The Size Premium in the Long Run

Ching-Chih Lu*

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Abstract

Contrary to the usual practice of including a size premium in a small firm's cost-of-equity estimation, this paper shows that there should not be such a premium in the long run because firm size is a changing characteristic. By tracking the return performance of firms in the same size group for a longer horizon, I find that the size premium wears off just after two years. This is much shorter than the general assumption used in the cost-of-equity estimation, so the role of the size premium in it should be reconsidered.

Keywords: Cost of Equity Capital, Size Premium, Size Effect, Regime Switching

JEL Classification: G12, G14

*Department of Finance, National Chengchi University, No. 64, Sec.2 Zhinan Rd., Mucha, Taipei 116, Taiwan. E-mail: cclu@nccu.edu.tw.

1 Introduction

In the field of business valuation, practitioners usually include a size premium in a small firm's cost-of-equity estimation to account for a risk source or risk sources that cannot be captured by usual risk factors.[1] That is, on top of the cost of equity a small firm gets from the estimation by the CAPM or other models, it is usually offered an extra premium to compensate for the higher risk it is taking.[2] This paper aims to examine its validity, and the finding suggests that this commonly accepted size premium is not appropriate.

Since Banz (1981) and Reinganum (1981) both demonstrated that small size firms on the New York Stock Exchange usually outperform big firms than what the asset-pricing model of Sharpe (1964), Lintner (1965) and Black (1972) would suggest, the existence of the size effect has come into consideration by standard practice in the finance industry and soon became one of the most exploited concepts in modern finance. This size anomaly leads to an assumption that it might stem from a risk source or risk sources which cannot be explained by the market factor. Berk (1995) explains in theory that market value is inversely correlated with unmeasured risk because investors pay a lower price for a company's stock if it bears a higher risk than its CAPM beta could measure. The seminal works of Fama and French (1993), and Fama and French (1995) also acknowledge another kind of size effect in which

[1] Although there are many ways to define the size of a company, I stick to the most popular criteria, the market value of its equity, to proceed the discussion.

[2] Other than the CAPM, the build-up method and the Fama-French 3-factor model are also popular approaches in business valuation. The build-up method is advocated by the Ibbotson Associates, now a part of Morningstar, Inc., which aims to break down the expected return of a firm into a risk-free rate, a premium for equity risk, a risk premium attributable to this company by the industry it is in, and another risk premium for smaller size if applicable. This size premium is added in practice no matter whether the CAPM model or the build-up method is used. Please see Pratt and Grabowski (2008) Chapter 12 for a thorough discussion. Such a size premium is not required in the Fama-French 3-factor model because size is a risk factor embedded in it already.

small firms usually outperform big firms in realize returns and they use the return differential between small and big stork portfolios (I call it “small stock premium" hereafter for convenience) as a risk factor (also known as *SMB*). If the CAPM holds well, the small stock premium should be proportional to the difference between the CAPM betas of small and big stock portfolios in cross section, and the size premium should not exist. However, empirical evidence shows that the small stock premium is usually much bigger than the CAPM could explain because small firms usually have a significant size premium, which links these two different perspectives of size anomalies together.

Besides serving as a measure of an alternative risk source, the idea of the existence of a small stock premium is often used in forming a trading strategy. Since the commence of the Dimensional Fund Advisors (DFA hereafter) in 1981, the strategy of overweighing small-cap stocks to exploit this small stock premium has been utilized extensively. This same concept is also used to construct ETFs featuring size as an important characteristic. There are currently at least 6 micro-cap and 40 small-cap ETFs trading on the U.S. stock exchanges.[3] The main attraction of these ETFs is to exploit their potentially higher returns over big firms or the market.

With all the acknowledgement from both academics and practitioners, however, there lies an inconsistency between these applications of the size effect. The usage of the SMB factor requires yearly rebalancing of the size portfolios, and a trading strategy related to firm size demands probably even more frequent position adjustments. However, the size premium added to a small firm's cost-of-equity estimation is based

[3] Size is an important characteristic of these ETFs. However, it may not be the “only" characteristic. For example, the Vanguard Group, a U.S. investment management company, has three ETFs related to small-cap firms. Their exchange ticker symbols are VB, VBR, and VBK, which account for a total of $2.79 billion capital at the end of 2007. VBK is the combination of small-cap and growth stocks, while VBR is a small-cap and value stock ETF.

on the assumption that a firm will carry this extra premium in its discount factor moving forward for an extended period of time. Fama and French (2007) explain that the small stock premium comes from small firms gaining market capitalization and subsequently becoming bigger firms, but a firm's size behaves more like a long-lasting characteristic in the size premium application, which contradicts the empirical evidence. Although we do not know for certain which small firm will move to a bigger size group because of its own success, we do know that firms shift between different size groups in subsequent years after they were first assigned to a certain size rank. The size premium of a firm should be time-varying even if the CAPM beta of the size portfolio is time-invariant, so the cost of equity capital estimation could or should be adjusted accordingly if size has to be taken into consideration.

The existence of the size effect is not always perceived with full faith. This issue has to be addressed first, otherwise the debate of the application of the size premium will become a vain attempt. In the early 1980s when a fierce debate was conducted about the existence and the explanation of the size effect, Roll (1983) and Blume and Stambaugh (1983) both question the empirical importance of this phenomenon because the magnitude of the size effect is too sensitive to the technique used to evaluate the risk-adjusted return. Keim (1983) and Reinganum (1983) show that most of the risk-adjusted abnormal return to small firms occurs in the first two weeks in January, thus makes this effect easily exploited. It was the evaluation and the existence of the size premium being challenged, but the small stock premium was mostly untouched. Fiercer challenges came in the late 1990s, when Booth, Keim, and Ziemba (2000) argue that the January effect is not significantly different from zero in the returns to the DFA 9-10 portfolio over the period 1982-1995,[4] and Horowitz,

[4] The DFA 9-10 portfolio includes stocks with the lowest 20% market capitalization according to NYSE breakpoints.

Loughran, and Savin (2000b) also claim that the size effect ceases to exist after it was made well known because its benefit has already been exploited. Small firms do not have higher returns over big firms from the early 1980s to the mid-to-late 1990s, so the existence of the size effect is in doubt and deserves a thorough examination.

In this paper I will show that the size effect in the traditional definition is still intact given a longer sample period. The disappearance of the size effect in the 1980s and 1990s probably stems from a sample selection bias because the effect re-emerged in the late 1990s. I also examine whether this sample selection anomaly is a recurring scenario with a longer history of stock prices and find that the similar event occurred from the 1940s to 1960s.

However, an analysis of the evolution of the size premium will show that it is inappropriate to attach a fixed amount of premium to the cost of equity of a firm simply because of its current market capitalization. For a small stock portfolio which does not rebalance since the day it was constructed, its annual return and the size premium are all declining over years instead of staying at a relatively stable level. This confirms that a small firm should not be expected to have a higher size premium going forward sheerly because it is small now.

The paper proceeds as follows. Section 2 introduces the data used in this study. All NYSE, AMEX and NASDAQ operating firms are included and they are sorted by their respective market capitalization to form size portfolios. I also examine whether the size effect disappeared during the 1980s and 1990s and discuss its possible impact in this section. Section 3 offers a forward looking perspective of the size effect in response to the assumption of Fama and French (2007) that the small stock premium mainly resulted from firms moving between different size groups. We can also see the evolution of the size premium of the small stock portfolio and find evidence to conclude that a small firm does not always have a larger size premium simply because of its current size. Section 4 provides a method to separate the size premium into different regimes with macroeconomic variables, which shows that it is also very difficult to estimate the size premium with a time-varying estimation. Section 5 offers concluding remarks.

2 Data Description and the Evidence of the Existence of the Size Effect

2.1 Data Description

Monthly stock return data used in this research are collected from the University of Chicago Center for Research in Security Prices (CRSP) database. All NYSE, AMEX and NASDAQ operating firms are included when they are available on the CRSP tape.[5] Unlike Fama and French (1992), this study does not exclude financial firms from the sample because financial leverage is not in discussion. Since the market capitalization of a firm is the only firm characteristic covered in this paper and I also do not incorporate the Compustat database for the book equity data of companies, the number of firms each year is also greater than research considering both size and book-to-market equity characteristics. This choice of sample also prevents the potential survival bias generated by the Compustat database, please see the discussion in Kothari, Shanken, and Sloan (1995). The sample period is from December 1925 to December 2008.

The market portfolio return used in this paper is the CRSP value-weighted return on all NYSE, AMEX, and NASDAQ stocks, and the risk free rate is the total return on 30-day Treasury bill calculated by Ibbotson Associates.

To sort firms into different deciles according to their relative size, I follow the Fama and French (1992, 1993) tradition to use a firm's market equity at the end of June each year as the measure of its size. A firm has to be on the CRSP tape in

[5] American Depository Receipts, closed-end funds, Real Estate Investment Trusts, and companies incorporated outside the U.S. are excluded, which means only firms with CRSP share code 12 or less are included in this research.

June of year t to be included in a size portfolio from July of year t to June of year $t+1$ and years after that.[6] All NYSE listed firms are ranked each year according to their June market value, then these firms are allocated equally into 10 size portfolios on the basis of their relative size, so each portfolio has the same number of NYSE firms. The breakpoints between size portfolios are extracted from these NYSE firms, and AMEX and NASDAQ firms are inserted into these portfolios according to their market capitalization relative to the portfolio breakpoints. The first decile (portfolio 1) contains the smallest firms and the 10th decile (portfolio 10) includes the largest firms. In December 2008, Portfolio 1 has 1,895 firms and portfolio 10 has 158.

