\beta$	$_{BC}\beta$
20	Food & Kindred Products	30	Mean β	0.515	0.815	0.528	0.806
			σ(β)	0.232	0.448	0.227	0.424
28	Chemicals & Allied Products	30	Mean β	0.747	0.928	0.785	0.946
			σ(β)	0.237	0.391	0.216	0.329
29	Petroleum & Coal Products	18	Mean β	0.633	0.747	0.656	0.756
			σ(β)	0.144	0.188	0.148	0.176
33	Primary Metals	21	Mean β	1.036	1.399	1.106	1.436
			σ(β)	0.223	0.272	0.197	0.268
35	Machinery, except Electrical	28	Mean β	0.878	1.037	0.917	1.068
			σ(β)	0.262	0.240	0.271	0.259
36	Electrical Machinery and Equipment	13	Mean β	0.940	1.234	0.951	1.164
			σ(β)	0.320	0.505	0.283	0.363
37	Transportation Equipment	24	Mean β	0.860	1.062	0.875	1.048
			σ(β)	0.225	0.313	0.225	0.289
49	Utilities	27	Mean β	0.160	0.255	0.166	0.254
			σ(β)	0.086	0.133	0.098	0.147
53	Department Stores, etc.	17	Mean β	0.652	0.901	0.692	0.923
			σ(β)	0.187	0.282	0.198	0.279

Our second test, the chi-square test, requires us to rank our 300 $_A\beta$s into ten equal categories, each with 30 $_A\beta$s (four miscellaneous firms were taken out randomly). By noting the value of the highest and lowest $_A\beta$ for each of the ten categories, a distribution of the number of $_A\beta$s in each category, by risk-class, can be obtained. This was then repeated for the other three betas. To test whether the distribution for each of the four β's and for each of the risk-classes follows the expected uniform distribution, a chi-square test was performed.[13]

Even with just casual inspection of these distributions of the betas by risk-class, it is clear that two industries, primary metals and utilities, are so highly skewed that they greatly exaggerate our results.[14] Eliminating these

more strongly supported than the MM theory. If we compare $\sigma(_A\beta)$ to $\sigma(_B\beta)$ by risk-classes in Table 4, precisely the same results are obtained as those reported above for the continuously-compounded betas.

13. By risk-classes, seven of the nine chi-square values of $_A\beta$ are larger than those of $_B\beta$, as are eight out of nine for the continuously-compounded betas. This would occur by chance with probabilities of 0.0898 and 0.0195, respectively, if there were a 50% chance that either the firm or stock chi-square value could be larger. Nevertheless, if we inspect the individual chi-square values by risk-class, we note that most of them are large so that the probabilities of obtaining these values are highly unlikely. For all four βs, the distributions for most of the risk-classes are nonuniform.

14. Primary metals have extremely large betas; utilities have extremely small betas.

two industries, and also two miscellaneous firms so that an even 250 firms are in the sample, new upper and lower values of the β's were obtained for each of the ten class intervals and for each of the four β's.

In Table 5, the chi-square values are presented; for the total of all risk-classes, the probability of obtaining a chi-square value less than 120.63 is over 99.95% (for $_A\beta$), whereas the probability of obtaining a chi-square value less than 99.75 is between 99.5% and 99.9% (for $_B\beta$). More sharply contrasting results are obtained when $_{AC}\beta$ is compared to $_{BC}\beta$. For $_{AC}\beta$, the probability of obtaining less than 128.47 is over 99.95%, whereas for $_{BC}\beta$, the probability of obtaining less than 78.65 is only 90.0%. By abstracting from financial risk, the underlying systematic risk is much less scattered when grouped into risk-classes than when leverage is assumed not to affect the systematic risk. The null hypothesis that the β's in a risk-class come from the same distribution as all β's is rejected for $_{AC}\beta$, but not for $_{BC}\beta$ (at the 90% level). Although this, in itself, does not tell us *how* a risk-class differs from the total market, an inspection of the distributions of the betas by risk-class underlying Table 5 does indicate more clustering of the $_{AC}\beta$s than the $_{BC}\beta$s so that the MM theory is again favored over the traditional theory.

The analysis of variance test is our last comparison of the implications of the two theories. The ratio of the estimated variance between industries to the estimated variance within the industries (the F-statistic) when the seven

TABLE 5
CHI-SQUARE RESULTS FOR ALL β'S AND ALL INDUSTRIES
(EXCEPT UTILITIES AND PRIMARY METALS)

Industry		$_A\beta$	$_B\beta$	$_{AC}\beta$	$_{BC}\beta$
Food and Kindred	Chi-Square	18.67	11.33	26.00	9.33
	$P\{\chi^2 < \}^* =$	95-97.5%	70-75%	99.5-99.9%	50-60%
Chemicals	Chi-Square	9.33	10.67	12.00	7.33
	$P\{\chi^2 < \} =$	50-60%	60-70%	75-80%	30-40%
Petroleum	Chi-Square	17.56	25.33	18.67	22.00
	$P\{\chi^2 < \} =$	95-97.5%	99.5-99.9%	95-97.5%	99-99.5%
Machinery	Chi-Square	19.14	12.00	24.86	9.14
	$P\{\chi^2 < \} =$	97.5-98%	75-80%	99.5-99.9%	50-60%
Electrical Machinery	Chi-Square	13.92	7.77	12.38	9.31
	$P\{\chi^2 < \} =$	80-90%	40-50%	80-90%	50-60%
Transportation Equipment	Chi-Square	15.17	16.83	13.50	6.83
	$P\{\chi^2 < \} =$	90-95%	90-95%	80-90%	30-40%
Dep't Stores	Chi-Square	14.18	3.59	14.18	3.59
	$P\{\chi^2 < \} =$	80-90%	5-10%	80-90%	5-10%
Miscellaneous	Chi-Square	12.67	12.22	6.89	11.11
	$P\{\chi^2 < \} =$	80-90%	80-90%	30-40%	70-75%
Total	Chi-Square	120.63	99.75	128.47	78.65
	$P\{\chi^2 < \} =$	over 99.95%	99.5-99.90%	over 99.95%	90.0%

* Example: $P\{\chi^2 < 18.67\} = 95\text{-}97.5\%$ for 9 degrees of freedom.

industries are considered (again, the two obviously skewed industries, primary metals and utilities, were eliminated) is less for $_{B}\beta$ (F = 3.90) than for $_{A}\beta$ (F = 9.99), and less for $_{BC}\beta$ (F = 4.18) than for $_{AC}\beta$ (F = 10.83). The probability of obtaining these F-statistics for $_{A}\beta$ and $_{AC}\beta$ is less than 0.001, but for $_{B}\beta$ and $_{BC}\beta$ greater than or equal to 0.001. These results are consistent with the results obtained from our two previous tests. The MM theory is more compatible with the data than the traditional theory.[15]

V. Conclusions

This study attempted to tie together some of the notions associated with the field of corporation finance with those associated with security and portfolio analyses. Specifically, if the MM corporate tax leverage propositions are correct, then approximately 21 to 24% of the observed systematic risk of common stocks (when averaged over 304 firms) can be explained merely by the added financial risk taken on by the underlying firm with its use of debt and preferred stock. Corporate leverage does count considerably.

To determine whether the MM theory is correct, a number of tests on a contrasting implication of the MM and "traditional" theories of corporation finance were performed. The data confirmed MM's position, at least vis-à-vis our interpretation of the traditional theory's position. This should provide another piece of evidence on this controversial topic.

Finally, if the MM theory and the capital asset pricing model are correct, and if the adjustments made in equations (8) or (4a) result in accurate measures of the systematic risk of a leverage-free firm, the possibility is greater, without resorting to a fullblown risk-class study of the type MM did for the electric utility industry [8], of estimating the cost of capital for individual firms.

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15. All of our tests, it should be emphasized, although consistent, are only inferential. Aside from assuming that the two-digit SEC industry classification is a good proxy for risk-classes and that the errors in estimating the individual βs can be safely ignored, the tests rely on the two theories exhausting all the reasonable theories on leverage. But there is always the use of another line of reasoning. If the results of the MM electric utility study [8] are correct, and if these results can be generalized to all firms and to all risk-classes, then it can be claimed that the MM theory is universally valid. Then our result in Section III does indicate the correct effect of the firm's capital structure on the systematic risk of common stocks.

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Equity and the small-stock effect
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Financial News

By Michael Annin

Equity and the Small-Stock Effect

The capital asset pricing model shows risk inherent in return on equity. But something goes wrong when it's used for small-sized companies.

Does the size of a company affect the rate of return it should earn? If smaller companies should earn a higher return than larger firms, then small utilities, because of their size, should be allowed to adjust the rates they charge to customers.

By far the most notable and well-documented apparent anomaly in the stock market is the effect of company size on equity returns. The first study focusing on the impact that company size exerts on security returns was performed by Rolf W. Banz. Banz sorted New York Stock Exchange (NYSE) stocks into quintiles based on their market capitalization (price per share times number of shares outstanding), and calculated total returns for a value-weighted portfolio of the stocks in each quintile. His results indicate that returns for companies from the smallest quintile surpassed all other quintiles, as well as the Standard & Poor's 500 and other large stock indices. A number of other researchers have replicated Banz's work in other countries; nevertheless, a consensus has not yet been formed on why small stocks behave as they do.

One explanation for the higher returns is the lack of information on small companies. Investors must search more diligently for data. For small utilities, investors face additional obstacles, such as a smaller customer base, limited financial resources, and a lack of diversification across customers, energy sources, and geography. These obstacles imply a higher investor return.

The Flaw in CAPM

One of the more common cost of equity models used in practice today is the capital asset pricing model (CAPM). The CAPM describes the expected return on any company's stock as proportional to the amount of systematic risk an investor assumes. The traditional CAPM formula can be stated as:

$$R_s = [\beta_s \times RP] + R_f$$

where:

R_s = expected return or cost of equity on the stock of company "s"

β = the *beta* of the stock of company "s"

RP = the expected equity risk premium

R_f = expected return on a riskless asset.

Table 1: The Size Premium in CAPM
(By Decile Portfolio in NYSE, 1926-94)

Decile	*Beta*	Arithmetic Mean Return	Actual Return in Excess of Riskless Rate**	CAPM Return in Excess of Riskless Rate**	Size Premium (Return in Excess CAPM)
1	0.90	11.01%	5.88%	6.33%	–0.44%
2	1.04	13.09	7.97	7.34	0.63
3	1.09	13.83	8.71	7.70	1.01
4	1.13	14.44	9.32	7.98	1.33
5	1.17	15.50	10.38	8.22	2.16
6	1.19	15.45	10.33	8.38	1.95
7	1.24	15.92	10.79	8.75	2.05
8	1.29	16.84	11.72	9.05	2.67
9	1.36	17.83	12.71	9.57	3.14
10	1.47	21.98	16.86	10.33	6.53

**Betas* are estimated from monthly returns in excess of the 20-year government bond income return, January 1926-December 1994.
**Historical riskless rate measured by the 69-year arithmetic mean income return component of 20-year government bonds.
Source: SBBI 1995 Yearbook

Table 2: CAPM vs. CAPM w/ Size Premium

(By Percentile for Electric, Gas, and Sanitary Services Utilities)

	CAPM	CAPM with Size Premium
90th Percentile	16.42%	18.92%
75th Percentile	12.56%	14.72%
Median	10.89%	12.58%
25th Percentile	9.86%	11.39%
10th Percentile	8.63%	10.65%

(Weighted by Market Capitalization)

	CAPM	CAPM with Size Premium
Industry Composite	11.76%	12.33%
Large Company Composite	12.05%	12.07%
Small Company Composite	13.93%	17.95%

Source: Cost of Capital Quarterly '95 Yearbook by Ibbotson Associates
Note: Public utilities include electric, gas, and sanitary services companies.

Table 1 shows *beta* and risk premiums over the past 69 years for each decile of the NYSE. It shows that a hypothetical risk premium calculated under the CAPM fails to match the actual risk premium, shown by actual market returns. The shortfall in the CAPM return rises as company size decreases, suggesting a need to revise the CAPM.

The risk premium component in the actual returns (realized equity risk premium) is the return that compensates investors for taking on risk equal to the risk of the market as a whole (estimated by the 69-year arithmetic mean return on large company stocks, 12.2 percent, less the historical riskless rate). The risk premium in the CAPM returns is *beta* multiplied by the realized equity risk premium.

The smaller deciles show returns not fully explainable by the CAPM. The difference in risk premiums (realized versus CAPM) grows larger as one moves from the largest companies in decile 1 to the smallest in decile 10. The difference is especially pronounced for deciles 9 and 10, which contain the smallest companies.

Based on this analysis, we modify the CAPM formula to include a small-stock premium. The modified CAPM formula can be stated as follows:

$$R_s = [\beta_s \times RP] + R_f + SP$$

where:

SP = small-stock premium.

Because the small-stock premium can be identified by company size, the appropriate premium to add for any particular company will depend on its equity capitalization. For instance, a utility with a market capitalization of $1 billion would require a small capitalization adjustment of approximately 1.3 percent over the traditional CAPM; at $400 million, approximately 2.1 percent, and at only $100 million, approximately 4 percent.

Again, these additions to the traditional CAPM represent an adjustment over and above any increase already provided to these smaller companies by having higher *betas*.

Implications for Smaller Utilities

These findings carry important ramifications for relatively small public utilities. Boosting the traditional CAPM return by a full 400 basis points for small utilities translates into a substantial premium over larger utilities.

Table 2 shows the results of an analysis of 202 utility companies that calculated cost of equity figures. Composites (arithmetic means) weighted by equity capitalization were also calculated for the largest and smallest 20 companies. The results show the impact size has on cost of equity.

For the traditional CAPM, the large-company composite shows a cost of equity of 12.05 percent; the small company composite, 13.93 percent. However, once the respective small capitalization premium is added in, the spread increases dramatically, to 12.07 and 17.95 percent, respectively. Clearly, the smaller the utility (in terms of equity capitalization), the larger the impact that size exerts on the expected return of that security. ▼

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The Cross-Section of Expected Stock Returns

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ABSTRACT

Two easily measured variables, size and book-to-market equity, combine to capture the cross-sectional variation in average stock returns associated with market β, size, leverage, book-to-market equity, and earnings-price ratios. Moreover, when the tests allow for variation in β that is unrelated to size, the relation between market β and average return is flat, even when β is the only explanatory variable.

THE ASSET-PRICING MODEL OF Sharpe (1964), Lintner (1965), and Black (1972) has long shaped the way academics and practitioners think about average returns and risk. The central prediction of the model is that the market portfolio of invested wealth is mean-variance efficient in the sense of Markowitz (1959). The efficiency of the market portfolio implies that (a) expected returns on securities are a positive linear function of their market βs (the slope in the regression of a security's return on the market's return), and (b) market βs suffice to describe the cross-section of expected returns.

There are several empirical contradictions of the Sharpe-Lintner-Black (SLB) model. The most prominent is the size effect of Banz (1981). He finds that market equity, ME (a stock's price times shares outstanding), adds to the explanation of the cross-section of average returns provided by market βs. Average returns on small (low ME) stocks are too high given their β estimates, and average returns on large stocks are too low.

Another contradiction of the SLB model is the positive relation between leverage and average return documented by Bhandari (1988). It is plausible that leverage is associated with risk and expected return, but in the SLB model, leverage risk should be captured by market β. Bhandari finds, however, that leverage helps explain the cross-section of average stock returns in tests that include size (ME) as well as β.

Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) find that average returns on U.S. stocks are positively related to the ratio of a firm's book value of common equity, BE, to its market value, ME. Chan, Hamao, and Lakonishok (1991) find that book-to-market equity, BE/ME, also has a strong role in explaining the cross-section of average returns on Japanese stocks.

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Finally, Basu (1983) shows that earnings-price ratios (E/P) help explain the cross-section of average returns on U.S. stocks in tests that also include size and market β. Ball (1978) argues that E/P is a catch-all proxy for unnamed factors in expected returns; E/P is likely to be higher (prices are lower relative to earnings) for stocks with higher risks and expected returns, whatever the unnamed sources of risk.

Ball's proxy argument for E/P might also apply to size (ME), leverage, and book-to-market equity. All these variables can be regarded as different ways to scale stock prices, to extract the information in prices about risk and expected returns (Keim (1988)). Moreover, since E/P, ME, leverage, and BE/ME are all scaled versions of price, it is reasonable to expect that some of them are redundant for describing average returns. Our goal is to evaluate the joint roles of market β, size, E/P, leverage, and book-to-market equity in the cross-section of average returns on NYSE, AMEX, and NASDAQ stocks.

Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973) find that, as predicted by the SLB model, there is a positive simple relation between average stock returns and β during the pre-1969 period. Like Reinganum (1981) and Lakonishok and Shapiro (1986), we find that the relation between β and average return disappears during the more recent 1963–1990 period, even when β is used alone to explain average returns. The appendix shows that the simple relation between β and average return is also weak in the 50-year 1941–1990 period. In short, our tests do not support the most basic prediction of the SLB model, that average stock returns are positively related to market βs.

Unlike the simple relation between β and average return, the univariate relations between average return and size, leverage, E/P, and book-to-market equity are strong. In multivariate tests, the negative relation between size and average return is robust to the inclusion of other variables. The positive relation between book-to-market equity and average return also persists in competition with other variables. Moreover, although the size effect has attracted more attention, book-to-market equity has a consistently stronger role in average returns. Our bottom-line results are: (a) β does not seem to help explain the cross-section of average stock returns, and (b) the combination of size and book-to-market equity seems to absorb the roles of leverage and E/P in average stock returns, at least during our 1963–1990 sample period.

If assets are priced rationally, our results suggest that stock risks are multidimensional. One dimension of risk is proxied by size, ME. Another dimension of risk is proxied by BE/ME, the ratio of the book value of common equity to its market value.

It is possible that the risk captured by BE/ME is the relative distress factor of Chan and Chen (1991). They postulate that the earning prospects of firms are associated with a risk factor in returns. Firms that the market judges to have poor prospects, signaled here by low stock prices and high ratios of book-to-market equity, have higher expected stock returns (they are penalized with higher costs of capital) than firms with strong prospects. It is also possible, however, that BE/ME just captures the unraveling (regression toward the mean) of irrational market whims about the prospects of firms.

Whatever the underlying economic causes, our main result is straightforward. Two easily measured variables, size (ME) and book-to-market equity (BE/ME), provide a simple and powerful characterization of the cross-section of average stock returns for the 1963–1990 period.

In the next section we discuss the data and our approach to estimating β. Section II examines the relations between average return and β and between average return and size. Section III examines the roles of E/P, leverage, and book-to-market equity in average returns. In sections IV and V, we summarize, interpret, and discuss applications of the results.

I. Preliminaries

A. Data

We use all nonfinancial firms in the intersection of (a) the NYSE, AMEX, and NASDAQ return files from the Center for Research in Security Prices (CRSP) and (b) the merged COMPUSTAT annual industrial files of income-statement and balance-sheet data, also maintained by CRSP. We exclude financial firms because the high leverage that is normal for these firms probably does not have the same meaning as for nonfinancial firms, where high leverage more likely indicates distress. The CRSP returns cover NYSE and AMEX stocks until 1973 when NASDAQ returns also come on line. The COMPUSTAT data are for 1962–1989. The 1962 start date reflects the fact that book value of common equity (COMPUSTAT item 60), is not generally available prior to 1962. More important, COMPUSTAT data for earlier years have a serious selection bias; the pre-1962 data are tilted toward big historically successful firms.

To ensure that the accounting variables are known before the returns they are used to explain, we match the accounting data for all fiscal yearends in calendar year $t - 1$ (1962–1989) with the returns for July of year t to June of $t + 1$. The 6-month (minimum) gap between fiscal yearend and the return tests is conservative. Earlier work (e.g., Basu (1983)) often assumes that accounting data are available within three months of fiscal yearends. Firms are indeed required to file their 10-K reports with the SEC within 90 days of their fiscal yearends, but on average 19.8% do not comply. In addition, more than 40% of the December fiscal yearend firms that do comply with the 90-day rule file on March 31, and their reports are not made public until April. (See Alford, Jones, and Zmijewski (1992).)

We use a firm's market equity at the end of December of year $t - 1$ to compute its book-to-market, leverage, and earnings-price ratios for $t - 1$, and we use its market equity for June of year t to measure its size. Thus, to be included in the return tests for July of year t, a firm must have a CRSP stock price for December of year $t - 1$ and June of year t. It must also have monthly returns for at least 24 of the 60 months preceding July of year t (for "pre-ranking" β estimates, discussed below). And the firm must have COMPUSTAT data on total book assets (A), book equity (BE), and earnings (E), for its fiscal year ending in (any month of) calendar year $t - 1$.

Our use of December market equity in the E/P, BE/ME, and leverage ratios is objectionable for firms that do not have December fiscal yearends because the accounting variable in the numerator of a ratio is not aligned with the market value in the denominator. Using ME at fiscal yearends is also problematic; then part of the cross-sectional variation of a ratio for a given year is due to market-wide variation in the ratio during the year. For example, if there is a general fall in stock prices during the year, ratios measured early in the year will tend to be lower than ratios measured later. We can report, however, that the use of fiscal-yearend MEs, rather than December MEs, in the accounting ratios has little impact on our return tests.

Finally, the tests mix firms with different fiscal yearends. Since we match accounting data for all fiscal yearends in calendar year $t - 1$ with returns for July of t to June of $t + 1$, the gap between the accounting data and the matching returns varies across firms. We have done the tests using the smaller sample of firms with December fiscal yearends with similar results.

B. Estimating Market βs

Our asset-pricing tests use the cross-sectional regression approach of Fama and MacBeth (1973). Each month the cross-section of returns on stocks is regressed on variables hypothesized to explain expected returns. The time-series means of the monthly regression slopes then provide standard tests of whether different explanatory variables are on average priced.

Since size, E/P, leverage, and BE/ME are measured precisely for individual stocks, there is no reason to smear the information in these variables by using portfolios in the Fama-MacBeth (FM) regressions. Most previous tests use portfolios because estimates of market βs are more precise for portfolios. Our approach is to estimate βs for portfolios and then assign a portfolio's β to each stock in the portfolio. This allows us to use individual stocks in the FM asset-pricing tests.

B.1. β Estimation: Details

In June of each year, all NYSE stocks on CRSP are sorted by size (ME) to determine the NYSE decile breakpoints for ME. NYSE, AMEX, and NASDAQ stocks that have the required CRSP-COMPUSTAT data are then allocated to 10 size portfolios based on the NYSE breakpoints. (If we used stocks from all three exchanges to determine the ME breakpoints, most portfolios would include only small stocks after 1973, when NASDAQ stocks are added to the sample.)

We form portfolios on size because of the evidence of Chan and Chen (1988) and others that size produces a wide spread of average returns and βs. Chan and Chen use only size portfolios. The problem this creates is that size and the βs of size portfolios are highly correlated (-0.988 in their data), so asset-pricing tests lack power to separate size from β effects in average returns.

To allow for variation in β that is unrelated to size, we subdivide each size decile into 10 portfolios on the basis of pre-ranking βs for individual stocks. The pre-ranking βs are estimated on 24 to 60 monthly returns (as available) in the 5 years before July of year t. We set the β breakpoints for each size decile using only NYSE stocks that satisfy our COMPUSTAT-CRSP data requirements for year $t - 1$. Using NYSE stocks ensures that the β breakpoints are not dominated after 1973 by the many small stocks on NASDAQ. Setting β breakpoints with stocks that satisfy our COMPUSTAT-CRSP data requirements guarantees that there are firms in each of the 100 size-β portfolios.

After assigning firms to the size-β portfolios in June, we calculate the equal-weighted monthly returns on the portfolios for the next 12 months, from July to June. In the end, we have post-ranking monthly returns for July 1963 to December 1990 on 100 portfolios formed on size and pre-ranking βs. We then estimate βs using the full sample (330 months) of post-ranking returns on each of the 100 portfolios, with the CRSP value-weighted portfolio of NYSE, AMEX, and (after 1972) NASDAQ stocks used as the proxy for the market. We have also estimated βs using the value-weighted or the equal-weighted portfolio of NYSE stocks as the proxy for the market. These βs produce inferences on the role of β in average returns like those reported below.

We estimate β as the sum of the slopes in the regression of the return on a portfolio on the current and prior month's market return. (An additional lead and lag of the market have little effect on these sum βs.) The sum βs are meant to adjust for nonsynchronous trading (Dimson (1979)). Fowler and Rorke (1983) show that sum βs are biased when the market return is autocorrelated. The 1st- and 2nd-order autocorrelations of the monthly market returns for July 1963 to December 1990 are 0.06 and -0.05, both about 1 standard error from 0. If the Fowler-Rorke corrections are used, they lead to trivial changes in the βs. We stick with the simpler sum βs. Appendix Table AI shows that using sum βs produces large increases in the βs of the smallest ME portfolios and small declines in the βs of the largest ME portfolios.

Chan and Chen (1988) show that full-period β estimates for portfolios can work well in tests of the SLB model, even if the true βs of the portfolios vary through time, if the variation in the βs is proportional,

$$\beta_{jt} - \beta_j = k_t(\beta_j - \beta), \tag{1}$$

where β_{jt} is the true β for portfolio j at time t, β_j is the mean of β_{jt} across t, and β is the mean of the β_j. The Appendix argues that (1) is a good approximation for the variation through time in the true βs of portfolios (j) formed on size and β. For diehard β fans, sure to be skeptical of our results on the weak role of β in average stock returns, we can also report that the results stand up to robustness checks that use 5-year pre-ranking βs, or 5-year post-ranking βs, instead of the full-period post-ranking βs.

We allocate the full-period post-ranking β of a size-β portfolio to each stock in the portfolio. These are the βs that will be used in the Fama-MacBeth cross-sectional regressions for individual stocks. We judge that the precision of the full-period post-ranking portfolio βs, relative to the imprecise β estimates that would be obtained for individual stocks, more than makes up for the fact that true βs are not the same for all stocks in a portfolio. And note that assigning full-period portfolio βs to stocks does not mean that a stock's β is constant. A stock can move across portfolios with year-to-year changes in the stock's size (ME) and in the estimates of its β for the preceding 5 years.

B.2. β Estimates

Table I shows that forming portfolios on size and pre-ranking βs, rather than on size alone, magnifies the range of full-period post-ranking βs. Sorted on size alone, the post-ranking βs range from 1.44 for the smallest ME portfolio to 0.92 for the largest. This spread of βs across the 10 size deciles is smaller than the spread of post-ranking βs produced by the β sort of *any* size decile. For example, the post-ranking βs for the 10 portfolios in the smallest size decile range from 1.05 to 1.79. Across all 100 size-β portfolios, the post-ranking βs range from 0.53 to 1.79, a spread 2.4 times the spread, 0.52, obtained with size portfolios alone.

Two other facts about the βs are important. First, in each size decile the post-ranking βs closely reproduce the ordering of the pre-ranking βs. We take this to be evidence that the pre-ranking β sort captures the ordering of true post-ranking βs. (The appendix gives more evidence on this important issue.) Second, the β sort is not a refined size sort. In any size decile, the average values of ln(ME) are similar across the β-sorted portfolios. Thus the pre-ranking β sort achieves its goal. It produces strong variation in post-ranking βs that is unrelated to size. This is important in allowing our tests to distinguish between β and size effects in average returns.

II. β and Size

The Sharpe-Lintner-Black (SLB) model plays an important role in the way academics and practitioners think about risk and the relation between risk and expected return. We show next that when common stock portfolios are formed on size alone, there seems to be evidence for the model's central prediction: average return is positively related to β. The βs of size portfolios are, however, almost perfectly correlated with size, so tests on size portfolios are unable to disentangle β and size effects in average returns. Allowing for variation in β that is unrelated to size breaks the logjam, but at the expense of β. Thus, when we subdivide size portfolios on the basis of pre-ranking βs, we find a strong relation between average return and size, but no relation between average return and β.

A. *Informal Tests*

Table II shows post-ranking average returns for July 1963 to December 1990 for portfolios formed from one-dimensional sorts of stocks on size or β. The portfolios are formed at the end of June each year and their equal-weighted returns are calculated for the next 12 months. We use returns for July to June to match the returns in later tests that use the accounting data. When we sort on just size or 5-year pre-ranking βs, we form 12 portfolios. The middle 8 cover deciles of size or β. The 4 extreme portfolios (1A, 1B, 10A, and 10B) split the bottom and top deciles in half.

Table II shows that when portfolios are formed on size alone, we observe the familiar strong negative relation between size and average return (Banz (1981)), and a strong positive relation between average return and β. Average returns fall from 1.64% per month for the smallest ME portfolio to 0.90% for the largest. Post-ranking βs also decline across the 12 size portfolios, from 1.44 for portfolio 1A to 0.90 for portfolio 10B. Thus, a simple size sort seems to support the SLB prediction of a positive relation between β and average return. But the evidence is muddied by the tight relation between size and the βs of size portfolios.

The portfolios formed on the basis of the ranked market βs of stocks in Table II produce a wider range of βs (from 0.81 for portfolio 1A to 1.73 for 10B) than the portfolios formed on size. Unlike the size portfolios, the β-sorted portfolios do not support the SLB model. There is little spread in average returns across the β portfolios, and there is no obvious relation between β and average returns. For example, although the two extreme portfolios, 1A and 10B, have much different βs, they have nearly identical average returns (1.20% and 1.18% per month). These results for 1963–1990 confirm Reinganum's (1981) evidence that for β-sorted portfolios, there is no relation between average return and β during the 1964–1979 period.

The 100 portfolios formed on size and then pre-ranking β in Table I clarify the contradictory evidence on the relation between β and average return produced by portfolios formed on size or β alone. Specifically, the two-pass sort gives a clearer picture of the separate roles of size and β in average returns. Contrary to the central prediction of the SLB model, the second-pass β sort produces little variation in average returns. Although the post-ranking βs in Table I increase strongly in each size decile, average returns are flat or show a slight tendency to decline. In contrast, within the columns of the average return and β matrices of Table I, average returns and βs decrease with increasing size.

The two-pass sort on size and β in Table I says that variation in β that is tied to size is positively related to average return, but variation in β unrelated to size is not compensated in the average returns of 1963–1990. The proper inference seems to be that there is a relation between size and average return, but controlling for size, there is no relation between β and average return. The regressions that follow confirm this conclusion, and they produce another that is stronger. The regressions show that when one allows

Table I

Average Returns, Post-Ranking βs and Average Size For Portfolios Formed on Size and then β: Stocks Sorted on ME (Down) then Pre-Ranking β (Across): July 1963 to December 1990

Portfolios are formed yearly. The breakpoints for the size (ME, price times shares outstanding) deciles are determined in June of year t (t = 1963–1990) using all NYSE stocks on CRSP. All NYSE, AMEX, and NASDAQ stocks that meet the CRSP-COMPUSTAT data requirements are allocated to the 10 size portfolios using the NYSE breakpoints. Each size decile is subdivided into 10 β portfolios using pre-ranking βs of individual stocks, estimated with 2 to 5 years of monthly returns (as available) ending in June of year t. We use only NYSE stocks that meet the CRSP-COMPUSTAT data requirements to establish the β breakpoints. The equal-weighted monthly returns on the resulting 100 portfolios are then calculated for July of year t to June of year $t + 1$.

The post-ranking βs use the full (July 1963 to December 1990) sample of post-ranking returns for each portfolio. The pre- and post-ranking βs (here and in all other tables) are the sum of the slopes from a regression of monthly returns on the current and prior month's returns on the value-weighted portfolio of NYSE, AMEX, and (after 1972) NASDAQ stocks. The average return is the time-series average of the monthly equal-weighted portfolio returns, in percent. The average size of a portfolio is the time-series average of monthly averages of ln(ME) for stocks in the portfolio at the end of June of each year, with ME denominated in millions of dollars

The average number of stocks per month for the size-β portfolios in the smallest size decile varies from 70 to 177. The average number of stocks for the size-β portfolios in size deciles 2 and 3 is between 15 and 41, and the average number for the largest 7 size deciles is between 11 and 22.

The All column shows statistics for equal-weighted size-decile (ME) portfolios. The All row shows statistics for equal-weighted portfolios of the stocks in each β group.

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel A: Average Monthly Returns (in Percent)											
All	1.25	1.34	1.29	1.36	1.31	1.33	1.28	1.24	1.21	1.25	1.14
Small-ME	1.52	1.71	1.57	1.79	1.61	1 50	1.50	1.37	1.63	1.50	1.42
ME-2	1.29	1.25	1.42	1.36	1.39	1.65	1.61	1.37	1 31	1.34	1.11
ME-3	1.24	1.12	1.31	1.17	1.70	1.29	1.10	1.31	1.36	1.26	0.76
ME-4	1.25	1.27	1.13	1.54	1.06	1.34	1.06	1.41	1.17	1.35	0.98
ME-5	1.29	1.34	1.42	1.39	1.48	1.42	1.18	1.13	1.27	1.18	1.08
ME-6	1.17	1.08	1.53	1.27	1.15	1.20	1.21	1.18	1.04	1.07	1.02
ME-7	1.07	0.95	1.21	1.26	1.09	1.18	1.11	1.24	0.62	1.32	0.76
ME-8	1.10	1.09	1.05	1.37	1.20	1.27	0.98	1.18	1.02	1.01	0.94
ME-9	0.95	0.98	0.88	1.02	1.14	1.07	1.23	0.94	0.82	0.88	0.59
Large-ME	0.89	1.01	0.93	1.10	0.94	0.93	0.89	1.03	0.71	0.74	0.56

Table I—*Continued*

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
					Panel B: Post-Ranking βs						
All		0.87	0.99	1.09	1.16	1.26	1.29	1 35	1.45	1.52	1.72
Small-ME	1.44	1.05	1.18	1.28	1.32	1.40	1.40	1.49	1.61	1.64	1 79
ME-2	1.39	0.91	1.15	1.17	1.24	1.36	1.41	1.43	1.50	1.66	1.76
ME-3	1.35	0 97	1 13	1.13	1.21	1.26	1.28	1.39	1.50	1.51	1.75
ME-4	1.34	0 78	1.03	1.17	1.16	1.29	1.37	1.46	1.51	1 64	1.71
ME-5	1 25	0 66	0.85	1.12	1.15	1.16	1.26	1.30	1.43	1.59	1.68
ME-6	1.23	0.61	0.78	1.05	1.16	1.22	1.28	1.36	1.46	1.49	1.70
ME-7	1.17	0.57	0.92	1.01	1.11	1.14	1.26	1.24	1.39	1.34	1.60
ME-8	1.09	0.53	0.74	0.94	1.02	1.13	1.12	1.18	1.26	1.35	1.52
ME-9	1 03	0 58	0.74	0.80	0.95	1.06	1.15	1.14	1.21	1.22	1.42
Large-ME	0.92	0.57	0.71	0.78	0.89	0.95	0.92	1.02	1.01	1.11	1.32
					Panel C: Average Size (ln(ME))						
All	4.11	3.86	4.26	4 33	4.41	4.27	4.32	4.26	4.19	4 03	3.77
Small-ME	2.24	2.12	2.27	2.30	2.30	2.28	2.29	2.30	2.32	2.25	2.15
ME-2	3.63	3.65	3.68	3.70	3.72	3.69	3 70	3.69	3.69	3.70	3.68
ME-3	4.10	4.14	4.18	4.12	4.15	4.16	4.16	4.18	4 14	4.15	4.15
ME-4	4.50	4.53	4.53	4.57	4.54	4.56	4.55	4.52	4.58	4.52	4.56
ME-5	4.89	4.91	4.91	4.93	4.95	4.93	4.92	4 93	4.92	4.92	4.95
ME-6	5.30	5.30	5 33	5 34	5.34	5.33	5.33	5.33	5.33	5.34	5.36
ME-7	5.73	5.73	5.75	5.77	5.76	5.73	5.77	5.77	5 76	5.72	5.76
ME-8	6.24	6.26	6.27	6.26	6.24	6.24	6.27	6.24	6.24	6.24	6 26
ME-9	6.82	6.82	6.84	6.82	6.82	6.81	6.81	6.81	6.81	6.80	6.83
Large-ME	7.93	7.94	8.04	8.10	8.04	8 02	8.02	7.94	7.80	7.75	7.62

Table II

Properties of Portfolios Formed on Size or Pre-Ranking β: July 1963 to December 1990

At the end of June of each year t, 12 portfolios are formed on the basis of ranked values of size (ME) or pre-ranking β. The pre-ranking βs use 2 to 5 years (as available) of monthly returns ending in June of t. Portfolios 2–9 cover deciles of the ranking variables. The bottom and top 2 portfolios (1A, 1B, 10A, and 10B) split the bottom and top deciles in half. The breakpoints for the ME portfolios are based on ranked values of ME for all NYSE stocks on CRSP. NYSE breakpoints for pre-ranking βs are also used to form the β portfolios. NYSE, AMEX, and NASDAQ stocks are then allocated to the size or β portfolios using the NYSE breakpoints. We calculate each portfolio's monthly equal-weighted return for July of year t to June of year $t + 1$, and then reform the portfolios in June of $t + 1$.