2.2 Does the Size Effect Still Exist?

In response to the question raised by Horowitz, Loughran, and Savin (2000b) about whether the size effect still exists, some basic statistics are presented in Table 1 to show that the effect did disappear during the 1980s and the early 1990s, but it was intact in most of the other sample periods. The statistics from the full sample are shown in Panel A. They are consistent with early findings on the size effect: big firms report lower returns than small firms, and the CAPM beta is also negatively related to size. The size premiums in the last row of each panel are calculated as follows:

$$\begin{aligned} SP_{i,t} &= R_{i,t} - \left(R_{f,t} + \beta_i (R_{m,t} - R_{f,t})\right), \text{ and} \\ SP_i &= \frac{1}{T}\sum_{t=1}^{T} SP_{i,t} \qquad i = 1, \ldots 10. \end{aligned} \tag{1}$$

[6] Instead of the usual one-year holding period immediately following the size sorting date, I also extend the holding period to longer time spans to see how persistent the size premium is for the same group of firms.

where SP_i represents the average size premium of portfolio i which is shown in the table, $R_{i,t}$ and $R_{m,t}$ are monthly returns on size portfolio i and the market portfolio, respectively. R_f is the risk-free rate. β_i is the CAPM beta estimated by regressing $(R_i - R_f)$ on $(R_m - R_f)$ with the matching sample period. This size premium captures the part of the size portfolio return which cannot be explained by the CAPM. Practitioners usually add it to the cost-of-equity estimation of small-cap firms to compensate for their higher risks. Another way to estimate the size premium is through the estimation of the CAPM alpha. However, I will not adopt this approach because the sample period used by the regression to estimate CAPM coefficients and the one used by the realized return in equation (1) do not always match in this article.

[Insert Table 1 here.]

Panel B displays the statistics of the same variables with the sample period before June 1980, roughly when the size effect was made well known by academia. Although the statistics in the first two panels are not exactly the same, they look very much alike.

Panel C of Table 1 is consistent with the assertion of Horowitz, Loughran, and Savin (2000a) that there is no significant difference between the performance of different size portfolios during the period from 1980 to 1996.[7] The average returns on different size portfolios are no longer negatively related to their market capitalizations. From portfolio 1 to 4, the four smallest size portfolios, the average returns are increasing instead of moving in the opposite direction shown in the early years. The pattern of size premiums is also different from the ones shown in the previous two

[7] This period can be extended to 1998 and the results are still in the similar pattern to what one would get with sample period from 1980 to 1996, so this longer sub-sample period is chosen instead of the one used by Horowitz, Loughran, and Savin (2000a).

panels. For instance, portfolio 1 and 2 did not have the largest size premiums, they had biggest size “discounts" instead.

It is often suggested that pricing anomalies may disappear after they were made known to the public by researchers or financial practitioners if these anomalies were easily exploited. Horowitz, Loughran, and Savin (2000a) show that simply adding $0.125 to the December 31 price of small stocks can easily lower their average January returns from over 8% to -0.37% during the 1982-1997 span. Since Keim (1983) and Reinganum (1983) showed that most of the size premiums to small firms occurred during the first two weeks in January, it is no surprise that the January effect could be totally wiped out just by informed investors flocking into the market to buy small firm stocks in December, and so goes the size premium.

Sixteen years of time is not short, but the recent development shows that the result in Panel C is more likely to be an aberration from the formerly established rule than a new norm. Panel D presents the statistics from the past 10 years and shows that the negative relation between firm size and equity return has been restored, with only a few exceptions from some mid-cap size portfolios. The inconsistency of the mid-cap portfolios probably arises because the sample period is too short to offer a robust pattern between a firm’s size and its return. It has to be noted that the realized equity premium of the U.S. market during these 10 years is slightly below zero, which is significantly lower than the historical standard. This might contribute to the flat security market line, where the beta of size portfolios seems independent of their respective average return.

Another serious threat generated by the data from the 1980s and 1990s is that the return differential between small and big firm size portfolios, also known as SMB in the Fama-French 3-factor model, may have an insignificant or even a negative price of risk. This implies that the SMB factor is either meaningless or has a negative effect on the stock return. We can use a simple cross-sectional regression to show how and why this matters.

[Insert Table 2 here.]

Table 2 displays price-of-risk estimations of the popular Fama-French factors with different sample periods. Following the Fama and MacBeth (1973) procedures, in each sub-sample period I run time-series regressions of each test portfolio return in excess of the risk-free rate ($R^e_{it} = R_{it} - R_{ft}$) on the excess market return ($R^e_{mt} = R_{mt} - R_{ft}$), the returns on the small size portfolios minus the returns on the big size portfolio (SMB), and the differential between the returns on high and low book-to-market equity firms (HML).[8]

$$R^e_{it} = \alpha_i + \beta_i R^e_{mt} + s_i SMB_t + h_i HML_t + \varepsilon_{it} \qquad t = 1, 2, \ldots, T, \forall i. \tag{2}$$

The test portfolios include 5-by-5 portfolios formed on book-to-market equity and size, and 17 industry portfolios.[9] Since there are missing observations in the return series of the portfolio with the highest book-to-market equity and the largest size, it is taken out of the test portfolios. These portfolios are chosen because they cover different aspects of security characteristics.

The next step is to regress the expected returns of test portfolios from each sample period on their respective risk loading estimates from the time-series regression. I

[8]Please refer to Fama and French (1993) for the detailed definition of SMB and HML. Data on these two variables are obtained from Professor Kenneth French's website at Dartmouth University.

[9]All the portfolio data are also acquired from French's website.

take the average return of each portfolio from the corresponding sample period as their return expectation. The cross-sectional regression is:

$$E_T(R_i^e) = \beta_i \lambda_1 + s_i \lambda_2 + h_i \lambda_3 + \alpha_i, \qquad i = 1, 2, \ldots, N. \tag{3}$$

where λ_2 is the price of the risk represented by the size factor SMB. During the period from 1980 to 1998, the price of SMB is insignificantly different from zero and its magnitude is also comparably smaller than it is in the other sub-periods. The number is 0.29 before 1980 and 0.20 after 1998, but it is only 0.07 from July 1980 to June 1998. The other parameters do not change as dramatically over different sub-periods. The price of a risk factor being equal to zero discredits its explanatory power to the cross-sectional variability of returns, and this is exactly the case for the SMB factor from 1980 to 1998.

It may be too early to say that the explanatory power of the SMB factor fully recovers in the post-1996 or the post-1998 period, but it is clear that the zero or slightly negative SMB price during the 1980s and 1990s is not necessary a lasting problem.

2.3 Regime Shifts of the small stock premium

As mentioned earlier, the size premium and the small stock premium are related because the risk-adjusted abnormal return of small firms is an important part of the return differential between small and big stock portfolios. According to Table 1 Panel A, the small stock premium of portfolio 1 is 3.39%, which accounts for half of the return difference between portfolio 1 and 10. Since the size premium is highly dependent on the asset pricing model and the sample period it is using, I will focus on the possible structural change or regime shift of the small stock premium in this section first.

Although the differential between the returns on size portfolio 1 and portfolio 10 is different from the definition of the SMB factor in the Fama and French 3-factor model, I will borrow this acronym to represent the small stock premium for the following discussion. Motivated by the earlier discussion of the disappearance of the small stock premium in the 1980s and 1990s and the reappearance in the following years, I believe that there may exist structural changes or regime shifts of the expected mean of SMB. Panel A of Figure 1 exhibits the annual return differential between portfolio 1 and portfolio 10, in which we see annual SMB alternates between high and low values but certain persistency exists. From 1984 to 1998, the supposedly positive SMB is negative in most years except in 1988 and 1991 to 1993. The sample average of the equity risk premium during these 15 years is 10.53%, which is well above the historical average. Big firms performed exceptionally well while small firms did not during this period, so the disappearance of SMB should certainly came from the size premium, or lack thereof.

[Insert Figure 1 here.]

Assuming that the expected mean and variance of SMB can be expressed by a two state Markov-switching model, so the state variable S_t, which governs the regime shift, takes a value of 1 or 2. When $S_t = 1$, the expected mean of SMB_t is in the state of a low value, while $S_t = 2$ represents the state when the expected mean of SMB_t is high.

$$y_t = \mu_k + \sigma_k \varepsilon_t \qquad \varepsilon_t \sim N(0,1). \tag{4}$$

where y_t represents SMB_t, μ_k and σ_k are state-dependent mean and standard deviation of SMB_t. k=1 or 2, which identifies the state SMB_t is in at time t.

The state variable S_t is assumed to follow a 2-state first-order Markov process with fixed transition probabilities as follows:

$$\begin{aligned} p &= \Pr(S_t = 1|S_{t-1} = 1) \\ 1-p &= \Pr(S_t = 2|S_{t-1} = 1) \\ q &= \Pr(S_t = 2|S_{t-1} = 2) \\ 1-q &= \Pr(S_t = 1|S_{t-1} = 2) \end{aligned} \tag{5}$$

The mean and variance of SMB are determined by the current state, and the state variable S_t is not dependent on the past information beyond one period.