BE is the book value of common equity plus balance-sheet deferred taxes, A is total book assets, and E is earnings (income before extraordinary items, plus income-statement deferred taxes, minus preferred dividends). BE, A, and E are for each firm's latest fiscal year ending in calendar year $t - 1$. The accounting ratios are measured using market equity ME in December of year $t - 1$. Firm size ln(ME) is measured in June of year t, with ME denominated in millions of dollars.

The average return is the time-series average of the monthly equal-weighted portfolio returns, in percent. ln(ME), ln(BE/ME), ln(A/ME), ln(A/BE), E/P, and E/P dummy are the time-series averages of the monthly average values of these variables in each portfolio. Since the E/P dummy is 0 when earnings are positive, and 1 when earnings are negative, E/P dummy gives the average proportion of stocks with negative earnings in each portfolio.

β is the time-series average of the monthly portfolio βs. Stocks are assigned the post-ranking β of the size-β portfolio they are in at the end of June of year t (Table I). These individual-firm βs are averaged to compute the monthly βs for each portfolio for July of year t to June of year $t + 1$.

Firms is the average number of stocks in the portfolio each month.

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Portfolios Formed on Size												
Return	1.64	1.16	1.29	1.24	1.25	1.29	1.17	1.07	1.10	0.95	0.88	0.90
β	1.44	1.44	1.39	1.34	1.33	1.24	1.22	1.16	1.08	1.02	0.95	0.90
ln(ME)	1.98	3.18	3.63	4.10	4.50	4.89	5.30	5.73	6.24	6.82	7.39	8.44
ln(BE/ME)	−0.01	−0.21	−0.23	−0.26	−0.32	−0.36	−0.36	−0.44	−0.40	−0.42	−0.51	−0.65
ln(A/ME)	0.73	0.50	0.46	0.43	0.37	0.32	0.32	0.24	0.29	0.27	0.17	−0.03
ln(A/BE)	0.75	0.71	0.69	0.69	0.68	0.67	0.68	0.67	0.69	0.70	0.68	0.62
E/P dummy	0.26	0.14	0.11	0.09	0.06	0.04	0.04	0.03	0.03	0.02	0.02	0.01
E(+)/P	0.09	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0 10	0.10	0.09	0.09
Firms	772	189	236	170	144	140	128	125	119	114	60	64

Table II—*Continued*

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Portfolios Formed on Pre-Ranking β												
Return	1.20	1 20	1.32	1.26	1.31	1.30	1.30	1.23	1.23	1.33	1.34	1.18
β	0.81	0.79	0.92	1.04	1.13	1.19	1.26	1.32	1.41	1.52	1 63	1.73
ln(ME)	4.21	4.86	4.75	4.68	4.59	4.48	4.36	4.25	3.97	3.78	3.52	3.15
ln(BE/ME)	−0.18	−0.13	−0.22	−0.21	−0.23	−0.22	−0.22	−0.25	−0.23	−0.27	−0.31	−0.50
ln(A/ME)	0.60	0.66	0.49	0.45	0.42	0.42	0.45	0.42	0.47	0 46	0.46	0.31
ln(A/BE)	0.78	0.79	0.71	0.66	0.64	0.65	0.67	0.67	0.70	0.73	0.77	0 81
E/P dummy	0.12	0.06	0.09	0.09	0.08	0.09	0.10	0.12	0.12	0.14	0.17	0.23
E(+)/P	0.11	0.12	0.10	0.10	0.10	0.10	0.10	0.09	0.10	0.09	0 09	0.08
Firms	116	80	185	181	179	182	185	205	227	267	165	291

for variation in β that is unrelated to size, the relation between β and average return is flat, even when β is the only explanatory variable.

B. Fama-MacBeth Regressions

Table III shows time-series averages of the slopes from the month-by-month Fama-MacBeth (FM) regressions of the cross-section of stock returns on size, β, and the other variables (leverage, E/P, and book-to-market equity) used to explain average returns. The average slopes provide standard FM tests for determining which explanatory variables on average have non-zero expected premiums during the July 1963 to December 1990 period.

Like the average returns in Tables I and II, the regressions in Table III say that size, ln(ME), helps explain the cross-section of average stock returns. The average slope from the monthly regressions of returns on size alone is -0.15%, with a t-statistic of -2.58. This reliable negative relation persists no matter which other explanatory variables are in the regressions; the average slopes on ln(ME) are always close to or more than 2 standard errors from 0. The size effect (smaller stocks have higher average returns) is thus robust in the 1963–1990 returns on NYSE, AMEX, and NASDAQ stocks.

In contrast to the consistent explanatory power of size, the FM regressions show that market β does not help explain average stock returns for 1963–1990. In a shot straight at the heart of the SLB model, the average slope from the regressions of returns on β alone in Table III is 0.15% per month and only 0.46 standard errors from 0. In the regressions of returns on size and β, size has explanatory power (an average slope -3.41 standard errors from 0), but the average slope for β is negative and only 1.21 standard errors from 0. Lakonishok and Shapiro (1986) get similar results for NYSE stocks for 1962–1981. We can also report that β shows no power to explain average returns (the average slopes are typically less than 1 standard error from 0) in FM regressions that use various combinations of β with size, book-to-market equity, leverage, and E/P.

C. Can β Be Saved?

What explains the poor results for β? One possibility is that other explanatory variables are correlated with true βs, and this obscures the relation between average returns and measured βs. But this line of attack cannot explain why β has no power when used alone to explain average returns. Moreover, leverage, book-to-market equity, and E/P do not seem to be good proxies for β. The averages of the monthly cross-sectional correlations between β and the values of these variables for individual stocks are all within 0.15 of 0.

Another hypothesis is that, as predicted by the SLB model, there is a positive relation between β and average return, but the relation is obscured by noise in the β estimates. However, our full-period post-ranking βs do not seem to be imprecise. Most of the standard errors of the βs (not shown) are

Table III

Average Slopes (*t*-Statistics) from Month-by-Month Regressions of Stock Returns on β, Size, Book-to-Market Equity, Leverage, and E/P: July 1963 to December 1990

Stocks are assigned the post-ranking β of the size-β portfolio they are in at the end of June of year *t* (Table I). BE is the book value of common equity plus balance-sheet deferred taxes, A is total book assets, and E is earnings (income before extraordinary items, plus income-statement deferred taxes, minus preferred dividends) BE, A, and E are for each firm's latest fiscal year ending in calendar year $t - 1$. The accounting ratios are measured using market equity ME in December of year $t - 1$. Firm size ln(ME) is measured in June of year *t*. In the regressions, these values of the explanatory variables for individual stocks are matched with CRSP returns for the months from July of year *t* to June of year $t + 1$. The gap between the accounting data and the returns ensures that the accounting data are available prior to the returns. If earnings are positive, E(+)/P is the ratio of total earnings to market equity and E/P dummy is 0. If earnings are negative, E(+)/P is 0 and E/P dummy is 1.

The average slope is the time-series average of the monthly regression slopes for July 1963 to December 1990, and the *t*-statistic is the average slope divided by its time-series standard error.

On average, there are 2267 stocks in the monthly regressions. To avoid giving extreme observations heavy weight in the regressions, the smallest and largest 0.5% of the observations on E(+)/P, BE/ME, A/ME, and A/BE are set equal to the next largest or smallest values of the ratios (the 0.005 and 0.995 fractiles). This has no effect on inferences.

β	ln(ME)	ln(BE/ME)	ln(A/ME)	ln(A/BE)	E/P Dummy	E(+)/P
0.15 (0.46)						
	−0.15 (−2 58)					
−0.37 (−1.21)	−0.17 (−3.41)					
		0.50 (5.71)				
			0.50 (5 69)	−0.57 (−5.34)		
					0.57 (2.28)	4.72 (4.57)
	−0.11 (−1.99)	0.35 (4.44)				
	−0 11 (−2 06)		0.35 (4.32)	−0 50 (−4.56)		
	−0.16 (−3.06)				0.06 (0 38)	2.99 (3.04)
	−0.13 (−2.47)	0.33 (4.46)			−0.14 (−0.90)	0.87 (1.23)
	−0.13 (−2.47)		0.32 (4.28)	−0.46 (−4.45)	−0.08 (−0.56)	1.15 (1.57)

0.05 or less, only 1 is greater than 0.1, and the standard errors are small relative to the range of the βs (0.53 to 1.79).

The β-sorted portfolios in Tables I and II also provide strong evidence against the β-measurement-error story. When portfolios are formed on pre-ranking βs alone (Table II), the post-ranking βs for the portfolios almost perfectly reproduce the ordering of the pre-ranking βs. Only the β for portfolio 1B is out of line, and only by 0.02. Similarly, when portfolios are formed on size and then pre-ranking βs (Table I), the post-ranking βs in each size decile closely reproduce the ordering of the pre-ranking βs.

The correspondence between the ordering of the pre-ranking and post-ranking βs for the β-sorted portfolios in Tables I and II is evidence that the post-ranking βs are informative about the ordering of the true βs. The problem for the SLB model is that there is no similar ordering in the average returns on the β-sorted portfolios. Whether one looks at portfolios sorted on β alone (Table II) or on size and then β (Table I), average returns are flat (Table II) or decline slightly (Table I) as the post-ranking βs increase.

Our evidence on the robustness of the size effect and the absence of a relation between β and average return is so contrary to the SLB model that it behooves us to examine whether the results are special to 1963–1990. The appendix shows that NYSE returns for 1941–1990 behave like the NYSE, AMEX, and NASDAQ returns for 1963–1990; there is a reliable size effect over the full 50-year period, but little relation between β and average return. Interestingly, there is a reliable simple relation between β and average return during the 1941–1965 period. These 25 years are a major part of the samples in the early studies of the SLB model of Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973). Even for the 1941–1965 period, however, the relation between β and average return disappears when we control for size.

III. Book-to-Market Equity, E/P, and Leverage

Tables I to III say that there is a strong relation between the average returns on stocks and size, but there is no reliable relation between average returns and β. In this section we show that there is also a strong cross-sectional relation between average returns and book-to-market equity. If anything, this book-to-market effect is more powerful than the size effect. We also find that the combination of size and book-to-market equity absorbs the apparent roles of leverage and E/P in average stock returns.

A. Average Returns

Table IV shows average returns for July 1963 to December 1990 for portfolios formed on ranked values of book-to-market equity (BE/ME) or earnings-price ratio (E/P). The BE/ME and E/P portfolios in Table IV are formed in the same general way (one-dimensional yearly sorts) as the size and β portfolios in Table II. (See the tables for details.)

The relation between average return and E/P has a familiar U-shape (e.g., Jaffe, Keim, and Westerfield (1989) for U.S. data, and Chan, Hamao, and Lakonishok (1991) for Japan). Average returns decline from 1.46% per month for the negative E/P portfolio to 0.93% for the firms in portfolio 1B that have low but positive E/P. Average returns then increase monotonically, reaching 1.72% per month for the highest E/P portfolio.

The more striking evidence in Table IV is the strong positive relation between average return and book-to-market equity. Average returns rise from 0.30% for the lowest BE/ME portfolio to 1.83% for the highest, a difference of 1.53% per month. This spread is twice as large as the difference of 0.74% between the average monthly returns on the smallest and largest size portfolios in Table II. Note also that the strong relation between book-to-market equity and average return is unlikely to be a β effect in disguise; Table IV shows that post-ranking market βs vary little across portfolios formed on ranked values of BE/ME.

On average, only about 50 (out of 2317) firms per year have negative book equity, BE. The negative BE firms are mostly concentrated in the last 14 years of the sample, 1976–1989, and we do not include them in the tests. We can report, however, that average returns for negative BE firms are high, like the average returns of high BE/ME firms. Negative BE (which results from persistently negative earnings) and high BE/ME (which typically means that stock prices have fallen) are both signals of poor earning prospects. The similar average returns of negative and high BE/ME firms are thus consistent with the hypothesis that book-to-market equity captures cross-sectional variation in average returns that is related to relative distress.

B. Fama-MacBeth Regressions

B.1. BE/ME

The FM regressions in Table III confirm the importance of book-to-market equity in explaining the cross-section of average stock returns. The average slope from the monthly regressions of returns on ln(BE/ME) alone is 0.50%, with a t-statistic of 5.71. This book-to-market relation is stronger than the size effect, which produces a t-statistic of -2.58 in the regressions of returns on ln(ME) alone. But book-to-market equity does not replace size in explaining average returns. When both ln(ME) and ln(BE/ME) are included in the regressions, the average size slope is still -1.99 standard errors from 0; the book-to-market slope is an impressive 4.44 standard errors from 0.

B.2. Leverage

The FM regressions that explain returns with leverage variables provide interesting insight into the relation between book-to-market equity and average return. We use two leverage variables, the ratio of book assets to market equity, A/ME, and the ratio of book assets to book equity, A/BE. We interpret A/ME as a measure of market leverage, while A/BE is a measure

Table IV

Properties of Portfolios Formed on Book-to-Market Equity (BE/ME) and Earnings-Price Ratio (E/P): July 1963 to December 1990

At the end of each year $t - 1$, 12 portfolios are formed on the basis of ranked values of BE/ME or E/P. Portfolios 2–9 cover deciles of the ranking variables. The bottom and top 2 portfolios (1A, 1B, 10A, and 10B) split the bottom and top deciles in half. For E/P, there are 13 portfolios; portfolio 0 is stocks with negative E/P. Since BE/ME and E/P are not strongly related to exchange listing, their portfolio breakpoints are determined on the basis of the ranked values of the variables for all stocks that satisfy the CRSP-COMPUSTAT data requirements. BE is the book value of common equity plus balance-sheet deferred taxes, A is total book assets, and E is earnings (income before extraordinary items, plus income-statement deferred taxes, minus preferred dividends). BE, A, and E are for each firm's latest fiscal year ending in calendar year $t - 1$. The accounting ratios are measured using market equity ME in December of year $t - 1$. Firm size ln(ME) is measured in June of year t, with ME denominated in millions of dollars. We calculate each portfolio's monthly equal-weighted return for July of year t to June of year $t + 1$, and then reform the portfolios at the end of year t.

Return is the time-series average of the monthly equal-weighted portfolio returns (in percent). ln(ME), ln(BE/ME), ln(A/ME), ln(A/BE), E(+)/P, and E/P dummy are the time-series averages of the monthly average values of these variables in each portfolio Since the E/P dummy is 0 when earnings are positive, and 1 when earnings are negative, E/P dummy gives the average proportion of stocks with negative earnings in each portfolio.

β is the time-series average of the monthly portfolio βs. Stocks are assigned the post-ranking β of the size-β portfolio they are in at the end of June of year t (Table I). These individual-firm βs are averaged to compute the monthly βs for each portfolio for July of year t to June of year $t + 1$. Firms is the average number of stocks in the portfolio each month.

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel A: Stocks Sorted on Book-to-Market Equity (BE/ME)													
Return		0.30	0.67	0.87	0.97	1.04	1.17	1.30	1.44	1.50	1.59	1.92	1.83
β		1.36	1.34	1.32	1.30	1.28	1.27	1.27	1.27	1.27	1.29	1.33	1.35
ln(ME)		4.53	4.67	4.69	4.56	4.47	4.38	4.23	4.06	3.85	3.51	3.06	2.65
ln(BE/ME)		−2.22	−1.51	−1.09	−0.75	−0.51	−0 32	−0.14	0.03	0.21	0.42	0.66	1.02
ln(A/ME)		−1.24	−0.79	−0.40	−0.05	0.20	0.40	0.56	0.71	0.91	1.12	1.35	1.75
ln(A/BE)		0.94	0.71	0.68	0.70	0.71	0.71	0.70	0.68	0.70	0.70	0.70	0.73
E/P dummy		0.29	0.15	0.10	0.08	0.08	0.08	0.09	0.09	0.11	0.15	0.22	0.36
E(+)/P		0.03	0.04	0.06	0.08	0.09	0.10	0.11	0.11	0.12	0.12	0.11	0.10
Firms		89	98	209	222	226	230	235	237	239	239	120	117

Table IV—*Continued*

Portfolio	0	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Panel B: Stocks Sorted on Earnings-Price Ratio (E/P)													
Return	1.46	1.04	0.93	0.94	1.03	1.18	1.22	1.33	1.42	1.46	1.57	1.74	1.72
β	1.47	1.40	1.35	1.31	1.28	1.26	1.25	1.26	1.24	1.23	1.24	1.28	1.31
ln(ME)	2.48	3.64	4.33	4.61	4.64	4.63	4.58	4.49	4.37	4.28	4.07	3.82	3.52
ln(BE/ME)	−0.10	−0.76	−0.91	−0.79	−0.61	−0.47	−0.33	−0.21	-0.08	0.02	0.15	0.26	0.40
ln(A/ME)	0.90	−0.05	−0.27	−0.16	0.03	0.18	0.31	0.44	0.58	0.70	0.85	1.01	1.25
ln(A/BE)	0.99	0.70	0.63	0.63	0.64	0.65	0.64	0.65	0.66	0.68	0 71	0.75	0.86
E/P dummy	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
E(+)/P	0.00	0.01	0.03	0.05	0.06	0.08	0.09	0.11	0.12	0.14	0.16	0.20	0.28
Firms	355	88	90	182	190	193	196	194	197	195	195	95	91

of book leverage. The regressions use the natural logs of the leverage ratios, ln(A/ME) and ln(A/BE), because preliminary tests indicated that logs are a good functional form for capturing leverage effects in average returns. Using logs also leads to a simple interpretation of the relation between the roles of leverage and book-to-market equity in average returns.

The FM regressions of returns on the leverage variables (Table III) pose a bit of a puzzle. The two leverage variables are related to average returns, but with opposite signs. As in Bhandari (1988), higher market leverage is associated with higher average returns; the average slopes for ln(A/ME) are always positive and more than 4 standard errors from 0. But higher book leverage is associated with lower average returns; the average slopes for ln(A/BE) are always negative and more than 4 standard errors from 0.

The puzzle of the opposite slopes on ln(A/ME) and ln(A/BE) has a simple solution. The average slopes for the two leverage variables are opposite in sign but close in absolute value, e.g., 0.50 and −0.57. Thus it is the difference between market and book leverage that helps explain average returns. But the difference between market and book leverage is book-to-market equity, ln(BE/ME) = ln(A/ME) − ln(A/BE). Table III shows that the average book-to-market slopes in the FM regressions are indeed close in absolute value to the slopes for the two leverage variables.

The close links between the leverage and book-to-market results suggest that there are two equivalent ways to interpret the book-to-market effect in average returns. A high ratio of book equity to market equity (a low stock price relative to book value) says that the market judges the prospects of a firm to be poor relative to firms with low BE/ME. Thus BE/ME may capture the relative-distress effect postulated by Chan and Chen (1991). A high book-to-market ratio also says that a firm's market leverage is high relative to its book leverage; the firm has a large amount of market-imposed leverage because the market judges that its prospects are poor and discounts its stock price relative to book value. In short, our tests suggest that the relative-distress effect, captured by BE/ME, can also be interpreted as an involuntary leverage effect, which is captured by the difference between A/ME and A/BE.

B.3. E/P

Ball (1978) posits that the earnings-price ratio is a catch-all for omitted risk factors in expected returns. If current earnings proxy for expected future earnings, high-risk stocks with high expected returns will have low prices relative to their earnings. Thus, E/P should be related to expected returns, whatever the omitted sources of risk. This argument only makes sense, however, for firms with positive earnings. When current earnings are negative, they are not a proxy for the earnings forecasts embedded in the stock price, and E/P is not a proxy for expected returns. Thus, the slope for E/P in the FM regressions is based on positive values; we use a dummy variable for E/P when earnings are negative.

The U-shaped relation between average return and E/P observed in Table IV is also apparent when the E/P variables are used alone in the FM regressions in Table III. The average slope on the E/P dummy variable (0.57% per month, 2.28 standard errors from 0) confirms that firms with negative earnings have higher average returns. The average slope for stocks with positive E/P (4.72% per month, 4.57 standard errors from 0) shows that average returns increase with E/P when it is positive.

Adding size to the regressions kills the explanatory power of the E/P dummy. Thus the high average returns of negative E/P stocks are better captured by their size, which Table IV says is on average small. Adding both size and book-to-market equity to the E/P regressions kills the E/P dummy and lowers the average slope on E/P from 4.72 to 0.87 ($t = 1.23$). In contrast, the average slopes for ln(ME) and ln(BE/ME) in the regressions that include E/P are similar to those in the regressions that explain average returns with only size and book-to-market equity. The results suggest that most of the relation between (positive) E/P and average return is due to the positive correlation between E/P and ln(BE/ME), illustrated in Table IV; firms with high E/P tend to have high book-to-market equity ratios.

IV. A Parsimonious Model for Average Returns

The results to here are easily summarized:

(1) When we allow for variation in β that is unrelated to size, there is no reliable relation between β and average return.
(2) The opposite roles of market leverage and book leverage in average returns are captured well by book-to-market equity.
(3) The relation between E/P and average return seems to be absorbed by the combination of size and book-to-market equity.

In a nutshell, market β seems to have no role in explaining the average returns on NYSE, AMEX, and NASDAQ stocks for 1963–1990, while size and book-to-market equity capture the cross-sectional variation in average stock returns that is related to leverage and E/P.

A. Average Returns, Size and Book-to-Market Equity

The average return matrix in Table V gives a simple picture of the two-dimensional variation in average returns that results when the 10 size deciles are each subdivided into 10 portfolios based on ranked values of BE/ME for individual stocks. Within a size decile (across a row of the average return matrix), returns typically increase strongly with BE/ME: on average, the returns on the lowest and highest BE/ME portfolios in a size decile differ by 0.99% (1.63% − 0.64%) per month. Similarly, looking down the columns of the average return matrix shows that there is a negative relation between average return and size: on average, the spread of returns across the size portfolios in a BE/ME group is 0.58% per month. The average return matrix gives life to the conclusion from the regressions that,

Table V

Average Monthly Returns on Portfolios Formed on Size and Book-to-Market Equity; Stocks Sorted by ME (Down) and then BE/ME (Across): July 1963 to December 1990

In June of each year t, the NYSE, AMEX, and NASDAQ stocks that meet the CRSP-COMPUSTAT data requirements are allocated to 10 size portfolios using the NYSE size (ME) breakpoints. The NYSE, AMEX, and NASDAQ stocks in each size decile are then sorted into 10 BE/ME portfolios using the book-to-market ratios for year $t-1$. BE/ME is the book value of common equity plus balance-sheet deferred taxes for fiscal year $t-1$, over market equity for December of year $t-1$. The equal-weighted monthly portfolio returns are then calculated for July of year t to June of year $t+1$.

Average monthly return is the time-series average of the monthly equal-weighted portfolio returns (in percent).

The All column shows average returns for equal-weighted size decile portfolios. The All row shows average returns for equal-weighted portfolios of the stocks in each BE/ME group.

		Book-to-Market Portfolios									
	All	Low	2	3	4	5	6	7	8	9	High
All	1.23	0.64	0.98	1.06	1.17	1.24	1.26	1.39	1.40	1.50	1.63
Small-ME	1.47	0.70	1.14	1.20	1.43	1.56	1.51	1.70	1.71	1.82	1.92
ME-2	1.22	0.43	1.05	0.96	1.19	1.33	1.19	1.58	1.28	1.43	1.79
ME-3	1.22	0.56	0.88	1.23	0.95	1.36	1.30	1.30	1.40	1.54	1.60
ME-4	1.19	0.39	0.72	1.06	1.36	1.13	1.21	1.34	1.59	1.51	1.47
ME-5	1.24	0.88	0.65	1.08	1.47	1.13	1.43	1.44	1.26	1.52	1.49
ME-6	1.15	0.70	0.98	1.14	1.23	0.94	1.27	1.19	1.19	1.24	1.50
ME-7	1.07	0.95	1.00	0.99	0.83	0.99	1.13	0.99	1.16	1.10	1.47
ME-8	1.08	0.66	1.13	0.91	0.95	0.99	1.01	1.15	1.05	1.29	1 55
ME-9	0.95	0.44	0.89	0.92	1.00	1.05	0.93	0.82	1.11	1.04	1.22
Large-ME	0.89	0.93	0.88	0.84	0.71	0.79	0.83	0.81	0.96	0.97	1.18

controlling for size, book-to-market equity captures strong variation in average returns, and controlling for book-to-market equity leaves a size effect in average returns.

B. The Interaction between Size and Book-to-Market Equity

The average of the monthly correlations between the cross-sections of ln(ME) and ln(BE/ME) for individual stocks is -0.26. The negative correlation is also apparent in the average values of ln(ME) and ln(BE/ME) for the portfolios sorted on ME or BE/ME in Tables II and IV. Thus, firms with low market equity are more likely to have poor prospects, resulting in low stock prices and high book-to-market equity. Conversely, large stocks are more likely to be firms with stronger prospects, higher stock prices, lower book-to-market equity, and lower average stock returns.

The correlation between size and book-to-market equity affects the regressions in Table III. Including ln(BE/ME) moves the average slope on ln(ME) from -0.15 ($t = -2.58$) in the univariate regressions to -0.11 ($t = -1.99$) in the bivariate regressions. Similarly, including ln(ME) in the regressions lowers the average slope on ln(BE/ME) from 0.50 to 0.35 (still a healthy 4.44 standard errors from 0). Thus, part of the size effect in the simple regressions is due to the fact that small ME stocks are more likely to have high book-to-market ratios, and part of the simple book-to-market effect is due to the fact that high BE/ME stocks tend to be small (they have low ME).

We should not, however, exaggerate the links between size and book-to-market equity. The correlation (−0.26) between ln(ME) and ln(BE/ME) is not extreme, and the average slopes in the bivariate regressions in Table III show that ln(ME) and ln(BE/ME) are both needed to explain the cross-section of average returns. Finally, the 10 × 10 average return matrix in Table V provides concrete evidence that, (a) controlling for size, book-to-market equity captures substantial variation in the cross-section of average returns, and (b) within BE/ME groups average returns are related to size.

C. Subperiod Averages of the FM Slopes

The message from the average FM slopes for 1963–1990 (Table III) is that size on average has a negative premium in the cross-section of stock returns, book-to-market equity has a positive premium, and the average premium for market β is essentially 0. Table VI shows the average FM slopes for two roughly equal subperiods (July 1963–December 1976 and January 1977–December 1990) from two regressions: (a) the cross-section of stock returns on size, ln(ME), and book-to-market equity, ln(BE/ME), and (b) returns on β, ln(ME), and ln(BE/ME). For perspective, average returns on the value-weighted and equal-weighted (VW and EW) portfolios of NYSE stocks are also shown.

In FM regressions, the intercept is the return on a standard portfolio (the weights on stocks sum to 1) in which the weighted averages of the explanatory variables are 0 (Fama (1976), chapter 9). In our tests, the intercept is weighted toward small stocks (ME is in millions of dollars so ln(ME) = 0 implies ME = $1 million) and toward stocks with relatively high book-to-market ratios (Table IV says that ln(BE/ME) is negative for the typical firm, so ln(BE/ME) = 0 is toward the high end of the sample ratios). Thus it is not surprising that the average intercepts are always large relative to their standard errors and relative to the returns on the NYSE VW and EW portfolios.

Like the overall period, the subperiods do not offer much hope that the average premium for β is economically important. The average FM slope for β is only slightly positive for 1963–1976 (0.10% per month, $t = 0.25$), and it is negative for 1977–1990 (−0.44% per month, $t = -1.17$). There is a hint that the size effect is weaker in the 1977–1990 period, but inferences about the average size slopes for the subperiods lack power.

Unlike the size effect, the relation between book-to-market equity and average return is so strong that it shows up reliably in both the 1963–1976 and the 1977–1990 subperiods. The average slopes for ln(BE/ME) are all more than 2.95 standard errors from 0, and the average slopes for the

Table VI

Subperiod Average Monthly Returns on the NYSE Equal-Weighted and Value-Weighted Portfolios and Subperiod Means of the Intercepts and Slopes from the Monthly FM Cross-Sectional Regressions of Returns on (a) Size (ln(ME)) and Book-to-Market Equity (ln(BE/ME)), and (b) β, ln(ME), and ln(BE/ME)

Mean is the time-series mean of a monthly return, Std is its time-series standard deviation, and t(Mn) is Mean divided by its time-series standard error.

	7/63–12/90 (330 Mos.)			7/63–12/76 (162 Mos.)			1/77–12/90 (168 Mos.)		
Variable	Mean	Std	t(Mn)	Mean	Std	t(Mn)	Mean	Std	t(Mn)
NYSE Value-Weighted (VW) and Equal-Weighted (EW) Portfolio Returns									
VW	0.81	4.47	3.27	0.56	4.26	1.67	1.04	4.66	2.89
EW	0.97	5.49	3.19	0.77	5.70	1.72	1.15	5.28	2.82
$R_{it} = a + b_{2t}\ln(ME_{it}) + b_{3t}\ln(BE/ME_{it}) + e_{it}$									
a	1.77	8.51	3.77	1.86	10.10	2.33	1.69	6.67	3.27
b_2	−0.11	1.02	−1.99	−0.16	1.25	−1.62	−0.07	0.73	−1.16
b_3	0.35	1.45	4.43	0.36	1.53	2.96	0.35	1.37	3.30
$R_{it} = a + b_{1t}\beta_{it} + b_{2t}\ln(ME_{it}) + b_{3t}\ln(BE/ME_{it}) + e_{it}$									
a	2.07	5.75	6.55	1.73	6.22	3.54	2.40	5.25	5.92
b_1	−0.17	5.12	−0.62	0.10	5.33	0.25	−0.44	4.91	−1.17
b_2	−0.12	0.89	−2.52	−0.15	1.03	−1.91	−0.09	0.74	−1.64
b_3	0.33	1.24	4.80	0.34	1.36	3.17	0.31	1.10	3.67

subperiods (0.36 and 0.35) are close to the average slope (0.35) for the overall period. The subperiod results thus support the conclusion that, among the variables considered here, book-to-market equity is consistently the most powerful for explaining the cross-section of average stock returns.

Finally, Roll (1983) and Keim (1983) show that the size effect is stronger in January. We have examined the monthly slopes from the FM regressions in Table VI for evidence of a January seasonal in the relation between book-to-market equity and average return. The average January slopes for ln(BE/ME) are about twice those for February to December. Unlike the size effect, however, the strong relation between book-to-market equity and average return is not special to January. The average monthly February-to-December slopes for ln(BE/ME) are about 4 standard errors from 0, and they are close to (within 0.05 of) the average slopes for the whole year. Thus, there is a January seasonal in the book-to-market equity effect, but the positive relation between BE/ME and average return is strong throughout the year.

D. β and the Market Factor: Caveats

Some caveats about the negative evidence on the role of β in average returns are in order. The average premiums for β, size, and book-to-market equity depend on the definitions of the variables used in the regressions. For example, suppose we replace book-to-market equity (ln(BE/ME)) with book equity (ln(BE)). As long as size (ln(ME)) is also in the regression, this change will not affect the intercept, the fitted values or the R^2. But the change, in variables increases the average slope (and the t-statistic) on ln(ME). In other words, it increases the risk premium associated with size. Other redefinitions of the β, size, and book-to-market variables will produce different regression slopes and perhaps different inferences about average premiums, including possible resuscitation of a role for β. And, of course, at the moment, we have no theoretical basis for choosing among different versions of the variables.

Moreover, the tests here are restricted to stocks. It is possible that including other assets will change the inferences about the average premiums for β, size, and book-to-market equity. For example, the large average intercepts for the FM regressions in Table VI suggest that the regressions will not do a good job on Treasury bills, which have low average returns and are likely to have small loadings on the underlying market, size, and book-to-market factors in returns. Extending the tests to bills and other bonds may well change our inferences about average risk premiums, including the revival of a role for market β.

We emphasize, however, that different approaches to the tests are not likely to revive the Sharpe-Lintner-Black model. Resuscitation of the SLB model requires that a better proxy for the market portfolio (a) overturns our evidence that the simple relation between β and average stock returns is flat and (b) leaves β as the only variable relevant for explaining average returns. Such results seem unlikely, given Stambaugh's (1982) evidence that tests of the SLB model do not seem to be sensitive to the choice of a market proxy. Thus, if there is a role for β in average returns, it is likely to be found in a multi-factor model that transforms the flat simple relation between average return and β into a positively sloped conditional relation.

V. Conclusions and Implications

The Sharpe-Lintner-Black model has long shaped the way academics and practitioners think about average return and risk. Black, Jensen, and Scholes (1972) and Fama and MacBeth (1973) find that, as predicted by the model, there is a positive simple relation between average return and market β during the early years (1926–1968) of the CRSP NYSE returns file. Like Reinganum (1981) and Lakonishok and Shapiro (1986), we find that this simple relation between β and average return disappears during the more recent 1963–1990 period. The appendix that follows shows that the relation between β and average return is also weak in the last half century (1941–1990) of returns on NYSE stocks. In short, our tests do not support the central prediction of the SLB model, that average stock returns are positively related to market β.

Banz (1981) documents a strong negative relation between average return and firm size. Bhandari (1988) finds that average return is positively related to leverage, and Basu (1983) finds a positive relation between average return and E/P. Stattman (1980) and Rosenberg, Reid, and Lanstein (1985) document a positive relation between average return and book-to-market equity for U.S. stocks, and Chan, Hamao, and Lakonishok (1992) find that BE/ME is also a powerful variable for explaining average returns on Japanese stocks.

Variables like size, E/P, leverage, and book-to-market equity are all scaled versions of a firm's stock price. They can be regarded as different ways of extracting information from stock prices about the cross-section of expected stock returns (Ball (1978), Keim (1988)). Since all these variables are scaled versions of price, it is reasonable to expect that some of them are redundant for explaining average returns. Our main result is that for the 1963–1990 period, size and book-to-market equity capture the cross-sectional variation in average stock returns associated with size, E/P, book-to-market equity, and leverage.

A. Rational Asset-Pricing Stories

Are our results consistent with asset-pricing theory? Since the FM intercept is constrained to be the same for all stocks, FM regressions always impose a linear factor structure on returns and expected returns that is consistent with the multifactor asset-pricing models of Merton (1973) and Ross (1976). Thus our tests impose a rational asset-pricing framework on the relation between average return and size and book-to-market equity.

Even if our results are consistent with asset-pricing theory, they are not economically satisfying. What is the economic explanation for the roles of size and book-to-market equity in average returns? We suggest several paths of inquiry.

(a) The intercepts and slopes in the monthly FM regressions of returns on ln(ME) and ln(BE/ME) are returns on portfolios that mimic the underlying common risk factors in returns proxied by size and book-to-market equity (Fama (1976), chapter 9). Examining the relations between the returns on these portfolios and economic variables that measure variation in business conditions might help expose the nature of the economic risks captured by size and book-to-market equity.

(b) Chan, Chen, and Hsieh (1985) argue that the relation between size and average return proxies for a more fundamental relation between expected returns and economic risk factors. Their most powerful factor in explaining the size effect is the difference between the monthly returns on low- and high-grade corporate bonds, which in principle captures a kind of default risk in returns that is priced. It would be interesting to test whether loadings on this or other economic factors, such as those of Chen, Roll, and Ross (1986), can explain the roles of size and book-to-market equity in our tests.