SMB_t under each state is assumed to follow the normal distribution and the parameters of the distribution function are only contingent on the state k, so

$$f(y_t|S_t = k) = \frac{1}{\sqrt{2\pi\sigma_k^2}} \exp\left(\frac{-(y_t - \mu_k)^2}{2\sigma_k^2}\right) \tag{6}$$

for $k = 1,2$. The log-likelihood function is

$$\ln \mathscr{L}(y_1, y_2, \ldots, y_T; \theta) = \sum_{t=1}^{T} \ln[\Pr(S_t = 1) f(y_t|S_t = 1) + \Pr(S_t = 2) f(y_t|S_t = 2)] \tag{7}$$

and the regime probability $\Pr(S_t = k)$ can be estimated with the following recursive representation proposed by Gray (1996):

$$\Pr(S_t = 1) = (1-q)\left[\frac{f(y_{t-1}|S_{t-1} = 2)\Pr(S_{t-1} = 2)}{f(y_{t-1}|S_{t-1} = 1)\Pr(S_{t-1} = 1) + f(y_{t-1}|S_{t-1} = 2)\Pr(S_{t-1} = 2)}\right]$$

$$+p\left[\frac{f(y_{t-1}|S_{t-1}=1)\Pr(S_{t-1}=1)}{f(y_{t-1}|S_{t-1}=1)\Pr(S_{t-1}=1)+f(y_{t-1}|S_{t-1}=2)\Pr(S_{t-1}=2)}\right] \quad (8)$$

where the lowercase p and q are the transition probabilities defined in equation (5) and $\Pr(S_t = 2) = 1 - \Pr(S_t = 1)$.

Table 3 presents the estimation results of the above Markov-switching model along with an unconditional normal distribution model as its comparison. The sample period is from July 1940 to December 2008 instead of starting from July 1926 because it has to be trimmed short in the following sections to accommodate the portfolio positions with longer holding periods. According to the log-likelihood values, AIC, and BIC statistics of these two models, the Markov-switching model fits the sample better than the model with the assumption that SMB follows an unconditional normal distribution. The expected mean of the low SMB state is insignificantly different from zero, which explains why SMB can disappear over an extended period. The average annualized returns under two different states are -2.67% and 44.97%.

[Insert Table 3 here.]

Panel B of Figure 1 displays the smoothed probability in state 2 (high SMB state). Table 3 also shows the transition probabilities p and q, which are 0.9579 and 0.8090, respectively. These results imply that the low SMB regime is more persistent than the high SMB regime. On average the high SMB regime lasts for 5.2 months, and the low SMB regime keeps at the same state for 23.8 months. If the true data generating process of SMB follows the description of this Markov-switching model, it is no surprise that the small stock premium could disappear over a long period during the 1980s and most of the 1990s then resurfaces in recent years.

From Figure 1 we can also see that SMB is persistently low from 1946 to 1963, which indicates that the experience from the 1980s and 90s indeed has a predecessor. Repeat the same exercise done in Table 1 for this period, we can find that portfolio 1 has an average size premium at -1.77% per annum, while portfolio 10 has a slightly positive 0.42% average size premium. The average of SMB from 1946 to 1963 is -0.74%, which mostly stems from the low size premium of small stocks instead of the difference between their respective CAPM projections.[10] These results show that the temporary disappearance of the size effect is a recurring event. However, when we look at a longer time span, the small stock premium could still hold true at least on average.

[10]CAPM beta is still negatively related to firm size during this period, but the slope of the security market line calculated with returns on size portfolios and their respective betas is smaller than it is calculated with the full sample.

3 Size as a Genetic Code or a Short-Lived Characteristic?

If the size premium ceases to exist like Horowitz, Loughran, and Savin (2000b) assert, or its magnitude has no relation to firm size, there is no need to give a "premium" to a small firm when estimating its cost of equity capital. In fact, given what we see in Panel C of Table 1 we might have to give small-cap firms a discount if the negative size premium of portfolio 1 remains. The data from the last 10 years seem to restore the order of the size premium and the necessity to add it to small firms, but I will show in this section that it still remains to be proved whether a small-cap firm should require this size premium in its cost-of-equity estimation.

3.1 Design of the $t+j$ Portfolio

Fama and French (2007) find that the return differential between small and big firms is mainly driven by small-cap firms moving up the size rank to become large-cap firms. This perspective changes the assumption of the size premium a small firm should get in the long run. The logic is simple: a small firm becomes a big firm because its market capitalization increases faster than its peer, which usually results from its fast growing price. However, small firms cannot keep the higher average return of old once they become big firms, otherwise the small stock premium will turn into a big stock premium. Although this is mainly an explanation of the small stock premium instead of the size premium, the discussion in the previous section shows that these two premiums are related.

Since the Fama-French size portfolios are constructed in each June and are held for a whole year until they are rebalanced in June next year, their finding implies that some firms are likely to switch to different size groups sooner than a year, especially for the small firms to become big firms. The usual practice of the size premium estimation is to calculate it with annually rebalanced size portfolios,[11] then we add this number to a firm's cost of equity for the following years to discount its future cash flows to the present value. We know this is probably a proper assessment of the discount factor for the first year, but is it still proper if an originally small firm becomes a big firm from the second year on and does not warrant such a premium hereafter?

To investigate whether the size premium is changing over time and how it evolves, I design the following $t+j$ size portfolio approach. In the traditional size portfolio formation, securities are assigned to each portfolio in June and the portfolios are held from July to June next year under a buy-and-hold strategy. In the $t+j$ size portfolio approach I also choose to sort securities in June of each year t, but instead of holding the portfolios for the following year, I also look at the monthly returns for an one-year holding period from July of year $t+j$-1 to June of year $t+j$, where $j = 2, \ldots, 15$.[12] All the firms are identified and tracked by their CRSP permanent number. If a firm goes bankrupt or is merged by another firm in the following years, then it is taken out of the portfolio once it is off the CRSP tape. Otherwise it keeps in the same $t+j$ size portfolio as assigned in the initial sorting date no matter how big or how small its market capitalization becomes.

[11]For getting the size premium estimation, some practitioners rebalance the size portfolios more frequently. For example, Ibbotson Associates sorts and assigns all eligible companies to different size portfolios with the closing price and shares outstanding data for the last trading day of March, June, September and December instead of June each year.

[12]This approach reduces to the traditional size portfolio formation when $j = 1$.

For example, the firms in t+2 portfolios from July 1989 to June 1990 were sorted and assigned to different size portfolios in June 1988; the same composition of firms is used in t+1 portfolios from July 1988 to June 1989, which are 12 months immediately after the sorting date. The t+3 portfolios in July 1990 also consist of the same firms, except for those were delisted during the first two years. There is also another set of t+2 portfolios from July 1988 to June 1989, each consists firms sorted by their June 1987 size. We can string together all the t+2 portfolios to see how firms perform a year after its original sorting date for a whole year. The same process is done for all $t+j$ size portfolios. This approach allows us to follow the average performance of firms j years after they were assigned to a specific size group.

If a firm's size behaves as a characteristic and this attribute follows the firm for an extended period of time, return patterns among different $t+j$ size portfolios should not change much for different j. On the other hand, if a small firm deserves a lower size premium after it becomes a bigger firm, the size premium in the following years will decrease accordingly. By tracking the historical performance of firms sorted by size, we can get a better idea on how the size premium of a firm behaves and whether it is a good indicator of an extra risk source.

3.2 Size Premium is Changing Over Time

Practitioners usually consider a fixed size premium for a firm for subsequent years, which implies that either firms will not migrate to other size groups, or they will still demand the same size premium even after they switch to different size groups. To make a valid comparison between different $t+j$ portfolios, I change the starting date of all portfolios from July 1926 to July 1940 to accommodate the t+15 portfolios, which have companies being sorted in June 1926 but will not report the first return observation until July 1940.[13]

Table 4 presents the average size premiums of different $t+j$ size portfolios in reference to the respective CAPM projected returns on the traditional size portfolios. The "traditional" size portfolio means that firms are sorted and assigned to different size portfolios according to their June market capitalization, and the portfolios are held from July of the same year to June next year. The definition of the average size premium of a $t+j$ size portfolio is

$$\begin{aligned} SP_{i,t}^{t+j} &= R_{i,t}^{t+j} - \left(R_{f,t} + \beta_i(R_{m,t} - R_{f,t})\right), \text{ and} \\ SP_{i}^{t+j} &= \frac{1}{T}\sum_{t=1}^{T} SP_{i,t}^{t+j}, \end{aligned} \tag{9}$$

where $R_{i,t}^{t+j}$ represents the time t return on the $t+j$ portfolio of firms in the ith size group, and β_i is the same as in equation (1).

[Insert Table 4 here.]

The first decile size portfolio, which contains firms with the lowest market capitalizations among all listed firms on the sorting date, usually has a large and significant CAPM alpha and a beta too low to project the realized return. Table 1 shows that portfolio 1 has a size premium of 3.39% per annum with the sample period from July 1926 to December 2008. The corresponding number in Table 4 is the average size premium of the $t+1$ portfolio for portfolio 1. Although the benchmark is still calculated with the same beta, it drops to 1.49% because the sample period here does not start until July 1940. The difference reflects a large historical size premium for the

[13] The security return data on CRSP tape start from December 1925, so June 1926 becomes the first available sorting date.

small firms from 1926 to 1940. The premiums change a lot with different sample periods, but the pattern is nevertheless revealing. The smallest firms still get a bigger size premium, while the biggest firms even get a size discount.

If firms are supposed to be awarded a fixed size premium for years, we should see the numbers in Table 4 remain stable over different $t+j$ portfolios within each size group. The result is apparently contrary to this hypothesis. The size premium of portfolio 1 drops dramatically two years after the initial sorting date and becomes insignificantly different from zero in the third year. After that the small firms get a discount and such a discount gradually becomes significantly different from zero. On the other hand, portfolio 10 sees its size premium going up from the negative value in the first two years to a positive but insignificant number for the most part of the following eight years. Most of the size portfolios have a declining size premium after the sorting date except for portfolio 10, which reflects the fact that returns on different size portfolios tend to converge to the same number over years. Table 5 shows that the difference in average returns on different size portfolios gradually becomes insignificant as sorting dates pass by.