(c) In a similar vein, Chan and Chen (1991) argue that the relation between size and average return is a relative-prospects effect. The earning prospects of distressed firms are more sensitive to economic conditions. This results in a distress factor in returns that is priced in expected returns. Chan and Chen construct two mimicking portfolios for the distress factor, based on dividend changes and leverage. It would be interesting to check whether loadings on their distress factors absorb the size and book-to-market equity effects in average returns that are documented here.

(d) In fact, if stock prices are rational, BE/ME, the ratio of the book value of a stock to the market's assessment of its value, should be a direct indicator of the relative prospects of firms. For example, we expect that high BE/ME firms have low earnings on assets relative to low BE/ME firms. Our work (in progress) suggests that there is indeed a clean separation between high and low BE/ME firms on various measures of economic fundamentals. Low BE/ME firms are persistently strong performers, while the economic performance of high BE/ME firms is persistently weak.

B. Irrational Asset-Pricing Stories

The discussion above assumes that the asset-pricing effects captured by size and book-to-market equity are rational. For BE/ME, our most powerful expected-return variable, there is an obvious alternative. The cross-section of book-to-market ratios might result from market overreaction to the relative prospects of firms. If overreaction tends to be corrected, BE/ME will predict the cross-section of stock returns.

Simple tests do not confirm that the size and book-to-market effects in average returns are due to market overreaction, at least of the type posited by DeBondt and Thaler (1985). One overreaction measure used by DeBondt and Thaler is a stock's most recent 3-year return. Their overreaction story predicts that 3-year losers have strong post-ranking returns relative to 3-year winners. In FM regressions (not shown) for individual stocks, the 3-year lagged return shows no power even when used alone to explain average returns. The univariate average slope for the lagged return is negative, -6 basis points per month, but less than 0.5 standard errors from 0.

C. Applications

Our main result is that two easily measured variables, size and book-to-market equity, seem to describe the cross-section of average stock returns. Prescriptions for using this evidence depend on (a) whether it will persist, and (b) whether it results from rational or irrational asset-pricing.

It is possible that, by chance, size and book-to-market equity happen to describe the cross-section of average returns in our sample, but they were and are unrelated to expected returns. We put little weight on this possibility, especially for book-to-market equity. First, although BE/ME has long been touted as a measure of the return prospects of stocks, there is no evidence that its explanatory power deteriorates through time. The 1963–1990 relation between BE/ME and average return is strong, and remarkably similar for the 1963–1976 and 1977–1990 subperiods. Second, our preliminary work on economic fundamentals suggests that high-BE/ME firms tend to be persistently poor earners relative to low-BE/ME firms. Similarly, small firms have a long period of poor earnings during the 1980s not shared with big firms. The systematic patterns in fundamentals give us some hope that size and book-to-market equity proxy for risk factors in returns, related to relative earning prospects, that are rationally priced in expected returns.

If our results are more than chance, they have practical implications for portfolio formation and performance evaluation by investors whose primary concern is long-term average returns. If asset-pricing is rational, size and BE/ME must proxy for risk. Our results then imply that the performance of managed portfolios (e.g., pension funds and mutual funds) can be evaluated by comparing their average returns with the average returns of benchmark portfolios with similar size and BE/ME characteristics. Likewise, the expected returns for different portfolio strategies can be estimated from the historical average returns of portfolios with matching size and BE/ME properties.

If asset-pricing is irrational and size and BE/ME do not proxy for risk, our results might still be used to evaluate portfolio performance and measure the expected returns from alternative investment strategies. If stock prices are irrational, however, the likely persistence of the results is more suspect.

Appendix
Size Versus β: 1941–1990

Our results on the absence of a relation between β and average stock returns for 1963–1990 are so contrary to the tests of the Sharpe-Lintner-Black model by Black, Jensen, and Scholes (1972), Fama and MacBeth (1973), and (more recently) Chan and Chen (1988), that further tests are appropriate. We examine the roles of size and β in the average returns on NYSE stocks for the half-century 1941–1990, the longest available period that avoids the high volatility of returns in the Great Depression. We do not include the accounting variables in the tests because of the strong selection bias (toward successful firms) in the COMPUSTAT data prior to 1962.

We first replicate the results of Chan and Chen (1988). Like them, we find that when portfolios are formed on size alone, there are strong relations between average return and either size or β; average return increases with β and decreases with size. For size portfolios, however, size (ln(ME)) and β are almost perfectly correlated (−0.98), so it is difficult to distinguish between the roles of size and β in average returns.

One way to generate strong variation in β that is unrelated to size is to form portfolios on size and then on β. As in Tables I to III, we find that the resulting independent variation in β just about washes out the positive simple relation between average return and β observed when portfolios are formed on size alone. The results for NYSE stocks for 1941–1990 are thus much like those for NYSE, AMEX, and NASDAQ stocks for 1963–1990.

This appendix also has methodological goals. For example, the FM regressions in Table III use returns on individual stocks as the dependent variable. Since we allocate portfolio βs to individual stocks but use firm-specific values of other variables like size, β may be at a disadvantage in the regressions for individual stocks. This appendix shows, however, that regressions for portfolios, which put β and size on equal footing, produce results comparable to those for individual stocks.

A. *Size Portfolios*

Table AI shows average monthly returns and market βs for 12 portfolios of NYSE stocks formed on the basis of size (ME) at the end of each year from 1940 to 1989. For these size portfolios, there is a strong positive relation between average return and β. Average returns fall from 1.96% per month for the smallest ME portfolio (1A) to 0.93% for the largest (10B) and β falls from 1.60 to 0.95. (Note also that, as claimed earlier, estimating β as the sum of the slopes in the regression of a portfolio's return on the current and prior month's NYSE value-weighted return produces much larger βs for the smallest ME portfolios and slightly smaller βs for the largest ME portfolios.)

The FM regressions in Table AI confirm the positive simple relation between average return and β for size portfolios. In the regressions of the size-portfolio returns on β alone, the average premium for a unit of β is 1.45% per month. In the regressions of individual stock returns on β (where stocks are assigned the β of their size portfolio), the premium for a unit of β is 1.39%. Both estimates are about 3 standard errors from 0. Moreover, the βs of size portfolios do not leave a residual size effect; the average residuals from the simple regressions of returns on β in Table AI show no relation to size. These positive SLB results for 1941–1990 are like those obtained by Chan and Chen (1988) in tests on size portfolios for 1954–1983.

There is, however, evidence in Table AI that all is not well with the βs of the size portfolios. They do a fine job on the relation between size and average return, but they do a lousy job on their main task, the relation between β and average return. When the residuals from the regressions of returns on β are grouped using the pre-ranking βs of individual stocks, the average residuals are strongly positive for low-β stocks (0.51% per month for group 1A) and negative for high-β stocks (−1.05% for 10B). Thus the market lines estimated with size-portfolio βs exaggerate the tradeoff of average return for β; they underestimate average returns on low-β stocks and overestimate average returns on high-β stocks. This pattern in the β-sorted average residuals for individual stocks suggests that (a) there is variation in β across stocks that is lost in the size portfolios, and (b) this variation in β is not rewarded as well as the variation in β that is related to size.

B. *Two-Pass Size-β Portfolios*

Like Table I, Table AII shows that subdividing size deciles using the (pre-ranking) βs of individual stocks results in strong variation in β that is

Table AI

Average Returns, Post-Ranking βs and Fama-MacBeth Regression Slopes for Size Portfolios of NYSE Stocks: 1941–1990

At the end of each year $t-1$, stocks are assigned to 12 portfolios using ranked values of ME. Included are all NYSE stocks that have a CRSP price and shares for December of year $t-1$ and returns for at least 24 of the 60 months ending in December of year $t-1$ (for pre-ranking β estimates). The middle 8 portfolios cover size deciles 2 to 9. The 4 extreme portfolios (1A, 1B, 10A, and 10B) split the smallest and largest deciles in half. We compute equal-weighted returns on the portfolios for the 12 months of year t using all surviving stocks. Average Return is the time-series average of the monthly portfolio returns for 1941–1990, in percent. Average firms is the average number of stocks in the portfolios each month. The simple βs are estimated by regressing the 1941–1990 sample of post-ranking monthly returns for a size portfolio on the current month's value-weighted NYSE portfolio return. The sum βs are the sum of the slopes from a regression of the post-ranking monthly returns on the current and prior month's VW NYSE returns.

The independent variables in the Fama-MacBeth regressions are defined for each firm at the end of December of each year $t-1$. Stocks are assigned the post-ranking (sum) β of the size portfolio they are in at the end of year $t-1$. ME is price times shares outstanding at the end of year $t-1$. In the individual-stock regressions, these values of the explanatory variables are matched with CRSP returns for each of the 12 months of year t. The portfolio regressions match the equal-weighted portfolio returns with the equal-weighted averages of β and ln(ME) for the surviving stocks in each month of year t. Slope is the average of the (600) monthly FM regression slopes and SE is the standard error of the average slope. The residuals from the monthly regressions for year t are grouped into 12 portfolios on the basis of size (ME) or pre-ranking β (estimated with 24 to 60 months of data, as available) at the end of year $t-1$. The average residuals are the time-series averages of the monthly equal-weighted portfolio residuals, in percent. The average residuals for regressions (1) and (2) (not shown) are quite similar to those for regressions (4) and (5) (shown).

	Portfolios Formed on Size											
	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Ave. return	1.96	1.59	1.44	1.36	1.28	1.24	1.23	1.17	1.15	1.13	0.97	0.93
Ave. firms	57	56	110	107	107	108	111	113	115	118	59	59
Simple β	1.29	1.24	1.21	1.19	1.16	1 13	1.13	1.12	1.09	1.05	1.00	0.98
Standard error	0.07	0.05	0.04	0.03	0.02	0 02	0.02	0.02	0.01	0.01	0.01	0.01
Sum β	1.60	1.44	1.37	1.32	1.26	1.23	1.19	1.17	1.12	1.06	0.99	0.95
Standard error	0.10	0.06	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.01	0.01	0.01

Table AI—*Continued*

	Portfolio Regressions				Individual Stock Regressions			
	(1) β	(2) ln(ME)	(3) β and ln(ME)		(4) β	(5) ln(ME)	(6) β and ln(ME)	
Slope	1.45	−0.137	3.05	0.149	1.39	−0.133	0.71	−0.060
SE	0.47	0.044	1.51	0.115	0.46	0.043	0.81	0.062

Average Residuals for Stocks Grouped on Size

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Regression (4)	0.17	0.00	−0.04	−0.06	−0.05	−0.04	0.00	−0.03	0.03	0.08	0.01	0.04
Standard error	0.11	0.06	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.05	0.06
Regression (5)	0.30	0.02	−0.05	−0.06	−0.08	−0.07	−0.03	−0.04	0.02	0.08	0.01	0.13
Standard error	0.14	0.07	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.07
Regression (6)	0.20	0.02	−0.05	−0.07	−0.08	−0.06	−0.01	−0.02	0.04	0.09	0.00	0.06
Standard error	0.10	0.06	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.05	0.05

Average Residuals for Stocks Grouped on Pre-Ranking β

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Regression (4)	0.51	0.61	0.38	0.32	0.16	0.12	0.03	−0.10	−0.27	−0.31	−0.66	−1.05
Standard error	0.21	0.19	0.13	0.08	0.04	0.03	0.04	0.05	0.09	0.11	0.18	0.23
Regression (5)	−0.10	0.00	0.02	0.09	0.05	0.07	0.05	0.00	−0.03	−0.01	−0.11	−0.33
Standard error	0.11	0.10	0.07	0.05	0.04	0.03	0.03	0.04	0.05	0.07	0.10	0.13
Regression (6)	0.09	0.25	0.13	0.19	0.11	0.14	0.09	0.01	−0.11	−0.12	−0.38	−0.70
Standard error	0.41	0.37	0.24	0.14	0.07	0.04	0.04	0.09	0.16	0.21	0.34	0.43

Table AII

Properties of Portfolios Formed on Size and Pre-Ranking β: NYSE Stocks Sorted by ME (Down) then Pre-Ranking β (Across): 1941–1990

At the end of year $t-1$, the NYSE stocks on CRSP are assigned to 10 size (ME) portfolios Each size decile is subdivided into 10 β portfolios using pre-ranking βs of individual stocks, estimated with 24 to 60 monthly returns (as available) ending in December of year $t-1$. The equal-weighted monthly returns on the resulting 100 portfolios are then calculated for year t. The average returns are the time-series averages of the monthly returns, in percent. The post-ranking βs use the full 1941–1990 sample of post-ranking returns for each portfolio. The pre- and post-ranking βs are the sum of the slopes from a regression of monthly returns on the current and prior month's NYSE value-weighted market return. The average size for a portfolio is the time-series average of each month's average value of ln(ME) for stocks in the portfolio. ME is denominated in millions of dollars. There are, on average, about 10 stocks in each size-β portfolio each month. The All column shows parameter values for equal-weighted size-decile (ME) portfolios. The All rows show parameter values for equal-weighted portfolios of the stocks in each β group.

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel A: Average Monthly Return (in Percent)											
All		1.22	1.30	1.32	1.35	1.36	1.34	1.29	1.34	1.14	1.10
Small-ME	1.78	1.74	1.76	2.08	1.91	1.92	1.72	1.77	1.91	1.56	1 46
ME-2	1.44	1.41	1.35	1.33	1.61	1.72	1.59	1.40	1.62	1.24	1.11
ME-3	1.36	1.21	1.40	1.22	1.47	1.34	1.51	1.33	1.57	1.33	1 21
ME-4	1.28	1.26	1.29	1.19	1.27	1.51	1.30	1.19	1.56	1.18	1.00
ME-5	1.24	1.22	1.30	1.28	1.33	1.21	1.37	1.41	1.31	0.92	1.06
ME-6	1.23	1.21	1.32	1 37	1.09	1.34	1.10	1.40	1.21	1.22	1.08
ME-7	1.17	1.08	1.23	1.37	1.27	1.19	1.34	1.10	1.11	0.87	1.17
ME-8	1.15	1.06	1.18	1.26	1.25	1.26	1.17	1.16	1.05	1.08	1.04
ME-9	1.13	0.99	1.13	1.00	1.24	1.28	1.31	1.15	1.11	1.09	1.05
Large-ME	0.95	0.99	1.01	1.12	1.01	0.89	0.95	0.95	1.00	0.90	0.68

Table AII—*Continued*

	All	Low-β	β-2	β-3	β-4	β-5	β-6	β-7	β-8	β-9	High-β
Panel B: Post-Ranking β											
All		0.76	0.95	1.05	1.14	1 22	1.26	1 34	1.38	1.49	1 69
Small-ME	1 52	1.17	1.40	1.31	1.50	1.46	1.50	1 69	1.60	1.75	1.92
ME-2	1.37	0.86	1.09	1.12	1.24	1 39	1.42	1.48	1.60	1.69	1.91
ME-3	1.32	0.88	0.96	1.18	1.19	1.33	1.40	1.43	1.56	1 64	1.74
ME-4	1.26	0.69	0.95	1.06	1.15	1 24	1 29	1 46	1.43	1.64	1.83
ME-5	1.23	0.70	0 95	1.04	1.10	1.22	1.32	1.34	1.41	1.56	1.72
ME-6	1.19	0.68	0.86	1.04	1.13	1.20	1.20	1 35	1.36	1.48	1.70
ME-7	1.17	0 67	0.88	0.95	1 14	1.18	1.26	1.27	1 32	1.44	1.68
ME-8	1.12	0.64	0.83	0 99	1.06	1.14	1.14	1.21	1.26	1.39	1.58
ME-9	1.06	0.68	0.81	0.94	0.96	1.06	1.11	1.18	1.22	1.25	1.46
Large-ME	0 97	0 65	0.73	0 90	0.91	0.97	1.01	1.01	1.07	1.12	1.38
Panel C: Average Size (ln(ME))											
All		4.39	4.39	4.40	4 40	4.39	4.40	4 38	4.37	4 37	4.34
Small-ME	1 93	2.04	1.99	2.00	1 96	1.92	1.92	1 91	1.90	1 87	1.80
ME-2	2.80	2.81	2.79	2.81	2.83	2 80	2 79	2.80	2.80	2.79	2.79
ME-3	3.27	3.28	3.27	3 28	3.27	3.27	3.28	3.29	3.27	3.27	3.26
ME-4	3.67	3.67	3.67	3.67	3.68	3.68	3.67	3.68	3.66	3.67	3.67
ME-5	4.06	4.07	4.06	4.05	4.06	4.07	4.06	4 05	4.05	4.06	4.06
ME-6	4 45	4.45	4.44	4.46	4.45	4.45	4 45	4.45	4.44	4.45	4.45
ME-7	4.87	4.86	4.87	4.86	4 87	4.87	4.88	4.87	4.87	4 85	4.87
ME-8	5.36	5.38	5.38	5.38	5.35	5.36	5.37	5.37	5.36	5 35	5.34
ME-9	5.98	5.96	5.98	5.99	6 00	5.98	5.98	5.97	5.95	5 96	5.96
Large-ME	7.12	7.10	7.12	7.16	7.17	7 20	7.29	7.14	7.09	7 04	6.83

independent of size. The β sort of a size decile always produces portfolios with similar average ln(ME) but much different (post-ranking) βs. Table AII also shows, however, that investors are not compensated for the variation in β that is independent of size. Despite the wide range of βs in each size decile, average returns show no tendency to increase with β. AII

The FM regressions in Table AIII formalize the roles of size and β in NYSE average returns for 1941–1990. The regressions of returns on β alone show that using the βs of the portfolios formed on size and β, rather than size alone, causes the average slope on β to fall from about 1.4% per month (Table AI) to about 0.23% (about 1 standard error from 0). Thus, allowing for variation in β that is unrelated to size flattens the relation between average return and β, to the point where it is indistinguishable from no relation at all.

The flatter market lines in Table AIII succeed, however, in erasing the negative relation between β and average residuals observed in the regressions of returns on β alone in Table AI. Thus, forming portfolios on size and β (Table AIII) produces a better description of the simple relation between average return and β than forming portfolios on size alone (Table AI). This improved description of the relation between average return and β is evidence that the β estimates for the two-pass size-β portfolios capture variation in true βs that is missed when portfolios are formed on size alone.