[Insert Table 5 here.]

If history can be any guide to the future performance, we are likely to overestimate the cost of equity capital of small firms and under-estimate the cost of equity of big firms by the current treatment of the size premium.

3.3 Robustness Check

We have seen in Table 1 that the historical averages of both the size premium and the small stock premium are sensitive to the choice of the sample period, but the pattern remains unchanged if given a long enough horizon. Here I will verify that the findings in this section are not sensitive to different breakpoints of size groups.

Fama and French (2007) divide firms into two groups in terms of size to explain the cause of the Fama-French SMB factor, so I also divide all the acting firms into two groups according to the NYSE median market-cap breakpoint in each June.

For better examining the relation between firm size and the corresponding return performance, I also rank firms according to their size each June and form three portfolios with firms of their size in the bottom 30%, middle 40%, and top 30% (S-30%, M-40% and B-30% hereafter) by the NYSE market-cap breakpoints.

The size premiums calculated with new breakpoints are displayed in Table 6. The big size portfolios (Big or B-30%) all have very small and insignificant size premiums like the size premium of portfolio 10 reported in Table 4. Please be noted that I still use the traditional size portfolio approach (it is equivalent to the t+1 portfolio here) with the new breakpoints and the sample period from 1926 to 2008 to estimate CAPM betas. The size premiums of "Small" and "S-30%" size portfolios are significant through t+1 to t+4 or t+5 portfolios, respectively, and they are also declining as j goes up. Ten or seven years after the initial sorting dates, these two small size portfolios even have a discount. These characteristics are all consistent with the pattern shown in portfolio 1 in Table 4.

[Insert Table 6 here.]

Comparing Table 6 to Table 4, it is apparent that the size premium for small stocks in the traditional sense does exist no matter how many size groups the stocks are divided into, but it fades out gradually if the same composition of firms is held longer than a year.[14]

If a group of firms have the same stream of expected future cash flows, it is possible that the firm with a higher risk is going to be priced lower. Such a firm may end up having a higher return because it is more likely to have a higher dividend yield. However, small firms do not only gather higher returns through higher dividend yields, they usually have higher capital appreciation rates too. Fama and French (2007) explain that migration of stocks across size groups is the cause of the small stock premium.[15] Once a small firm's market capitalization increases and it is qualified as a big firm, a size premium should not apply anymore. According to Table 4 and 6, small firms did have higher size premiums when they were first assigned to the small size portfolio, but this effect does not persist. A firm which belongs to portfolio 1 sees its size premium turns into a discount after a few years if it is still expected to be compensated as a small stock. It is probably reasonable for a small firm to get a larger discount factor than the CAPM suggests because it bears higher risks than the model can explain for the time being, but the usual practice could very likely over-compensate the risks a small firm is bearing.

If the size effect has to be considered in the cost-of-equity estimation, we should search for the root of this short-lived premium and identify the risk source it represents. This is just as important as how much it is, if not more important.

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[14]The small stock premium fades away until it is barely noticeable. However, the size premium for small stocks sometimes becomes a size discount if the same composition of stocks is held for a few years.

[15]In their article Fama and French use "size premium" to refer to the fact that small-cap firms have higher returns than big-cap firms without risk adjustment, which is equivalent to the "small stock premium" used in this paper. As shown earlier that these two premiums are related.

4 Size Premium under Different Economic Situations

Section 3 shows that a small firm can have a higher size premium only in the short run. Over a longer time span, a firm's size and even its sensitivity to risk are all subject to change, and its size premium changes accordingly.[16] In light of these results, I propose not to include a fixed size premium in the long-term cost-of-equity estimation. However, the size premium, no matter how short-lived it is, still appears to exist in the first few years for small firms. Take the popular discounted cash flow method as an example, the first few years matter the most if given a steady stream of future cash flows. By excluding the size premium from the cost-of-equity estimation, one might argue that we are also likely to understate the risk a small firm is taking.

The simplest way to resolve this conundrum seems to apply a time-varying cost of equity by adding different size premiums to the estimation according to the results in Table 4. The short-term size effect is thus accounted for, and the long-term size premium is also no longer permanent. However, Table 4 only displays the standard deviation of the average of the size premium, the variation of the annual size premium per se is much larger. If the size premium swings between high and low levels like the two-regime small stock premium model shown in section 2.3, adding an average size premium into the short-term cost-of-equity estimation may not help the matter. We could easily over-estimate the cost of equity of small firms in one period and suppress their value, while under-estimate the cost of equity in another period

[16]CAPM betas of all size groups are monotonically decreasing from t+1 through t+15 portfolios. These results are not shown in the tables, but they are available upon request. In this paper I use the traditional size portfolios with the full sample (July 1926 to December 2008) to estimate CAPM betas to get a consistent benchmark in all cases but ones in Table 1.

and bring the price to an un-deserving high level. In this section I will examine the likelihood of this scenario.

The concept of connecting financial distress to firm size has been discussed in the asset pricing literature to explain the anomalous cross-sectional pattern of stock returns. Queen and Roll (1987) find that a firm's unfavorable mortality rate is a decreasing function of its size, and Campbell, Hilscher, and Szilagyi (2008) further show that size has a negative relation with the excess return between safe and distress stocks. I will examine from a different angle to see whether economic distress has an effect on the size premiums.

I divide the sample period into several two-regime scenarios according to different macroeconomic variables related to distress and calculate the size effect under each regime. There are two reasons for this experiment: the first is that only the systematic risk should be taken into account when pricing a firm or an asset. If small firms are supposed to be awarded a higher premium sheerly because of their failure risk, then we should be able to distinguish different patterns of their size premium under different economic situations. Second, in light of the success of a simple Markov-switching model used on the small stock premium in section 2, it is natural to try a two-regime model on the size premium as well. However, the estimation of the size premium is highly contingent on the choice of the asset pricing model and the sample period, so I do not investigate the possible regime shifts of the size premium directly. Instead, I will try to explore the relation between the size premium and three different candidates of macroeconomic variables. If the size premium is at least partly driven by systematic risk sources, its magnitude should vary as the economic environment changes.

4.1 Identifying the States of Economy

The first state variable is an indicator variable which identifies the economic status during a business cycle: a dummy variable which equals 1 for months in the expansion period and 0 for months in the contraction period.[17] When in distress, smaller firms usually get hit harder because they have thinner cushion in common equity and their ability to raise capital via new debts, bank loans, or even government bailouts is also poorer than big firms. On the other hand, small firms which survive the storm can often see a sudden boom in their stock returns, as were evidenced by their bigger beta.[18] Whether the bigger volatility in the stock return for the small stock portfolio can translate to separate size premiums is the focus of the investigation. According to NBER's Business Cycle Dating Committee, there are 14 business cycles since 1926 to date with the shortest contraction period being 6 months and the shortest expansion period being 24 months.

The second indicator is the market trend, which is similar to the idea of the business cycle. I distinguish the bull and bear markets by a Markov-switching model on the CRSP value-weighted market portfolio return with the similar procedure laid

[17] NBER's Business Cycle Dating Committee publishes the U.S. business cycle peak and trough months on the NBER website. Their latest announcement on 12/01/2008 declares that the previous expansion period peaked in December 2007 and a recession soon followed. The conclusion of the current recession has not yet been determined as the writing of this paper. I assume all of year 2008 fell into the contraction period to make the sample period consistent with other state variables.

[18] Fama and French (1993) point out that small firms do not participate in the economic boom of the middle and late 1980s for an unknown reason. This finding is consistent with the argument of the disappearance of the size effect in the 1980s and 1990s. Indeed, the small stock premium was -10.4% per annum from December 1982 to July 1990, the expansion period right after the longest recession since the Great Depression. However, small firms greatly outperform big firms during the economic booms after the Great Depression or the recession caused by 1973 oil crisis, with average small stock premiums at 55.9% and 23.1%, respectively. It is probably premature to judge the experience in the 1980s as a new norm or just an anomaly. Nonetheless, the magnitude of SMB during the expansion periods in the middle 1930s and the late 1980s could counter the argument raised by Fama and French (1993).

out in section 2.3.[19] Regime 1 represents the state of the bear market with a lower mean return and higher volatility; regime 2 indicates the bull market with a higher mean return and lower volatility. An indicator variable is used to represent the bull market with its value being equal to 1 when the regime 2 smoothed inference of the month is greater than 0.5, and 0 otherwise. The reason to use a dummy to identify the market trend instead of the realized market return is to filter out noise. When we apply the size premium on the cost of equity capital estimation, we look for the long-term performance instead of the short-term disturbance. Looking too much into the day-to-day or month-to-month performance will mix up true trend and noise. For instance, even during the huge market downturn in the Great Depression, when the Dow Jones Industrial Average (DJIA) dropped from then historical high of 381.17 on 9/3/1929 to the following lowest point of 41.22 on 7/8/1932, we can still see the market posted double digit gains on return during the process. In February and June 1931, the monthly returns derived from the DJIA were 12.40% and 16.90%, respectively. These were great rallies even in any bull market, but they still cannot stop the free fall of the stock market and the investment environment would not be changed simply because of a sudden spark of life. Since the cost of equity capital and the size premium are all about the long term prospect of the firm, it is more fitting to examine the general market trend in this simple fashion.

The third indicator is the credit spread between AAA and BAA corporate bond rates. The data are obtained from the Federal Reserve Bank of St. Louis website. Although we cannot link a firm's size directly to its credit rating, large firms usually get better ratings and lower borrowing rates.[20] When there is abundant credit

[19]There is no consensus on the definition of bear or bull markets other than a general description. Here I adopt the market trend definition of the model 1 in Chen (2009).

[20]According to the summary statistics provided by Altman and Rijken (2004), firm's credit rating is negatively related to the market value of equity. I also compare the average market values between

floating in the market, the credit spread tends to narrow down because banks and funds compete against each other for an investment opportunity without thinking too much about the risk. This process will eventually drive the spread down. On the other hand, the credit spread increases when the credit market is in a dire condition and investors take default risks more seriously. Every banker will think twice before lending money out. When the credit spread is high, it is more likely that small firms endure a higher borrowing cost than big firms, therefore their failure risk induced by the poorer credit rating is also higher. I continue to apply the same technique previously used in the market trend indicator to separate the credit spreads into two different states, and then convert the smoothed inference into a dummy variable using the 0.50 threshold.

The transition probabilities of staying in the same state for the Markov-switching model of the market trend are 0.892 (bear market) and 0.963 (bull market); they are 0.987 (low credit spread) and 0.974 (high credit spread) for the credit spread. The common feature of these macroeconomic variables is that the states defined by them are all very persistent, so we can link these variables with the shift of the size premium over a longer span instead of the month-by-month movement. Once the state variable of the market trend shifts to the bull market state, it would stay put for 27 months on average, and a credit spread dummy remains in the state of a lower mean value for 78 months.

[Insert Figure 2 here.]

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firms with investment grade ratings and with non-investment grade ratings over the past 15 years. The average size of firms with better credit is 9 to 10 times bigger than the size of poorer rating firms. The sample includes all firms in the Compustat database from 1994 to 2008.

Figure 2 illustrates three different dummy variables on the right-hand side and their original data on the left.[21] It has to be noted that these state variables are all asymmetrical. We see expansion periods more often than contraction periods, longer bull markets than bear markets, and more days with low credit spreads than days with high ones. Over the total 822 observations, there are 698 months identified as in the expansion period, 646 months in the bull market, and 552 months in the low credit spread regime.

4.2 The Size Premium under Different Economic Environments

These state variables do not highly coincide with each other, but they are all capable of separating the size premium of small stocks under different states. I also use the $t+j$ portfolio approach to see whether these states can identify the size effect of stocks over the long run. Table 7 and 8 present the size premiums of the first and the 10th size portfolios under different economic situations.

[Insert Table 7 here.]

[Insert Table 8 here.]

The first column of Table 7 or 8 shows the same average size premiums as the corresponding column in Table 4. Through the second column to the last, the average size premiums under different states of the same macroeconomic variable are paired with each other. The second and third columns are the average size premiums in the expansion or contraction state identified by the business cycle dummy; the fourth and fifth columns show the averages during bull or bear markets from the market

[21] I use the GDP growth rate for the business cycle dummy as its “original data". However, it is well known that the Business Cycle Dating Committee of the NBER does not determine the peaks and troughs by the GDP data alone.

trend dummy; and the last two columns are average size premiums in the high or low state of the credit spread dummy.

The last row of each table shows the number of observations in a specific state. These three dummy variables post asymmetric states as earlier mentioned, but the credit spread dummy is significantly different from the others because the state brings the higher average returns has a lot less observations than the state brings the higher return for the other two dummy variables.[22]

Small stocks usually have a high and significant size premium, and this premium is even more pronounced in the expansion period or the high credit spread period, and interestingly, during the bear market. Portfolio 1 has a positive premium for most of the $t+j$ portfolios during the market downturn because the market trend dummy successfully identifies the low return period of the market, which in turn drives the benchmark even lower than the drop of the realized return on small stocks. The time series dynamics of the size premium revealed by the $t+j$ portfolio approach present a different scenario for the business cycle dummy. It is indecisive whether a small firm has a greater size premium during the expansion or contraction period.

Table 8 displays the size premium, or more precisely, the size discount of portfolio 10. Large firms usually can be explained well by the CAPM or other asset pricing models, so the common practice does not require a size premium on them. Even under different states, the size premiums are still small in magnitude comparing to the corresponding statistics of portfolio 1. If we focus on the first few $t+j$ portfolios, the business cycle does not seem to play an important role. The average size premi-

[22] The state generates the higher average return does not necessarily have the higher size premium. The latter also depends on the sensitivity to the market risk and the market return under this "unfavorable" state.

ums under different regimes of the market trends or credit spreads are much more different, but they are still not as pronounced as their counterparts in portfolio 1.

A one-sided t test on unequal sized variables is also applied here to compare the difference between average size premiums under different economic states. The size premiums in Table 7 and 8 are shown in **boldface fonts** if the difference is significant at the 10 percent level. We cannot reject the null hypothesis that none of the size premium pairs of portfolio 1 or 10 are significantly different during different periods of business cycles. The same test for different market trends shows the similar result for the first nine years for portfolio 1 and the first two years for portfolio 10. The state variable derived from the credit spread data is the most successful of all. The difference of the average size premiums of $t+j$ portfolios is significant at 10 percent level for most of the cases for portfolio 1, and it is also significant for the first 6 years for portfolio 10.

The size premium a small firm should demand for bearing higher risks is limited only in the first few years and its magnitude is difficult to predict. The empirical results imply that we should be very careful to identify the risks a firm is bearing instead of taking it only by the firm's current size. If there are other systematic risks which is related to size, we should reconsider whether that is the cause of a firm being riskier than the others and assign the specific risk premium to it accordingly.

5 Conclusion

This study verifies the existence of the size effect of annually rebalanced size portfolios with a longer sample period, but suggests not to include the size premium in the cost-of-equity estimation of small firms because this effect is only short-lived.

The assertion of the disappearance of the size effect in the 1980s and 90s was just a result of sample selection. Similar events of temporary disappearance of the size effect from different periods were found but they have never been proved permanent. Suffice it to say that the size effect did not simply disappear because it was revealed by academics and exploited by practitioners. It is shown in section 2 that the small stock premium can be better captured by a two-state Markov-switching model rather than the usual stationary normal distribution assumption. This empirical evidence is consistent with the story of the temporary disappearance of the size effect in the 1980s and 1990s.

Using the $t+j$ portfolio approach designed for this study, I demonstrate that the small stock premium declines if we hold the size portfolio longer than the usual one-year holding period rule. This can be considered as evidence of Fama and French (2007)'s finding that the size premium stems from small firms moving up the size rank to become big firms. Since firms move between size groups, the size premium should not be considered as a constant and it has to reflect the new size group they are currently in. The popular perception of a fixed size premium used by practitioners in the cost-of-equity estimation is obviously mistaken. I track the size premiums of different size portfolios for the subsequent 15 years after their formation date and find that most of the premiums converge toward zero, so firms should not be awarded a size premium for a long-term estimation.

If the size premium of a firm is estimated with the assumption that a firm moves from one size group to another all the time, it should be time-varying as well. The average size premium of portfolio 1, which includes all NYSE, NASDAQ and AMEX firms with market capitalization less than the first decile market-cap breakpoint of all NYSE listed firms, is 1.49% for the first year after its creation for the past 68 years. The same composition of firms still merit an average of 1.02% premium in the following year, but it declines rapidly after that. Adding a fixed size premium according to a firm's current size could very well overstate the relation between a firm's size and the risk it is bearing.

Certain macroeconomic variables can help us to distinguish the possible regimes of the size premium. These variables include the business cycle, the market trend, and the credit spread. However, the decision to distinguish the size premium of a firm under the assumption of one specific state is very difficult to make given how highly volatile the monthly size premium is. Adding a naive size premium to a firm's cost of equity capital estimation still potentially introduces more errors no matter this size premium is fixed or time-varying.

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Figure 1: The return difference between the first and the 10th decile size portfolios and the smoothed probability of the high small stock premium regime. Panel A shows the annual portfolio return difference between small and big stocks. It is apparent that big firms outperform small firms most of the time from the mid-1980s to late 1990s. This account for the “disappearance" of the size effect in that time span. Similar situation also happened in the 1950s and late 1960s to early 1970s. The smoothed inference of the high SMB regime is shown in Panel B.