Unfortunately, the flatter market lines in Table AIII have a cost, the emergence of a residual size effect. Grouped on the basis of ME for individual stocks, the average residuals from the univariate regressions of returns on the βs of the 100 size-β portfolios are strongly positive for small stocks and negative for large stocks (0.60% per month for the smallest ME group, 1A, and −0.27% for the largest, 10B). Thus, when we allow for variation in β that is independent of size, the resulting βs leave a large size effect in average returns. This residual size effect is much like that observed by Banz (1981) with the βs of portfolios formed on size and β.

The correlation between size and β is −0.98 for portfolios formed on size alone. The independent variation in β obtained with the second-pass sort on β lowers the correlation to −0.50. The lower correlation means that bivariate regressions of returns on β and ln(ME) are more likely to distinguish true size effects from true β effects in average returns.

The bivariate regressions (Table AIII) that use the βs of the size-β portfolios are more bad news for β. The average slopes for ln(ME) are close to the values in the univariate size regressions, and almost 4 standard errors from 0, but the average slopes for β are negative and less than 1 standard error from 0. The message from the bivariate regressions is that there is a strong relation between size and average return. But like the regressions in Table AIII that explain average returns with β alone, the bivariate regressions say that there is no reliable relation between β and average returns when the tests use βs that are not close substitutes for size. These uncomfortable SLB results for NYSE stocks for 1941–1990 are much like those for NYSE, AMEX, and NASDAQ stocks for 1963–1990 in Table III.

C. Subperiod Diagnostics

Our results for 1941–1990 seem to contradict the evidence in Black, Jensen, and Scholes (BJS) (1972) and Fama and MacBeth (FM) (1973) that there is a reliable positive relation between average return and β. The βs in BJS and FM are from portfolios formed on β alone, and the market proxy is the NYSE equal-weighted portfolio. We use the βs of portfolios formed on size and β, and our market is the value-weighted NYSE portfolio. We can report, however, that our inference that there isn't much relation between β and average return is unchanged when (a) the market proxy is the NYSE EW portfolio, (b) portfolios are formed on just (pre-ranking) βs, or (c) the order of forming the size-β portfolios is changed from size then β to β then size.

A more important difference between our results and the earlier studies is the sample periods. The tests in BJS and FM end in the 1960s. Table AIV shows that when we split the 50-year 1941–1990 period in half, the univariate FM regressions of returns on β produce an average slope for 1941–1965 (0.50% per month, $t = 1.82$) more like that of the earlier studies. In contrast, the average slope on β for 1966–1990 is close to 0 (-0.02, $t = 0.06$).

But Table AIV also shows that drawing a distinction between the results for 1941–1965 and 1966–1990 is misleading. The stronger tradeoff of average return for β in the simple regressions for 1941–1965 is due to the first 10 years, 1941–1950. This is the only period in Table AIV that produces an average premium for β (1.26% per month) that is both positive and more than 2 standard errors from 0. Conversely, the weak relation between β and average return for 1966–1990 is largely due to 1981–1990. The strong negative average slope in the univariate regressions of returns on β for 1981–1990 (-1.01, $t = -2.10$) offsets a positive slope for 1971–1980 (0.82, $t = 1.27$).

The subperiod variation in the average slopes from the FM regressions of returns on β alone seems moot, however, given the evidence in Table AIV that adding size always kills any positive tradeoff of average return for β in the subperiods. Adding size to the regressions for 1941–1965 causes the average slope for β to drop from 0.50 ($t = 1.82$) to 0.07 ($t = 0.28$). In contrast, the average slope on size in the bivariate regressions (-0.16, $t = -2.97$) is close to its value (-0.17, $t = -2.88$) in the regressions of returns on ln(ME) alone. Similar comments hold for 1941–1950. In short, any evidence of a positive average premium for β in the subperiods seems to be a size effect in disguise.

D. Can the SLB Model Be Saved?

Before concluding that β has no explanatory power, it is appropriate to consider other explanations for our results. One possibility is that the variation in β produced by the β sorts of size deciles in just sampling error. If so, it is not surprising that the variation in β within a size decile is unrelated to average return, or that size dominates β in bivariate tests. The standard errors of the βs suggest, however, that this explanation cannot save the SLB

Table AIII

Average Slopes, Their Standard Errors (SE), and Average Residuals from Monthly FM Regressions for Individual NYSE Stocks and for Portfolios Formed on Size and Pre-Ranking β: 1941-1990

Stocks are assigned the post-ranking β of the size-β portfolio they are in at the end of year $t - 1$ (Table AII). ln(ME) is the natural log of price times shares outstanding at the end of year $t - 1$. In the individual-stock regressions, these values of the explanatory variables are matched with CRSP returns for each of the 12 months in year t. The portfolio regressions match the equal-weighted portfolio returns for the size-β portfolios (Table AII) with the equal-weighted averages of β and ln(ME) for the surviving stocks in each month of year t. Slope is the time-series average of the monthly regression slopes from 1941-1990 (600 months); SE is the time-series standard error of the average slope.

The residuals from the monthly regressions in year t are grouped into 12 portfolios on the basis of size or pre-ranking β (estimated with 24 to 60 months of returns, as available) as of the end of year $t - 1$. The average residuals are the time-series averages of the monthly equal-weighted averages of the residuals in percent. The average residuals (not shown) from the FM regressions (1) to (3) that use the returns on the 100 size-β portfolios as the dependent variable are always within 0.01 of those from the regressions for individual stock returns. This is not surprising given that the correlation between the time-series of 1941-1990 monthly FM slopes on β or ln(ME) for the comparable portfolio and individual stock regressions is always greater than 0.99.

	Portfolio Regressions				Individual Stock Regressions			
	(1) β	(2) ln(ME)	(3) β and ln(ME)		(4) β	(5) ln(ME)	(6) β and ln(ME)	
Slope	0.22	−0.128	−0.13	−0.143	0.24	−0.133	−0.14	−0.147
SE	0.24	0.043	0.21	0.039	0.23	0.043	0.21	0.039

Average Residuals for Stocks Grouped on Size

	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Regression (4)	0.60	0.26	0.13	0.06	−0.01	−0.03	−0.03	−0.09	−0.10	−0.11	−0.25	−0.27
Standard error	0.21	0.10	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.05	0.06	0.08
Regression (5)	0.30	0.02	−0.05	−0.06	−0.08	−0.07	−0.03	−0.04	0.02	0.08	0.01	0.13
Standard error	0.14	0.07	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.07
Regression (6)	0.31	0.02	−0.05	−0.06	−0.09	−0.07	−0.03	−0.04	0.02	0.08	0.01	0.13
Standard error	0.14	0.07	0.04	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.04	0.07

Table AIII—*Continued*

	Portfolio Regressions						Individual Stock Regressions					
	(1) β		(2) ln(ME)		(3) β and ln(ME)		(4) β		(5) ln(ME)		(6) β and ln(ME)	
	Average Residuals for Stocks Grouped on Pre-Ranking β											
	1A	1B	2	3	4	5	6	7	8	9	10A	10B
Regression (4)	−0.08	0.03	−0.01	0 08	0.04	0.08	0.04	0.02	−0.03	0.02	−0 11	−0.32
Standard error	0.07	0.05	0.03	0.03	0.03	0.03	0.04	0.04	0 04	0.04	0.06	0.07
Regression (5)	−0.10	0.00	0.02	0.09	0.05	0.07	0.05	0.00	−0.03	−0.01	−0.11	−0.33
Standard error	0.11	0.10	0.07	0.05	0.04	0.03	0.03	0.04	0.05	0.07	0 10	0.13
Regression (6)	−0.17	−0.07	−0.02	0.07	0.04	0 06	0.05	0.03	0.00	0.04	−0.04	−0.23
Standard error	0.05	0.04	0.03	0.03	0 03	0.03	0.03	0.03	0.04	0.04	0.06	0.07

Table AIV

Subperiod Average Returns on the NYSE Value-Weighted and Equal-Weighted Portfolios and Average Values of the Intercepts and Slopes for the FM Cross-Sectional Regressions of Individual Stock Returns on β and Size (ln(ME))

Mean is the average VW or EW return or an average slope from the *monthly* cross-sectional regressions of individual stock returns on β and/or ln(ME). Std is the standard deviation of the time-series of returns or slopes, and t(Mn) is Mean over its time-series standard error. The average slopes (not shown) from the FM regressions that use the returns on the 100 size-β portfolios of Table AII as the dependent variable are quite close to those for individual stock returns. (The correlation between the 1941-1990 month-by-month slopes on β or ln(ME) for the comparable portfolio and individual stock regressions is always greater than 0.99.)

Panel A

Variable	1941-1990 (600 Mos.)			1941-1965 (300 Mos.)			1966-1990 (300 Mos.)		
	Mean	Std	t(Mn)	Mean	Std	t(Mn)	Mean	Std	t(Mn)
	NYSE Value-Weighted (VW) and Equal-Weighted (EW) Portfolio Returns								
VW	0.93	4.15	5 49	1.10	3.58	5.30	0.76	4.64	2.85
EW	1.12	5.10	5.37	1.33	4.42	5.18	0.91	5.70	2.77
	$R_{it} = a + b_{1t}\beta_{it} + e_{it}$								
a	0.98	3.93	6.11	0.84	3.18	4.56	1.13	4.57	4.26
b_1	0.24	5.52	1.07	0.50	4.75	1.82	−0.02	6.19	−0 06
	$R_{it} = a + b_{2t}\ln(ME_{it}) + e_{it}$								
a	1.70	8.24	5.04	1.88	6.43	5.06	1.51	9.72	2.69
b_2	−0.13	1.06	−3.07	−0.17	1.01	−2.88	−0.10	1.11	−1.54
	$R_{it} = a + b_{1t}\beta_{it} + b_{2t}\ln(ME_{it}) + e_{it}$								
a	1.97	6.16	7.84	1.80	4.77	6.52	2.14	7.29	5.09
b_1	−0.14	5.05	−0.66	0.07	4.15	0.28	−0.34	5.80	−1.01
b_2	−0.15	0.96	−3.75	−0.16	0.94	−2.97	−0.13	0.99	−2.34

Table AIV—*Continued*

Panel B:

Return	1941-1950 Mean	1941-1950 t(Mn)	1951-1960 Mean	1951-1960 t(Mn)	1961-1970 Mean	1961-1970 t(Mn)	1971-1980 Mean	1971-1980 t(Mn)	1981-1990 Mean	1981-1990 t(Mn)
	NYSE Value-Weighted (VW) and Equal-Weighted (EW) Portfolio Returns									
VW	1.05	2.88	1.18	3.95	0.66	1.84	0.72	1.67	1.04	2.40
EW	1.59	3.16	1.13	3.76	0.88	1.96	1.04	1.82	0.95	2.01
	$R_{it} = a + b_{1t}\beta_{it} + e_{it}$									
a	0.24	0.66	1.41	6.36	0.64	1.94	0.27	0.62	2.35	5.99
b_1	1.26	2.20	−0.19	−0.63	0.32	0.72	0.82	1.27	−1.01	−2.10
	$R_{it} = a + b_{2t}\ln(ME_{it}) + e_{it}$									
a	2.63	3.47	1.08	2.73	1.78	2.50	2.18	2.03	0.82	1.20
b_2	−0.37	−2.90	0.03	0.53	−0.17	−2.19	−0.20	−1.57	0.04	0.57
	$R_{it} = a + b_{1t}\beta_{it} + b_{2t}\ln(ME_{it}) + e_{it}$									
a	2.14	3.93	1.38	4.03	2.01	4.16	1.50	2.12	2.84	4.25
b_1	0.34	0.75	−0.17	−0.53	−0 11	−0.27	0.41	0.75	−1.14	−2.16
b_2	−0.34	−2.92	0.01	0.20	−0.18	−2.89	−0.16	−1.50	−0.07	−0.84

model. The standard errors for portfolios formed on size and β are only slightly larger (0.02 to 0.11) than those for portfolios formed on size alone (0.01 to 0.10, Table AI). And the range of the post-ranking βs within a size decile is always large relative to the standard errors of the βs.

Another possibility is that the proportionality condition (1) for the variation through time in true βs, that justifies the use of full-period post-ranking βs in the FM tests, does not work well for portfolios formed on size and β. If this is a problem, post-ranking βs for the size-β portfolios should not be highly correlated across subperiods. The correlation between the half-period (1941–1965 and 1966–1990) βs of the size-β portfolios is 0.91, which we take to be good evidence that the full-period β estimates for these portfolios are informative about true βs. We can also report that using 5-year βs (pre- or post-ranking) in the FM regressions does not change our negative conclusions about the role of β in average returns, as long as portfolios are formed on β as well as size, or on β alone.

Any attempt to salvage the simple positive relation between β and average return predicted by the SLB model runs into three damaging facts, clear in Table AII. (a) Forming portfolios on size and pre-ranking βs produces a wide range of post-ranking βs in every size decile. (b) The post-ranking βs closely reproduce (in deciles 2 to 10 they exactly reproduce) the ordering of the pre-ranking βs used to form the β-sorted portfolios. It seems safe to conclude that the increasing pattern of the post-ranking βs in every size decile captures the ordering of the true βs. (c) Contrary to the SLB model, the β sorts do not produce a similar ordering of average returns. Within the rows (size deciles) of the average return matrix in Table AII, the high-β portfolios have average returns that are close to or less than the low-β portfolios.

But the most damaging evidence against the SLB model comes from the univariate regressions of returns on β in Table AIII. They say that when the tests allow for variation in β that is unrelated to size, the relation between β and average return for 1941–1990 is weak, perhaps nonexistent, even when β is the only explanatory variable. We are forced to conclude that the SLB model does not describe the last 50 years of average stock returns.

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Chapter 7
Company Size and Return[7.1]

In previous versions of the Stocks, Bonds, Bills, and Inflation® (SBBI®) Yearbook the discussions in this chapter used data from the Center for Research in Security Prices (CRSP) to demonstrate various concepts about company size and return (i.e., the "size effect"). Starting with the 2020 SBBI® Yearbook®, these concepts are demonstrated using the Morningstar/Ibbotson Associates SBBI Large Stock series and SBBI Small Stock series.[7.2,7.3,7.4]

One of the most remarkable discoveries of modern finance is the finding of a relationship between company size and return, generally referred to as the "size effect." The size effect is based on the empirical observation that companies of smaller size tend to have higher returns than do larger companies.

A 1981 study by Rolf Banz examined the returns of New York Stock Exchange (NYSE) small-cap companies compared to the returns of NYSE large-cap companies over the period 1926–1975.[7.5] What Banz found was that the returns of small-cap companies were *greater* than the returns for large-cap companies. Banz's 1981 study is often cited as the first comprehensive study of the size effect. Banz found that there is a significant (negative) relationship between size and historical equity returns as size decreases, returns tend to increase, and vice versa.

7.1 This chapter is an overview of the relationship between size and return that is limited to analyzing the relative historical performance of "large-cap stocks" and "small-cap stocks," and does not include the much expanded analyses of the "size effect" as it relates to the development of cost of equity capital found on the Duff & Phelps online Cost of Capital Navigator platform at dpcostofcapital.com. The Cost of Capital Navigator guides the Analyst through the process of estimating the cost of equity capital, a key component of any valuation analysis. The Cost of Capital Navigator includes the critical information and data from the 1999–2021 CRSP Deciles Size Study and Risk Premium Report Study that were previously published in the *Valuation Handbook – U.S. Guide to Cost of Capital* from 2014 to 2017, and, before that, in the Ibbotson Associates/ Morningstar *Stocks, Bonds, Bills, and Inflation® (SBBI®) Valuation Yearbook* and *Risk Premium Report*, respectively, from 1999 to 2013. The valuation data and information in the Cost of Capital Navigator is the actual "as published" valuation data from those former publications. The 1999–2013 Ibbotson Associates/Morningstar size premia, industry risk premia, and other valuation data that are available within the Cost of Capital Navigator are used with permission from Morningstar, Inc. The Cost of Capital Navigator is web-based, so you can access it from your desktop, laptop, or tablet. To learn more and to purchase the Cost of Capital Navigator, visit dpcostofcapital.com. CRSP® is a registered trademark and service mark of Center for Research in Security Prices, LLC and has been licensed for use by Duff & Phelps, LLC. The Duff & Phelps publications and services are not sponsored, sold or promoted by CRSP®, its affiliates or its parent company. To learn more about CRSP, visit www.crsp.com.

7.2 The focus of the *Stocks, Bonds, Bills, and Inflation® (SBBI®) Yearbook* is to analyze the historical performance data of U.S. asset classes, as represented by the seven Morningstar/Ibbotson Associates "SBBI" series. The seven "SBBI" indices are: (i) SBBI U.S. Large Stocks, (ii) SBBI U.S. Small Stocks, (iii) SBBI U.S. Long-Term Corporate Bonds, (iv) SBBI U.S. Long-Term Government Bonds, (v) SBBI U.S. Intermediate-Term Government Bonds, (vi) SBBI U.S. 30-Day Treasury Bills, and (vii) SBBI U.S. Inflation. For detailed information about the SBBI series, see Chapter 3, "Description of the Basic Series".

7.3 The CRSP Deciles Size Study and Risk Premium Report Study, both of which provide size premia and other risk premia based upon data licensed from the Center for Research in Security Prices (CRSP) at the University of Chicago Booth School of Business, are fully available in the Duff & Phelps online Cost of Capital Navigator platform at dpcostofcapital.com.

7.4 A detailed discussion of company size and return (and size premia) based upon CRSP deciles 1-10 and the 10th decile split (10a, 10b, 10w, 10x, 10y, and 10z) is available in the Resources section of the Cost of Capital Navigator at dpcostofcapital.com (subscription required).

7.5 Rolf W. Banz, "The Relationship between Return and Market Value of Common Stocks," *Journal of Financial Economics* (March 1981): 3–18. This paper is often cited as the first comprehensive study of the size effect.