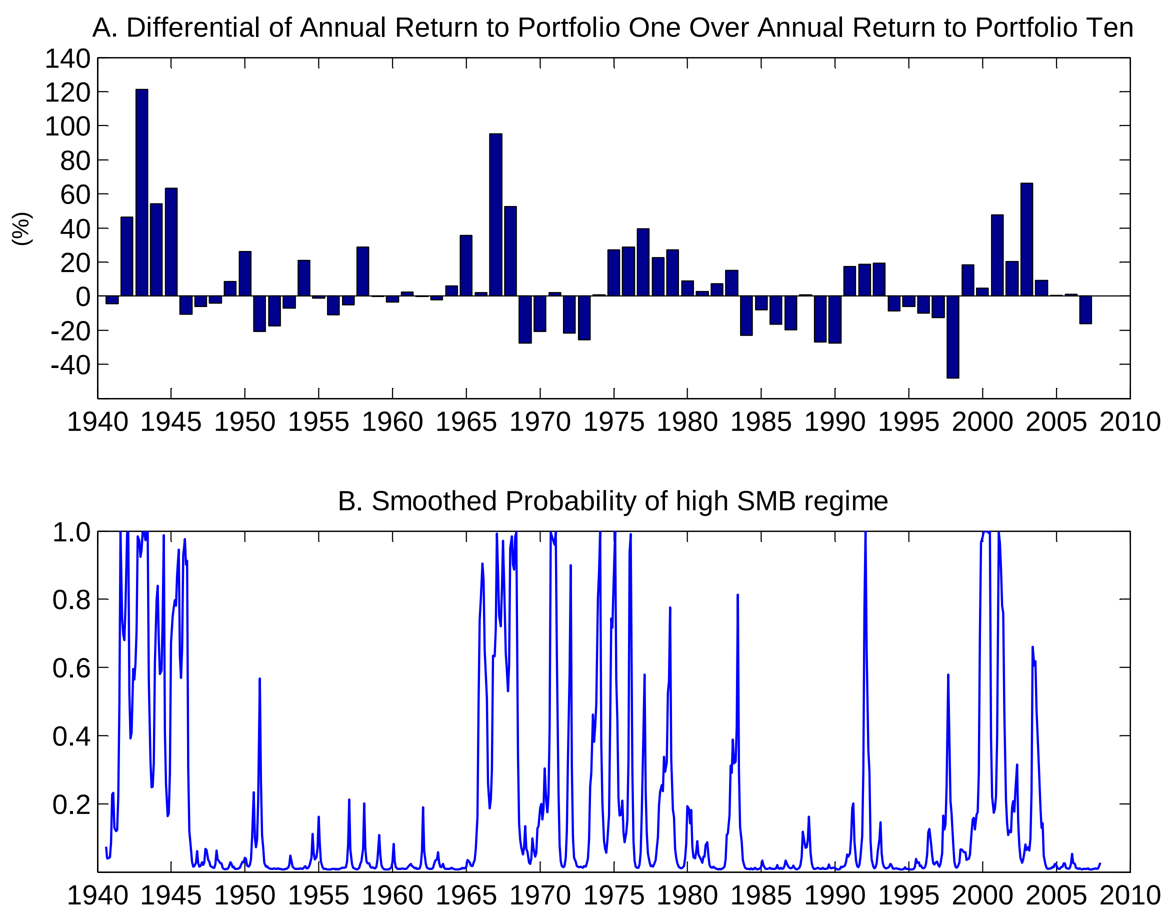

Figure 2: Three different dummy variables indicates three different economic environments. The first row includes the GDP growth rate of the U.S. and the business cycle dummy. The second row presents the CRSP monthly return and the market trend dummy variable derived from the smoothed probability of the bull market regime. The third row contains the credit spread and the high credit spread dummy also generated from the smoothed inference of a two-state Markov-switching model.

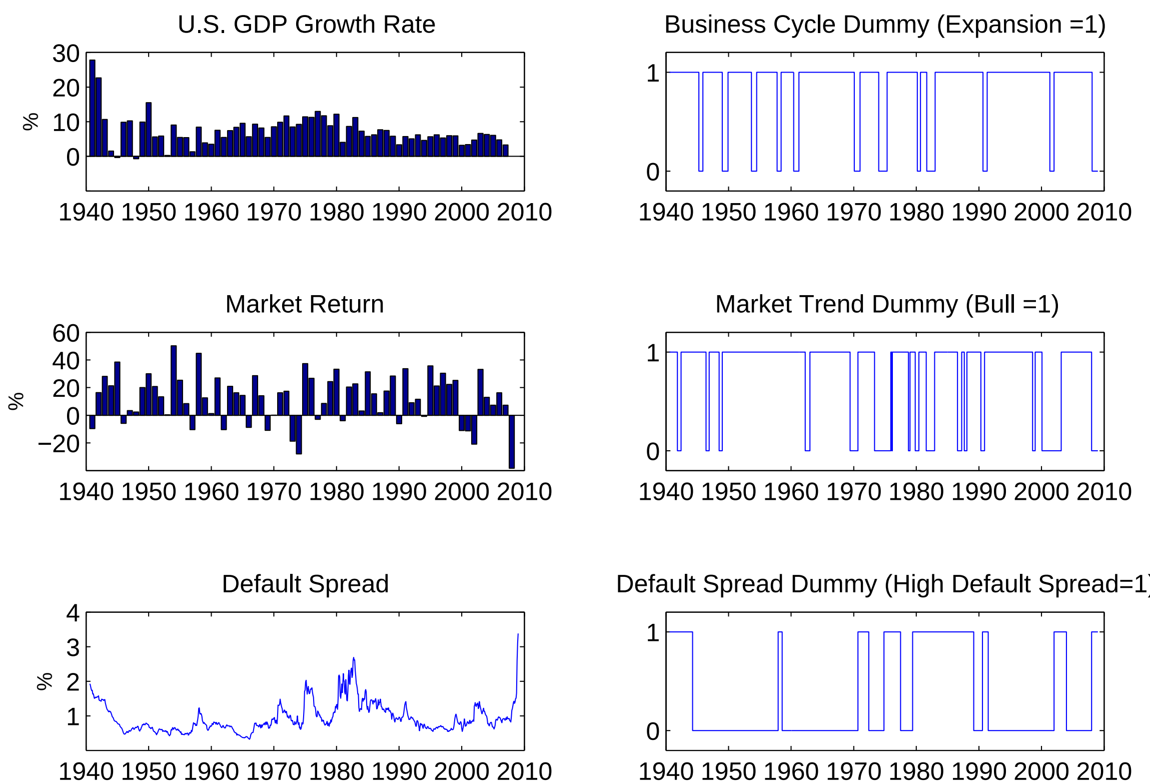

Table 1: **Returns on Size Portfolios and Size Premiums in Reference to CAPM**

Panel A. Full Sample (1926.7 to 2008.12)

	1 (Small)	2	3	4	5	6	7	8	9	10 (Big)
Mean Return	17.36	14.79	14.52	14.37	13.68	13.22	12.75	12.16	11.66	10.14
Standard Dev.	35.46	30.86	28.39	26.58	25.08	23.68	22.77	21.82	20.24	17.80
β	1.46	1.40	1.34	1.27	1.25	1.20	1.16	1.13	1.05	0.93
Size Premium	3.39	1.21	1.37	1.70	1.21	1.08	0.85	0.53	0.54	-0.10

Panel B. 1926.7 to 1980.6

	1 (Small)	2	3	4	5	6	7	8	9	10 (Big)
Mean Return	20.44	16.19	15.61	15.23	14.14	13.84	12.58	12.22	11.45	9.70
Standard Deviation	41.17	34.89	31.96	29.55	27.82	26.30	25.13	23.80	22.12	19.04
CAPM β	1.60	1.48	1.41	1.32	1.29	1.24	1.19	1.14	1.07	0.93
Size Premium	5.14	1.79	1.80	2.11	1.30	1.38	0.50	0.54	0.33	-0.29

Panel C. 1980.7 to 1998.6

	1 (Small)	2	3	4	5	6	7	8	9	10 (Big)
Mean Return	12.93	14.50	15.96	16.52	17.23	16.96	17.16	15.94	16.84	17.40
Standard Dev.	17.63	17.89	17.77	17.66	17.16	16.24	16.09	15.58	15.32	14.32
β	0.95	1.07	1.10	1.10	1.09	1.05	1.08	1.04	1.04	0.96
Size Premium	-2.99	-2.61	-1.40	-0.90	-0.08	0.01	-0.03	-0.93	0.01	1.31

Panel D. 1998.7 to 2008.12

	1 (Small)	2	3	4	5	6	7	8	9	10 (Big)
Mean Return	9.14	8.05	6.48	6.26	5.23	3.61	6.03	5.36	3.87	-0.03
Standard Dev.	25.11	26.08	23.24	22.94	21.33	19.83	19.57	20.24	17.13	16.10
β	1.06	1.21	1.15	1.13	1.13	1.08	1.08	1.14	0.98	0.92
Size Premium	7.47	6.59	4.95	4.68	3.66	1.97	4.38	3.80	2.07	-1.92

All securities in NYSE, AMEX and NASDAQ are sorted at the end of June of each year t and are assigned to ten different size portfolios according to NYSE breakpoints. The size portfolios are constructed with securities in each size group with their respective market cap as weights and are held from July of year t through June of year $t+1$.

β's are estimated with regression of monthly portfolio returns in excess of the Ibbotson Associates risk free rate on the CRSP value-weighted market returns in excess of the same risk free rate.

The size premium is calculated by subtracting the product of the CAPM beta and the equity premium from the size portfolio returns in excess of the risk free rate. All the equity risk premiums in different panels are estimated from their respective sample periods.

Returns, standard deviations and size premiums are all annualized and in percentage points.

Table 2: **Prices of Fama-French Risk Factors**

	1926.7-2007.12	1926.7-1980.6	1980.7-1998.6	1998.7-2007.12
$R_m - R_f$	0.64 (0.17)	0.70 (0.23)	0.84 (0.29)	-0.04 (0.44)
SMB	0.24 (0.11)	0.29 (0.14)	-0.04 (0.17)	0.47 (0.37)
HML	0.38 (0.12)	0.41 (0.15)	0.41 (0.18)	0.24 (0.35)

I calculate the price of risk of the Fama-French (1993) three factors with Fama and MacBeth (1973)'s two-pass regression approach. These data are retrieved from Professor French's website at Dartmouth. Test portfolios are obtained from 25 portfolios formed on size and book-to-market equity and 17 industry portfolios. Since there exist missing values in one of the 25 size/BM portfolio, it is taken out of the portfolio set. The returns on the remaining 41 test portfolios are named as R_{it}, $i = 1,2,\ldots,N, N = 41$.
First we find beta estimates from the time-series regressions,

$$R^e_{it} = \alpha_i + \beta_i R^e_{mt} + s_i SMB_t + h_i HML_t + \varepsilon_{it} \qquad t = 1,2,\ldots,T, \forall i.$$

where $R^e_{it} = R_{it} - R_{ft}$ and $R^e_{mt} = R_{mt} - R_{ft}$.
Then estimate the factor risk premiums λ from a cross-sectional regression,

$$E_T(R^e_i) = \beta_i \lambda_1 + s_i \lambda_2 + h_i \lambda_3 + \alpha_i, \qquad i = 1,2,\ldots,N.$$

Since the pricing errors α_i are likely to be correlated, we follow Cochrane (2005)'s suggestion to run a GLS cross-sectional regression and the estimations of the price of risk are

$$\begin{aligned} \hat{\lambda} &= (\beta\Sigma^{-1}\beta)^{-1}\beta\Sigma^{-1}E_T(R^e), \text{and} \\ \sigma^2(\hat{\lambda}) &= \frac{1}{T}\left[(\beta\Sigma_f^{-1}\beta)^{-1} + \Sigma_f\right] \end{aligned}$$

where β is an N-by-3 matrix with $[\beta_i \ s_i \ h_i]$ in each row, $\lambda = [\lambda_1 \ \lambda_2 \ \lambda_3]$, f is a T-by-3 matrix of the risk factors, R^e_{mt}, SMB, HML.
The sample period is broken down like in Table 1. The parameter estimates in each subperiod use only observations from that subperiod. Standard deviations of λ estimates are reported in parentheses.
The insignificance of parameters in the subperiod from July 1996 to December 2007 probably results from sample selection and short sample period. The most interesting finding is on λ_2, the price of the risk factor SMB. During the sample period from July 1980 to June 1996, the price of this factor is not only insignificant but also much smaller in its value.

Table 3: **Regime Switching Model of the return difference between the 1st and 10th decile Size Portfolios**

	Regime Switching Model			Unconditional Normal Dist	
	Parameter	Standard Deviation		Parameter	Standard Deviation
μ_1	-0.002436	0.00189	μ	0.004590	0.001825
μ_2	0.036465	0.01184			
σ_1^2	0.001263	0.00013	σ^2	0.052284	0.000136
σ_2^2	0.008167	0.00179			
p	0.9579	0.01991			
q	0.8090	0.11592			
Log-Likelihood Value	1367.73901			1257.87773	
AIC	-2723.47802			-2511.75546	
BIC	-2695.20758			-2502.33198	

Table 4: **Size Premium of *t+j* Decile Size Portfolio**

	Small	2	3	4	5	6	7	8	9	Big
t+1	1.49	0.57	0.94	1.26	0.87	0.48	1.02	0.48	0.50	-0.19
	(0.56)	(0.42)	(0.34)	(0.31)	(0.26)	(0.22)	(0.18)	(0.16)	(0.12)	(0.11)
t+2	1.02	1.70	1.63	1.50	1.16	0.53	0.36	0.84	0.36	-0.14
	(0.52)	(0.40)	(0.33)	(0.29)	(0.25)	(0.21)	(0.18)	(0.15)	(0.13)	(0.11)
t+3	-0.67	1.33	1.51	0.77	1.46	0.47	0.34	0.52	0.17	0.03
	(0.48)	(0.39)	(0.32)	(0.29)	(0.25)	(0.22)	(0.18)	(0.15)	(0.13)	(0.12)
t+4	-1.60	1.96	0.79	1.69	0.82	-0.04	0.59	0.37	0.40	0.10
	(0.45)	(0.37)	(0.32)	(0.29)	(0.25)	(0.22)	(0.18)	(0.16)	(0.12)	(0.12)
t+5	-0.83	1.42	1.26	0.58	-0.44	0.73	0.88	0.53	0.27	0.10
	(0.44)	(0.37)	(0.31)	(0.27)	(0.24)	(0.20)	(0.19)	(0.15)	(0.12)	(0.12)
t+6	-0.18	0.43	0.91	0.38	0.29	0.90	0.49	0.77	0.18	0.14
	(0.44)	(0.36)	(0.30)	(0.27)	(0.23)	(0.21)	(0.19)	(0.14)	(0.13)	(0.12)
t+7	-1.57	0.51	0.43	0.27	0.66	0.89	-0.78	0.12	0.50	0.29
	(0.43)	(0.35)	(0.30)	(0.26)	(0.24)	(0.21)	(0.17)	(0.15)	(0.14)	(0.12)
t+8	-1.31	-0.54	0.86	0.99	0.19	0.12	0.34	0.27	0.64	0.11
	(0.42)	(0.33)	(0.30)	(0.25)	(0.23)	(0.20)	(0.18)	(0.14)	(0.13)	(0.13)
t+9	-1.38	-0.46	0.43	-0.02	0.98	0.01	1.27	-0.42	0.47	0.16
	(0.39)	(0.32)	(0.30)	(0.26)	(0.24)	(0.21)	(0.20)	(0.17)	(0.14)	(0.13)
t+10	-1.61	-0.72	-0.65	1.22	-0.08	0.33	-1.02	-0.26	0.76	0.20
	(0.38)	(0.31)	(0.30)	(0.25)	(0.23)	(0.21)	(0.20)	(0.19)	(0.13)	(0.14)
t+11	-1.30	-0.62	-0.76	0.05	0.12	0.18	-0.36	0.56	-0.12	0.31
	(0.39)	(0.31)	(0.28)	(0.26)	(0.24)	(0.20)	(0.21)	(0.17)	(0.13)	(0.14)
t+12	-1.62	-1.60	-0.83	1.11	0.12	0.37	0.14	-0.21	-0.17	0.33
	(0.39)	(0.30)	(0.30)	(0.26)	(0.23)	(0.21)	(0.20)	(0.16)	(0.14)	(0.14)
t+13	-1.40	-2.30	-0.20	0.72	0.36	-0.04	-0.62	-0.51	-0.26	0.35
	(0.38)	(0.31)	(0.30)	(0.26)	(0.25)	(0.21)	(0.19)	(0.18)	(0.15)	(0.14)
t+14	-2.64	-1.08	-1.22	0.90	-0.45	-1.08	-0.91	-0.84	-0.26	0.42
	(0.38)	(0.31)	(0.31)	(0.27)	(0.25)	(0.22)	(0.21)	(0.19)	(0.15)	(0.15)
t+15	-3.14	-0.86	-1.50	-0.01	-1.02	-1.29	-0.83	-0.81	-1.21	0.68
	(0.39)	(0.31)	(0.30)	(0.26)	(0.24)	(0.24)	(0.23)	(0.20)	(0.16)	(0.15)

Standard deviations of mean returns (or return differential in the last column) are in the parentheses.

CAPM betas used in this table are estimated with full sample period (July 1926 to December 2008) instead of the trimmed sample period (July 1940 to December 2008) for the $t+j$ portfolios. The size premium of the $t+1$ portfolios here and the size premium of the Panel A of Table 1 should be the same if given the same length of sample.

Table 5: **Average Returns on *t+j* Decile Size Portfolio and Decile 1- Decile 10 Return Difference**

	Small	2	3	4	5	6	7	8	9	Big	1-10
t+1	16.17	14.85	14.78	14.61	14.02	13.29	13.58	12.76	12.27	10.68	5.49
	(0.81)	(0.74)	(0.69)	(0.67)	(0.63)	(0.60)	(0.59)	(0.57)	(0.53)	(0.49)	(0.63)
t+2	15.71	15.98	15.47	14.84	14.30	13.33	12.92	13.13	12.13	10.73	4.97
	(0.80)	(0.74)	(0.69)	(0.67)	(0.63)	(0.60)	(0.60)	(0.57)	(0.54)	(0.48)	(0.60)
t+3	14.01	15.61	15.35	14.12	14.61	13.27	12.89	12.81	11.94	10.90	3.12
	(0.79)	(0.75)	(0.69)	(0.66)	(0.63)	(0.62)	(0.59)	(0.57)	(0.53)	(0.48)	(0.58)
t+4	13.08	16.23	14.64	15.03	13.97	12.77	13.14	12.66	12.17	10.97	2.12
	(0.78)	(0.73)	(0.69)	(0.66)	(0.65)	(0.61)	(0.59)	(0.55)	(0.53)	(0.48)	(0.56)
t+5	13.85	15.69	15.10	13.93	12.71	13.53	13.43	12.81	12.04	10.97	2.88
	(0.78)	(0.73)	(0.70)	(0.66)	(0.64)	(0.60)	(0.58)	(0.56)	(0.53)	(0.47)	(0.55)
t+6	14.50	14.71	14.76	13.72	13.44	13.71	13.04	13.06	11.95	11.01	3.49
	(0.78)	(0.74)	(0.69)	(0.65)	(0.62)	(0.60)	(0.59)	(0.56)	(0.53)	(0.47)	(0.55)
t+7	13.12	14.79	14.27	13.61	13.80	13.70	11.77	12.41	12.27	11.15	1.96
	(0.79)	(0.73)	(0.68)	(0.63)	(0.63)	(0.60)	(0.59)	(0.56)	(0.53)	(0.47)	(0.56)
t+8	13.38	13.73	14.70	14.34	13.34	12.92	12.89	12.55	12.41	10.98	2.40
	(0.78)	(0.72)	(0.68)	(0.64)	(0.63)	(0.61)	(0.58)	(0.55)	(0.52)	(0.47)	(0.55)
t+9	13.30	13.82	14.27	13.33	14.13	12.82	13.82	11.86	12.24	11.03	2.27
	(0.76)	(0.70)	(0.69)	(0.64)	(0.63)	(0.60)	(0.59)	(0.55)	(0.53)	(0.46)	(0.51)
t+10	13.08	13.56	13.20	14.57	13.07	13.13	11.54	12.03	12.53	11.07	2.00
	(0.75)	(0.69)	(0.69)	(0.64)	(0.63)	(0.59)	(0.59)	(0.55)	(0.53)	(0.46)	(0.50)
t+11	13.38	13.65	13.09	13.40	13.27	12.99	12.19	12.85	11.65	11.18	2.20
	(0.74)	(0.70)	(0.68)	(0.63)	(0.63)	(0.58)	(0.58)	(0.54)	(0.53)	(0.46)	(0.49)
t+12	13.06	12.68	13.02	14.46	13.27	13.18	12.69	12.08	11.60	11.20	1.87
	(0.74)	(0.68)	(0.69)	(0.63)	(0.63)	(0.59)	(0.56)	(0.55)	(0.53)	(0.46)	(0.50)
t+13	13.28	11.97	13.65	14.07	13.51	12.77	11.93	11.78	11.51	11.21	2.07
	(0.74)	(0.68)	(0.69)	(0.62)	(0.61)	(0.59)	(0.58)	(0.54)	(0.53)	(0.46)	(0.49)
t+14	12.04	13.19	12.62	14.25	12.70	11.72	11.65	11.45	11.51	11.28	0.76
	(0.73)	(0.67)	(0.67)	(0.62)	(0.62)	(0.59)	(0.59)	(0.55)	(0.52)	(0.46)	(0.48)
t+15	11.54	13.42	12.34	13.34	12.12	11.52	11.72	11.48	10.56	11.55	-0.01
	(0.74)	(0.66)	(0.66)	(0.63)	(0.60)	(0.59)	(0.58)	(0.53)	(0.52)	(0.46)	(0.50)