Aspects of the Company Size Effect

The company size phenomenon is remarkable in several ways. First, the greater risk of small-cap stocks does not, in the context of the capital asset pricing model, fully account for their higher returns over the long term. In the capital asset pricing model (CAPM), only systematic, or beta risk, is rewarded; small-cap stock returns have exceeded those implied by their betas.

Second, the calendar annual return differences between small- and large-cap companies are serially correlated. This suggests that past annual returns may be of some value in predicting future annual returns. Such serial correlation, or autocorrelation, is practically unknown in the market for large-cap stocks and in most other equity markets, but is evident in the size premium series.

Third, the size effect is seasonal. For example, small-cap stocks outperformed large-cap stocks in January in a large majority of the years. Such predictability is surprising and suspicious in light of modern capital market theory. These three aspects of the size effect – long-term returns in excess of systematic risk, serial correlation, and seasonality – will be discussed in the following sections.

The Size Effect: Empirical Evidence

Summary statistics of annual total returns for Large-Cap stocks and Small-Cap stocks are shown in Exhibit 7.1 over the 1926–2020 period. The differences in return between large-cap stocks and small-cap stocks is apparent.[7.9]

7.9 Traditionally, researchers have used market value of equity (i.e.,market capitalization, or simply "market cap") as a measure of size in conducting historical rate of return studies. However, market cap is not the only measure of size that can be used to predict return, nor is it necessarily the best measure of size to use. In the online Duff & Phelps Cost of Capital Navigator platform, the size effect is examined in relation to *eight* measures of company size (including market cap): (i) market capitalization, (ii) book value of equity, (iii) 5-year average net income, (iv) market value of invested capital (MVIC), (v) total assets, (vi) 5-year average EBITDA, (vii) sales, and (viii) number of employees. The Cost of Capital Navigator guides the Analyst through the process of estimating the cost of equity capital, a key component of any valuation analysis. The Cost of Capital Navigator includes the critical information and data from the 1999–2021 CRSP Deciles Size Study and Risk Premium Report Study, as published in the former *Valuation Handbook – U.S. Guide to Cost of Capital* from 2014 to 2017, and, before that, in the former Ibbotson Associates/ Morningstar *Stocks, Bonds, Bills, and Inflation® (SBBI®) Valuation Yearbook* and *Risk Premium Report*, respectively, from 1999 to 2013. The valuation data and information in the Cost of Capital Navigator is the actual "as published" valuation data from those former publications. The 1999–2013 Ibbotson Associates/Morningstar size premia, industry risk premia, and other valuation data that are available within the Cost of Capital Navigator are used with permission from Morningstar, Inc. The Cost of Capital Navigator is web-based, so you can access it from your desktop, laptop, or tablet. To learn more and to purchase the Cost of Capital Navigator, visit dpcostofcapital.com.

Using the geometric (i.e., compound annual) returns in Exhibit 7.1, the terminal index values shown in Exhibit 7.2 can be calculated as:

Terminal Index Value = (1 + Geometric Mean Return)^n

Where n is the number of periods (in this case, 95 years).

The value of $1 invested over the 1926–2020 period in large-cap stocks is therefore calculated as:[7.10]

$$\$10{,}944.66 = (1 + 10.3\%)^{95}$$

The value of $1 invested over the 1926–2020 period in small-cap stocks is calculated as:[7.11]

$$\$41{,}977.83 = (1 + 11.9\%)^{95}$$

Do Small-Cap Stocks Always Outperform Large-Cap Stocks?

The increased risk faced by investors in small stocks is quite real. It is important to note, however, that the risk/return profile is over the *long-term*. The long-term expected return for any asset class can be quite different from short-term expected returns. Investors in small-cap stocks should expect losses and periods of *underperformance* relative to large-cap stocks. While this might lead some market observers to speculate that there is no size premium, statistical evidence suggests that periods of smaller stocks' underperformance should be expected. The evidence also suggests that the longer small-cap companies are given to "race" against large-cap companies, the greater the chance that small-cap companies outpace their larger counterparts.

In Exhibit 7.3, a detailed summary of the results of various "races" between small-cap companies and large-cap companies is shown, where the holding periods are limited to *exactly* 1 month, 60 months (5 years), 120 months (10 years), 240 months (20 years), and 360 months (30 years). The entire January 1926–December 2020 period is examined, as well as three more recent start date windows: April 1981–December 2020, January 1990–December 2020, and January 2000–December 2020. All three of the three more recent periods are *after* Banz wrote his March 1981 article that identified the size effect, and so they are labeled "Post Banz".[7.12]

In Exhibit 7.3 the number of periods examined is shown first, followed by the outperformance percentage of the total periods in parentheses.

7.10 Difference due to rounding. The full-decimal value of the compound annual return of large-cap stocks over the 1926–2020 time period is 10.28537350%

7.11 Difference due to rounding. The full-decimal value of the compound annual return of small-cap stocks over the 1926–2020 time period is 11.85705181%

7.12 Banz, Rolf W. "The Relationship between Return and Market Value of Common Stocks". *Journal of Financial Economics* (March 1981): 3–18. Professor Banz's 1981 article is often cited as the first comprehensive study of the size effect.

The model is analogous to the standard CAPM, but with the return on a minimum risk portfolio that is unrelated to market returns, R_Z, replacing the risk-free rate, R_F. The model has been empirically tested by Black, Jensen, and Scholes (1972), who find a flatter than predicted SML, consistent with the model and other researchers' findings. An updated version of the Black-Jensen-Scholes study is available in Brealey, Myers, and Allen (2006) and reaches similar conclusions.

The zero-beta CAPM cannot be literally employed to estimate the cost of capital, since the zero-beta portfolio is a statistical construct difficult to replicate. Attempts to estimate the model are formally equivalent to estimating the constants, a and b, in Equation 6-2. A practical alternative is to employ the Empirical CAPM, to which we now turn.

6.3 Empirical CAPM

As discussed in the previous section, several finance scholars have developed refined and expanded versions of the standard CAPM by relaxing the constraints imposed on the CAPM, such as dividend yield, size, and skewness effects. These enhanced CAPMs typically produce a risk-return relationship that is flatter than the CAPM prediction in keeping with the actual observed risk-return relationship. The ECAPM makes use of these empirical findings. The ECAPM estimates the cost of capital with the equation:

$$K = R_F + \acute{\alpha} + \beta \times (MRP - \acute{\alpha}) \qquad (6\text{-}5)$$

where $\acute{\alpha}$ is the "alpha" of the risk-return line, a constant, and the other symbols are defined as before. All the potential vagaries of the CAPM are telescoped into the constant $\acute{\alpha}$, which must be estimated econometrically from market data. Table 6-2 summarizes[10] the empirical evidence on the magnitude of alpha.[11]

[10] The technique is formally applied by Litzenberger, Ramaswamy, and Sosin (1980) to public utilities in order to rectify the CAPM's basic shortcomings. Not only do they summarize the criticisms of the CAPM insofar as they affect public utilities, but they also describe the econometric intricacies involved and the methods of circumventing the statistical problems. Essentially, the average monthly returns over a lengthy time period on a large cross-section of securities grouped into portfolios are related to their corresponding betas by statistical regression techniques; that is, Equation 6-5 is estimated from market data. The utility's beta value is substituted into the equation to produce the cost of equity figure. Their own results demonstrate how the standard CAPM underestimates the cost of equity capital of public utilities because of utilities' high dividend yield and return skewness.

[11] Adapted from Vilbert (2004).

TABLE 6-2
EMPIRICAL EVIDENCE ON THE ALPHA FACTOR

Author	Range of alpha
Fischer (1993)	−3.6% to 3.6%
Fischer, Jensen and Scholes (1972)	−9.61% to 12.24%
Fama and McBeth (1972)	4.08% to 9.36%
Fama and French (1992)	10.08% to 13.56%
Litzenberger and Ramaswamy (1979)	5.32% to 8.17%
Litzenberger, Ramaswamy and Sosin (1980)	1.63% to 5.04%
Pettengill, Sundaram and Mathur (1995)	4.6%
Morin (1989)	2.0%

For an alpha in the range of 1%–2% and for reasonable values of the market risk premium and the risk-free rate, Equation 6-5 reduces to the following more pragmatic form:

$$K = R_F + 0.25\,(R_M - R_F) + 0.75\,\beta(R_M - R_F) \qquad (6\text{-}6)$$

Over reasonable values of the risk-free rate and the market risk premium, Equation 6-6 produces results that are indistinguishable from the ECAPM of Equation 6-5.[12]

An alpha range of 1%–2% is somewhat lower than that estimated empirically. The use of a lower value for alpha leads to a lower estimate of the cost of capital for low-beta stocks such as regulated utilities. This is because the use of a long-term risk-free rate rather than a short-term risk-free rate already incorporates some of the desired effect of using the ECAPM. That is, the

[12] Typical of the empirical evidence on the validity of the CAPM is a study by Morin (1989) who found that the relationship between the expected return on a security and beta over the period 1926–1984 was given by:

$$\text{Return} = 0.0829 + 0.0520\,\beta$$

Given that the risk-free rate over the estimation period was approximately 6% and that the market risk premium was 8% during the period of study, the intercept of the observed relationship between return and beta exceeds the risk-free rate by about 2%, or 1/4 of 8%, and that the slope of the relationship is close to 3/4 of 8%. Therefore, the empirical evidence suggests that the expected return on a security is related to its risk by the following approximation:

$$K = R_F + x(R_M - R_F) + (1 - x)\beta(R_M - R_F)$$

where x is a fraction to be determined empirically. The value of x that best explains the observed relationship Return = 0.0829 + 0.0520 β is between 0.25 and 0.30. If x = 0.25, the equation becomes:

$$K = R_F + 0.25(R_M - R_F) + 0.75\beta(R_M - R_F)$$

Corporate Finance

A Focused Approach

Michael C. **Ehrhardt**
University of Tennessee

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9.3 Cost of Preferred Stock, r_{ps}

A number of firms, including NCC, use preferred stock as part of their permanent financing mix. Preferred dividends are not tax deductible. Therefore, the company bears their full cost, and *no tax adjustment is used when calculating the cost of preferred stock.* Note too that while some preferred stocks are issued without a stated maturity date, today most have a sinking fund that effectively limits their life. Finally, although it is not mandatory that preferred dividends be paid, firms generally have every intention of doing so, because otherwise (1) they cannot pay dividends on their common stock, (2) they will find it difficult to raise additional funds in the capital markets, and (3) in some cases preferred stockholders can take control of the firm.

The component cost of preferred stock, r_{ps}, is the cost used in weighted average cost of capital calculation. For preferred stock with a stated maturity date, we use the same approach as in the previous section for the cost of debt, keeping in mind that a firm has no tax saving with preferred stock. For preferred stock without a stated maturity date, r_{ps} is

$$\text{Component cost of preferred stock} = r_{ps} = \frac{D_{ps}}{P_{ps}(1 - F)} \qquad (9\text{-}3)$$

where D_{ps} is the preferred dividend, P_{ps} is the preferred stock price, and F is flotation cost as a percentage of proceeds.

To illustrate the calculation, assume that NCC has preferred stock that pays a $10 dividend per share and sells for $100 per share. If NCC issued new shares of preferred, it would incur an underwriting (or flotation) cost of 2.5%, or $2.50 per share, so it would net $97.50 per share. Therefore, NCC's cost of preferred stock is 10.3%:

$$r_{ps} = \$10/\$97.50 = 10.3\%$$

If we had not incorporated flotation costs, we would have incorrectly estimated $r_{ps} = \$10/\$100 = 10.0\%$, which is too big a difference to ignore. Therefore, analysts usually include flotation costs when estimating the cost of preferred stock.

SELF-TEST

Does the component cost of preferred stock include or exclude flotation costs? Explain.

Why is no tax adjustment made to the cost of preferred stock?

A company's preferred stock currently trades at $50 per share and pays a $3 annual dividend per share. Flotation costs are equal to 3% of the proceeds. If the company issues preferred stock, what is cost of the newly issued preferred stock? *(6.19%)*

9.4 Cost of Common Stock, r_s

Companies can raise common equity in two ways: (1) directly, by issuing new shares, and (2) indirectly, by reinvesting, or retaining, earnings. If new shares are issued, what rate of return must the company earn to satisfy the new stockholders? In Chapter 6, we saw that investors require a return of r_s. However, a company must earn more than r_s on new external equity to provide this rate of return to investors because there are flotation costs when a firm issues new equity.

Few mature firms issue new shares of common stock through public offerings.[7] In fact, less than 2% of all new corporate funds come from the external public equity market. There are three reasons for this:

1. Flotation costs can be quite high, as we show later in this chapter.
2. Investors perceive issuing equity as a negative signal about the true value of the company's stock. Investors believe that managers have superior knowledge about companies' future prospects, and that managers are most likely to issue new stock when they think the current stock price is higher than the true value. Therefore, if a mature company announces plans to issue additional shares, this typically causes its stock price to decline.
3. An increase in the supply of stock will put pressure on the stock's price, forcing the company to sell the new stock at a lower price than existed before the new issue was announced.

Therefore, we assume that the companies in the following examples do not plan to issue new shares.[8] We will address the impact of flotation costs on the cost of equity later in the chapter.

Does new equity capital raised indirectly by retaining earnings have a cost? The answer is a resounding yes. If some earnings are retained, then stockholders will incur an opportunity cost—the earnings could have been paid out as dividends (or used to repurchase stock), in which case stockholders could then have reinvested the money in other investments. *Thus, the firm should earn on its reinvested earnings at least as much as its stockholders themselves could earn on alternative investments of equivalent risk.*

What rate of return can stockholders expect to earn on equivalent-risk investments? The answer is r_s, because they expect to earn that return by simply buying the stock of the firm in question or that of a similar firm. *Therefore, r_s is the cost of common equity raised internally by reinvesting earnings.* If a company cannot earn at least r_s on reinvested earnings, then it should pass those earnings on to its stockholders and let them invest the money themselves in assets that do provide r_s.

Whereas debt and preferred stock are contractual obligations that have easily determined costs, it is more difficult to estimate r_s. However, we can employ the principles described in Chapters 6 and 7 to produce reasonably good cost of equity estimates. Three methods typically are used: (1) the Capital Asset Pricing Model (CAPM), (2) the discounted cash flow (DCF) method, and (3) the bond-yield-plus-risk-premium approach. These methods are not mutually exclusive. When faced with the task of estimating a company's cost of equity, we generally use all three methods and then choose among them on the basis of our confidence in the input data available for the specific case at hand.

SELF-TEST

What are the two sources of equity capital?

Why do most established firms not issue additional shares of common equity?

Explain why there is a cost to using reinvested earnings; that is, why aren't reinvested earnings a free source of capital?

[7]A few companies issue new shares through new-stock dividend reinvestment plans, which we discuss in Chapter 15. Also, quite a few companies sell stock to their employees, and companies occasionally issue stock to finance huge projects or mergers.
[8]There are times when companies should issue stock in spite of these problems; hence we discuss stock issues and the cost of equity later in the chapter.

20, 30, and 40 years ending in 2004. The resulting risk premium varies from 2.3% to 4.2%. Keeping the length of the period unchanged, and altering the end point by 2 years, the corresponding results for various periods ending in 2002 instead of 2004 show a risk premium varying from −0.4% to 3.0%.

The historical risk premium approach assumes that the average realized return is an appropriate surrogate for expected return, or, in other words, that investor expectations are realized. However, realized returns can be substantially different from prospective returns anticipated by investors, especially when measured over short time periods. Therefore, an historical risk premium study should consider the longest possible period for which data are available. Short-run periods during which investors earn a lower risk premium than they expect are offset by short-run periods during which investors earn a higher risk premium than they expect. Only over long time periods will investor return expectations and realizations converge. Clearly, the accuracy of the realized risk premium as an estimator of the prospective risk premium is enhanced by increasing the number of years used to estimate it. By analogy, one cannot predict with any reasonable degree of accuracy the result of a single, or even a few, flips of a balanced coin. But one can predict with a good deal of confidence that approximately 50 heads will appear in 100 tosses of the coin. Under these circumstances, it is most appropriate to estimate future experience from long-run evidence of investment performance. Therefore, the historical or realized market risk premium used to estimate the prospective or expected market risk premium should be based on the longest period available.

Because risk premiums based on short time periods can be particularly volatile, changing with capital market conditions, inflationary expectations, and fiscal-monetary forces, they should be ignored. One should rely instead on the long-term results, since periods of such length are long enough to smooth out short-term aberrations, and to encompass several business and interest rate cycles. In their comprehensive study of historical returns on stocks and bonds, Ibbotson Associates recommend the use of the entire study period in estimating the appropriate market risk premium, so as to minimize subjective judgment and to encompass as many diverse regimes of inflation, interest rate cycles, and economic cycles as possible. Because the S&P 500 contains a significant number of utility stocks, a risk premium analysis beginning after the passage and implementation of the Public Utility Holding Company Act of 1935 is most meaningful. This Act significantly changed the structure of the public utility industry. Since the Public Utility Holding Company Act of 1935 was not implemented until the beginning of 1937, numbers taken from before this date are less comparable to those taken after.

Realized returns can be construed as the sum of an expected return plus a component of unanticipated return, which will be positive or negative depending on whether investors underestimated or overestimated expected future

1

20-Year vs. 30-Year Treasuries

Our methodology for estimating the long-horizon equity risk premium makes use of the income return on a 20-year Treasury bond; however, the Treasury stopped issuing 20-year bonds in 1986. The 30-year bond that the Treasury returned to issuing in 2006 is theoretically more correct when dealing with the long-term nature of business valuation, yet Ibbotson Associates instead creates a series of returns using bonds on the market with approximately 20 years to maturity. The reason for the use of a 20-year maturity bond is that 30-year Treasury securities have only been issued over the relatively recent past, starting in February of 1977, and were suspended from 2002 to 2006.

The same reason applies to why we do not use the 10-year Treasury bond – a long history of market data is not available for 10-year bonds. We have persisted in using a 20-year bond to keep the basis of the time series consistent.

Income Return

Another point to keep in mind when calculating the equity risk premium is that the income return on the appropriate-horizon Treasury security, rather than the total return, is used in the calculation.

The total return comprises three return components: the income return, the capital appreciation return, and the reinvestment return. The income return is defined as the portion of the total return that results from a periodic cash flow or, in this case, the bond coupon payment. The capital appreciation return results from the price change of a bond over a specific period. Bond prices generally change in reaction to unexpected fluctuations in yields. Reinvestment return is the return on a given month's investment income when reinvested into the same asset class in the subsequent months of the year. The income return is thus used in the estimation of the equity risk premium because it represents the truly riskless portion of the return.

Arithmetic vs. Geometric Mean

The equity risk premium data presented in this book are arithmetic average risk premiums as opposed to geometric average risk premiums. The arithmetic average equity risk premium can be demonstrated to be most appropriate when discounting future cash flows. For use as the expected equity risk premium in either the CAPM or the building-block approach, the arithmetic mean or the simple difference of the arithmetic means of stock market returns and riskless rates is the relevant number. This is because both the CAPM and the building-block approach are additive models, in which the cost of capital is the sum of its parts. The geometric average is more appropriate for reporting past performance because it represents the compound average return.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

41. Refer to the Direct Testimony of John Spanos ("Spanos Testimony"), pages 6 and 12.

a. Explain in full detail whether the proposed depreciation rates are based on the Equal Life Group ("ELG") procedure or the Average Life Group ("ALG") procedure.

b. Identify whether Columbia Kentucky has used the ELG or ALG procedure to calculate the depreciation rates for the years 2000 – present date.

c. In the May 7, 2019 final Order in Case No. 2018-00281, the Commission stated that the "ELG procedure does not accurately match revenues and expenses, is front-loaded, and should not be allowed for ratemaking purposes." The Commission found that the proposed ELG procedure did not produce, fair, just, and reasonable rates, and that the depreciation rates should reflect the ALG procedure. Explain how Columbia Kentucky's proposed depreciation rates based upon the ELG procedure complies with recent Commission precedent.

d. If Columbia Kentucky's proposed depreciation rates are based on the ELG procedure, provide proposed depreciation rates based on the ALG procedure pursuant to the Commission's final Order in Case No. 2018-00281.

e. Provide the updated revenue request that includes depreciation rates based on the ALG procedure.

Response:

a. The proposed depreciation rates as presented in the Depreciation Study are based on the Average Life Group("ALG") procedure. Throughout the Depreciation Study and Spanos testimony the depreciation procedure is referenced as Average Service Life ("ASL") which is synonymous to ALG. There is a reference on page 6, line 12 in Spanos Direct Testimony of the Equal Life Group procedure which will be corrected.

b. All vintages in the depreciation study are calculated using the ALG procedure.

c. Although the ELG procedure is straight line depreciation and the most accurate method for determining depreciation rates, all depreciation rates in the Depreciation Study utilize the ALG procedure. The study follows the preference of the Commission and complies with the Commission practices, per the Order in Case No. 2018-00281.

d. The Depreciation Study proposed by Columbia Gas of Kentucky in this case utilize the ALG procedure.

e. Please refer to the response to sub-part d. above.

COLUMBIA GAS OF KENTUCKY, INC.
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DATED JULY 7, 2021

42. Refer to the Spanos Testimony, page 14.

a. Explain whether Columbia Kentucky has included amortization accounting in prior depreciation studies and rates. If not, explain why Columbia Kentucky is requesting amortization accounting to be included in the depreciation study and rates in the pending case.

Response:

a. Columbia Gas of Kentucky has included amortization accounting in prior depreciation studies and rates as this is the most appropriate methodology for these types of assets. The discussion of amortization accounting is set forth in Part V of the Depreciation Study and within the Direct Testimony of John J. Spanos. There are continual accounting practices for amortization of general plant that have occurred which are reflected with the alignment of the accumulated depreciation (book reserve).

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43. Refer to the Spanos Testimony, page 17. Mr. Spanos states that due to the accelerated pipeline replacement program for bare steel and cast iron mains, depreciation rates are also accelerated so the investment is fully recovered by year-end 2037. Due to Columbia Kentucky requesting for first generation plastic pipe to be included in the accelerated pipeline replacement program, explain in detail whether the depreciation rates for the plastic pipes were also accelerated in the depreciation study.

Response:

There is no accelerated pipeline replacement program through 2037 incorporated in the Depreciation Study for plastic pipe. The specific plastic pipe cannot be identified for accelerated replacement into the future. Additionally, the survivor curve for all the subaccounts of mains incorporates not only the historical indications but future plans for all main types. Therefore, the survivor curve selected for mains includes the expectation of early generation of plastic pipe being retired sooner than past plans however, there is no specific date of recovery included in the study as is the case for cast iron and bare steel. All plastic pipe does not have the same definitive plan such as cast iron and bare steel.

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44. Refer to the Spanos Testimony, Attachment JJS-2, 2022 Calculated Annual Depreciation Accruals, page 4.

a. Confirm that based upon the depreciation study, as of December 21, 2022, Columbia Kentucky's total depreciable plant is $703,323,333.69.

b. Provide the monetary amount for the total depreciable plant from the last depreciation study conducted for Columbia Kentucky.

c. Explain in detail the increase of the total depreciable plant in the proposed depreciation study, versus the last depreciation study.

d. Confirm that ratepayers have paid a total of $174,604,409 towards the depreciation of plant. If not confirmed, provide the total regarding the same.

e. Explain what future book accruals of $746,936,361 represent.

f. Confirm that Columbia Kentucky is proposing $13,746,600.60 of amortizable plant.

g. Provide the monetary amount for the amortizable plant from the last depreciation study conducted for Columbia Kentucky.

Response:

a. The total depreciable plant as of December 31, 2022 is projected to be $703,323,333.69, however, the amortizable plant amount of $13,746,600.60 should be included in the total depreciable plant. Therefore, the total depreciable plant to be considered is actually $717,069,934.29.

b. In the last depreciation study as of December 31, 2015, the total depreciable and amortizable plant was $392,967,798.65. This amount represents a historical or actual amount without projected plant as set forth in the December 31, 2022 amount.

c. The increase is related to 5 years of capital improvements and 2 years of projected capital improvements. The majority of the large increase in capital improvements relates to the main replacement program which affect Account 376, Mains and Account 380, Services. The average net plant change for the seven year period is approximately $46 million per year.

d. The amount of $174,604,049 is the projected book reserve as of December 31, 2022 for depreciable plant. However, the full projected book reserve as of December 31, 2022 must include the amortizable plant book reserve of $5,438,911. However, these amounts are projected as of December 31, 2022 so this does not reflect amounts ratepayers have paid. The book reserve reflects the accumulated depreciation on plant in service through the test year date. The depreciation study as of December 31, 2020 reflects a more accurate level of accumulated depreciation to date. This amount is $168,689,566 which has accumulated since the first year of recovery.

e. The future accruals column represents the remaining service value of the assets in service today still to be recovered. The service value is the original cost plus the net salvage component. Therefore, the summation of the service value minus the book reserve sets forth on an account by account basis the total future accruals as of the test year. This is standard development for recovery for regulating bodies.

f. The projected amount of $13,746,600.60 as of December 31, 2022 represents the total Amortizable Plant.

g. The historical amount in the last depreciation study as of December 31, 2015 for Amortizable Plant was $4,823,336.41.

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45. Refer to the Direct Testimony of Chun-Yi Lai, page 10.

a. Chun-Yi Lai states that Columbia Kentucky is projecting 209 full-time employees for 2022. As aforementioned, Ms. Cole stated in her testimony that Columbia Kentucky currently employs 201 active full-time employees.

i. Explain in detail why Columbia Kentucky is projecting eight additional full-time employees for the future test period in 2022.

ii. Explain whether the eight jobs are newly created positions or vacancies.

iii. Identify and provide a brief overview of all eight additional full-time jobs, and why each job is necessary to provide natural gas to the ratepayers.

iv. Provide a specific date as to when each new employee will be hired to fill the additional eight full-time jobs.

v. Provide justification for Columbia Kentucky adding eight additional full-time employees for the forecasted period ending December 31, 2022, when based upon Ms. Bartos' testimony, page 16, Columbia Kentucky is forecasting lower sales and lower transport volumes of gas per CCF in 2022 than in 2021.

vi. Provide the total monetary amount that Columbia Kentucky is including in the pending rate case for each of the eight new full-time job positions including but not limited to salary, benefits, taxes, etc.

b. Provide justification for the overall wage increase of 3% for exempt and non-exempt employees.

Response:

a.

i. Columbia is projecting eight additional full-time employees which are existing vacancies that Columbia plans to fill.

ii. The eight additional full-time employees are existing vacancies.

iii. Seven of the eight vacancies will reside in gas operations to perform work related, but not limited to, emergency response, leak repairs, meter change program, and oversight over construction contractor crews for safety and quality control. The remaining vacancy is an On-the-Job trainer that will focus on coaching, mentoring and developing field employees and providing support and feedback to employees and leadership. This role will develop employees through hands-on training and knowledge transfer to ensure they are successful in their roles, and that they are properly trained and are able to execute work efficiently, safely and in compliance with all federal, state, local and company requirements.

iv. The seven vacancies in gas operations are expected to be filled by September 13, 2021, and the On-the-job vacancy is expected to be filled by August 1, 2021.

v. There is no connection between these eight additional full-time employees and the lower usage forecasted by Witness Bartos.

vi. The estimated O&M impact is $618,000.

b. Please refer to pages 29 through 30 of the Direct Testimony of Kimberly Cartella in Tab 30 of the Application.

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46. Refer to the Direct Testimony of Chun-Yi Lai, pages 14 – 15.

a. Explain why employees have transferred from NiSource Corporate Service to Columbia in Large Customer Relations and Safety Compliance & Risk Management.

b. Explain whether NiSource and Columbia Kentucky have requested additional corporate insurance quotes due to the significant increase of corporate insurance amounts.

c. Explain in detail what is meant by locates.

d. Explain in detail what is meant by turnbacks.

e. Explain why costs have increased due to locates and turnbacks.

Response:

a. Large Customer Relations and Safety Compliance & Risk Management employees transferred from NiSource Corporate Service to Columbia to give the operating companies more oversight. This decision was made across NiSource companies.

b. NiSource uses insurance brokers to market and obtain quotes for all insurance programs. A variety of insurers are approached to ensure the best possible price and policy language.

c. KRS 367.4901 – 367.4917 requires Columbia Gas, as an operator, to locate its facilities when a ticket request is made through the notification center (or 811).

d. A turn-back is a term used to describe a difficult locate or when a facility cannot be located. This could be due to mapping, tracker wire, or multiple facilities in close proximity. In the event that Columbia is unable to locate, then it will need to send a more specialized crew to ensure that it avoids any potential damage during excavation. Columbia will use vacuum excavation trucks, hand dig, or other specialized technology to locate the underground facility ensuring that the excavating party knows where Columbia's facilities are located to avoid any potential damages.

e. Ticket volumes have gone up due to increased projects by municipalities, other utilities, and excavation activities. In addition, KRS 367.4901-367.4917 was amended in 2018 which will fine excavators and operators who do not call 811, fail to locate, or locate in error thus causing damage. This has led parties that did not historically call to begin calling in tickets so as not to be fined if there was damage. As the volume of locate ticket requests increase, generally so does the amount of turn-back tickets in a proportional manner.

COLUMBIA GAS OF KENTUCKY, INC.
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DATED JULY 7, 2021

47. Refer to the Direct Testimony of Susan Taylor ("Taylor Testimony"), page 7. Ms. Taylor states that a copy of the current Service Agreement, effective January 1, 2015, between NCSC and Columbia, was submitted to the Commission as an affiliate agreement on January 15, 2015. Explain whether the January 1, 2015 Service Agreement complies with KRS 278.2207(1)(b), which requires services and products provided to the utility by an affiliate to be priced at no greater than market price or in compliance with the utility's existing USDA, SEC, or FERC approve cost allocation methodology.

Response:

Yes the Service Agreement complies with KRS 278.2207. As noted in Attachment ST-2, 1.3 NCSC files cost of services and allocations with the FERC annually. Labor market studies are conducted to ensure salary and benefits are commensurate with the market, which is outlined in Section VII of the testimony of Witness Kimberly Cartella. In addition, procurement of materials, good and services goes through a competitive bidding practice to ensure market based services. Please note during the FERC audit, attached as KY PSC Case No. 2021-00183, AG 1-061, Attachment A, FERC auditors reviewed the bidding process and sampled charges and payments to determine accurate pricing for sale of goods and services to verify compliance with FERC market pricing rules. No exceptions were found and practices were deemed to be compliant with FERC market pricing rules.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

Refer to the Taylor Testimony, page 8, and confirm that this page should be blank.

Response:

Yes, there was an inadvertent page break inserted on page 8; therefore leaving a page blank to Taylor Testimony, page 8.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

49. Refer to the Taylor Testimony, page 9.

a. Explain in detail who at Columbia Kentucky has the authority to determine that an allocation percentage is not reasonable.

b. If Columbia Kentucky has ever asserted that an allocated percentage is not reasonable then identify all occurrences of the same in the past five years.

c. Explain in detail who at Columbia Kentucky has the authority to refuse to pay an allocated charge.

d. If Columbia Kentucky has ever refused to pay an allocated charge then identify all occurrences in the past 5 years.

Response:

a. The Director of Regulatory & Utility Planning has the authority to determine that an allocation percentage is not reasonable. As part of semi-annual update of NCS Allocation Survey, Accounting provides a file with new allocation rates, based on updated actual data volumes. In addition, a file explaining all differences of + / - 1 % is sent for review to Columbia Kentucky Controller and Director Regulatory & Utility Planning. Additionally, Accounting provides a monthly summary report of charges billed to Director Regulatory & Utility Planning for review which includes month over month comparisons of direct and allocated charges, Columbia Kentucky's allocated percentage comparison, and cost element detail. Refer to KY PSC Case No. 2021-00183, AG 1-049, Attachment A for recent example of monthly summary report.

b. Allocations are reviewed proactively during the budget process with Director of Regulatory & Utility Planning. During the budget review, NCSC allocations are reviewed by affiliate during budget process to analyze allocations by initiative. There is a formal meeting held to walk through the Columbia Kentucky budget for reasonableness. Any discussions or challenges on allocations or budget items would take place during this session. As actuals come through they are reviewed in comparison to budget for variances. Refer to Columbia's Response to the Attorney General's First Set of Requests for Information No. 139 for the allocated adjustments contained in the forecast period for one-time items, ii) future planned work, and iii) strategic initiatives. Refer to Columbia's Response to the Attorney General's First Set of Requests for Information No. 150 for documentation of meetings requested by Columbia Kentucky to review monthly Budget to Actual variances since 2018.

c. The Director of Regulatory & Utility Planning and President of Columbia Kentucky have the authority to refuse to pay an allocated charge.

d. To my knowledge, I am not aware of a refusal to pay an allocated charge since the last rate case after charges have been billed. As noted in part b above, any new initiatives outside of the normal cost allocation manual are proactively discussed and an allocation is determined ahead of the start of an initiative for approval prior to set up of project coding. With proper billing controls in place, it reduces the amount of billing exceptions.

COLUMBIA GAS OF KENTUCKY, INC.
RESPONSE TO ATTORNEY GENERAL'S FIRST REQUEST FOR INFORMATION
DATED JULY 7, 2021

50. Refer to the Taylor Testimony, page 12.

a. Provide a breakdown of all of the increased costs from 2018 when the Total O&M billed from NCSC to Columbia Kentucky was $16,743,067, versus the proposed Total O&M in the forecasted test period of $19,320,924.

b. Explain how an approximately 15% increase in costs from NCSC to Columbia Kentucky since 2018 is fair, just, and reasonable.

c. Explain whether Columbia Kentucky has recently analyzed the cost to hire either in-house operations or third-party vendors versus the costs allocated from NCSC for comparable services.

Response:

a. Increases in NCSC costs from 2018 to the forecasted test period are primarily related to merit for labor and inflation increases on third party contracted costs, incremental safety initiative costs related to Safety Management System (SMS) and Columbia's Safety Plan initiative which was $443,397 million in the forecasted test period, net increase in allocation to Columbia Kentucky due to change in entities, as noted in Columbia's Response to the Attorney General's First Set of Requests for Information, No.152, offset by NiSource initiatives to control costs of $1,013,226 in the forecasted period and additional NiSource initiatives added as a pro-forma adjustment of $666,016 See Columbia's Response to the Attorney General's First Set of Requests for Information, No.39 for support on the NiSource initiatives.

In addition, and as noted in part b below, direct billings by NCSC employees for Merrimack Valley recovery efforts during 2018 contributed to lower billings to Columbia Kentucky for a short time period, thus showing an abnormal inflated comparison for Management fee billings.

b. In 2018, the engagement of NCSC employees in the Merrimack Valley event's recovery efforts contributed largely to the variance. The Company estimates that the NCSC billings it received were reduced by approximately $0.55-0.78 million during the last four months of 2018. Adjusting for those two items, reduced billings in 2018 and incremental safety spend in 2022, the total O&M variance in 2018 to the forecasted test period was approximately 8% or 2% growth annually.

Further, Witness Taylor is using an inflation methodology for NCSC O&M costs consistent with that used by the Office of the Attorney General in its rebuttal testimony Case No. 2013-00167, p.33 and Case No. 2016-00162, p.21. In that rebuttal testimony, inflation is calculated starting with the previous base period, pro-forma adjusted test year. Witness Taylor has employed a consistent inflation methodology starting with a pro-forma NCSC base test period in the 2016-00162 case to illustrate the costs are just and reasonable.

c. Although Columbia Kentucky has not directly analyzed the cost to hire either in-house operations or third-party vendors versus the costs allocated from NCSC for comparable services, NiSource has currently conducted a review of NCSC services that could be performed by third party vendors for comparable services. This initiative, Enterprise Business Services, is included in Witness Taylor's testimony as a pro-forma adjustment. Further, other NiSource affiliates, as part of their Annual Report of Affiliate Transactions or as part of a base rate case, have procured an outside service to conduct an independent review comparing NCSC services against third party vendors service cost. The fee to conduct the review is paid directly by the affiliate requesting the service, and although not specific to Columbia Kentucky, the review on NCSC services yields consistent analysis and an indicator that NCSC allocated cost is reasonable to the affiliate.