Standard deviations of mean returns (or return differential in the last column) are in the parentheses.

Table 6: **Robustness Check: Size Premium of Different Size Portfolios in Reference to CAPM Projected Return**

	Small	Big	S-30%	M-40%	B-30%
t+1	0.96 (0.32)	0.02 (0.05)	0.91 (0.40)	0.91 (0.21)	-0.05 (0.06)
t+2	1.51 (0.31)	0.05 (0.05)	1.60 (0.38)	0.77 (0.20)	0.02 (0.07)
t+3	1.09 (0.30)	0.11 (0.06)	0.94 (0.36)	0.70 (0.19)	0.08 (0.08)
t+4	0.99 (0.28)	0.14 (0.07)	0.72 (0.35)	0.65 (0.18)	0.13 (0.08)
t+5	0.44 (0.26)	0.20 (0.07)	0.95 (0.34)	0.46 (0.17)	0.15 (0.08)
t+6	0.30 (0.25)	0.23 (0.07)	0.49 (0.32)	0.52 (0.17)	0.21 (0.09)
t+7	0.03 (0.24)	0.24 (0.07)	-0.10 (0.30)	0.07 (0.17)	0.28 (0.09)
t+8	0.17 (0.23)	0.20 (0.08)	-0.25 (0.30)	0.37 (0.16)	0.19 (0.09)
t+9	0.10 (0.23)	0.21 (0.09)	-0.31 (0.29)	0.52 (0.16)	0.15 (0.10)
t+10	-0.22 (0.22)	0.17 (0.09)	-1.05 (0.27)	-0.14 (0.16)	0.26 (0.10)
t+11	-0.35 (0.21)	0.22 (0.09)	-1.04 (0.26)	-0.30 (0.16)	0.24 (0.10)
t+12	-0.28 (0.21)	0.21 (0.10)	-1.30 (0.27)	0.23 (0.16)	0.18 (0.11)
t+13	-0.28 (0.21)	0.13 (0.10)	-1.16 (0.26)	-0.02 (0.16)	0.16 (0.11)
t+14	-0.50 (0.21)	0.07 (0.11)	-1.52 (0.26)	-0.55 (0.16)	0.21 (0.12)
t+15	-0.97 (0.20)	0.10 (0.12)	-1.68 (0.26)	-0.87 (0.17)	0.22 (0.12)

Standard deviations of mean returns (or return differential in the last column) are in the parentheses.

Table 7: **Average Size Premium of Portfolio 1 under Different Economic Environments**

	Total	Expansion	Contraction	Bull Mkt	Bear Mkt	High CS	Low CS
t+1	1.49	2.07	-1.78	0.65	4.57	**5.45**	**-0.45**
	(0.56)	(0.61)	(1.42)	(0.57)	(1.57)	**(1.15)**	**(0.62)**
t+2	1.02	1.36	-0.86	0.15	4.24	**4.57**	**-0.71**
	(0.52)	(0.56)	(1.35)	(0.53)	(1.47)	**(1.01)**	**(0.60)**
t+3	-0.67	-0.70	-0.47	-1.08	0.84	2.17	-2.06
	(0.48)	(0.52)	(1.30)	(0.50)	(1.32)	(0.90)	(0.57)
t+4	-1.60	-1.51	-2.09	-2.13	0.35	**2.62**	**-3.67**
	(0.45)	(0.48)	(1.30)	(0.47)	(1.23)	**(0.83)**	**(0.54)**
t+5	-0.83	-0.82	-0.87	-1.33	1.02	**3.34**	**-2.87**
	(0.44)	(0.48)	(1.19)	(0.45)	(1.24)	**(0.79)**	**(0.53)**
t+6	-0.18	-0.23	0.06	-0.72	1.80	**3.18**	**-1.83**
	(0.44)	(0.47)	(1.17)	(0.45)	(1.21)	**(0.75)**	**(0.54)**
t+7	-1.57	-1.67	-0.97	-1.26	-2.70	**2.56**	**-3.59**
	(0.43)	(0.46)	(1.16)	(0.43)	(1.24)	**(0.72)**	**(0.53)**
t+8	-1.31	-1.27	-1.51	-1.30	-1.32	**1.60**	**-2.73**
	(0.42)	(0.44)	(1.28)	(0.43)	(1.14)	**(0.72)**	**(0.51)**
t+9	-1.38	-1.25	-2.12	-1.93	0.64	**3.54**	**-3.79**
	(0.39)	(0.42)	(1.13)	(0.42)	(1.01)	**(0.68)**	**(0.48)**
t+10	-1.61	-1.47	-2.36	**-2.99**	**3.48**	**2.38**	**-3.56**
	(0.38)	(0.40)	(1.13)	**(0.40)**	**(1.03)**	**(0.65)**	**(0.47)**
t+11	-1.30	-1.21	-1.83	**-2.64**	**3.61**	**1.22**	**-2.54**
	(0.39)	(0.41)	(1.17)	**(0.40)**	**(1.03)**	**(0.65)**	**(0.48)**
t+12	-1.62	-1.80	-0.61	**-2.60**	**1.97**	**1.23**	**-3.01**
	(0.39)	(0.41)	(1.13)	**(0.41)**	**(1.06)**	**(0.69)**	**(0.47)**
t+13	-1.40	-1.22	-2.42	-2.20	1.55	0.35	-2.25
	(0.38)	(0.40)	(1.16)	(0.40)	(1.03)	(0.68)	(0.47)
t+14	-2.64	-2.33	-4.37	-3.39	0.11	**0.33**	**-4.09**
	(0.38)	(0.40)	(1.12)	(0.39)	(1.04)	**(0.67)**	**(0.46)**
t+15	-3.14	-3.20	-2.82	**-4.41**	**1.53**	**1.30**	**-5.32**
	(0.39)	(0.42)	(1.12)	**(0.39)**	**(1.12)**	**(0.74)**	**(0.45)**
Number of Observations	822	698	124	646	176	270	552

The standard deviation of the average size premium is in the parenthesis.

The first column shows the average size premium of the first decile size portfolio, which is the same as the first column of Table 4.

The number of observations in each state is in the last row of the table. The second and third columns are the expansion and contraction states; the fourth and fifth columns are the bull and bear market states; and the last two columns are the high and low credit spread states.

The size premiums are shown in **boldface fonts** if the difference is significant at the 10 percent level using a one-sided t test.

Table 8: **Average Size Premium of Portfolio 10 under Different Economic Environments**

	Total	Expansion	Contraction	Bull Mkt	Bear Mkt	High CS	Low CS
t+1	-0.19	-0.17	-0.27	-0.29	0.21	**-1.10**	**0.26**
	(0.11)	(0.12)	(0.29)	(0.11)	(0.32)	**(0.20)**	**(0.13)**
t+2	-0.14	-0.14	-0.12	-0.39	0.80	**-1.10**	**0.34**
	(0.11)	(0.12)	(0.29)	(0.11)	(0.34)	**(0.20)**	**(0.13)**
t+3	0.03	0.03	0.05	**-0.34**	**1.38**	**-0.87**	**0.47**
	(0.12)	(0.12)	(0.30)	**(0.11)**	**(0.35)**	**(0.20)**	**(0.14)**
t+4	0.10	0.04	0.43	**-0.33**	**1.66**	**-0.63**	**0.45**
	(0.12)	(0.13)	(0.31)	**(0.11)**	**(0.35)**	**(0.21)**	**(0.14)**
t+5	0.10	-0.03	0.85	**-0.42**	**2.02**	**-0.73**	**0.51**
	(0.12)	(0.13)	(0.32)	**(0.11)**	**(0.36)**	**(0.21)**	**(0.14)**
t+6	0.14	0.00	0.95	**-0.43**	**2.22**	**-0.59**	**0.50**
	(0.12)	(0.13)	(0.33)	**(0.11)**	**(0.38)**	**(0.21)**	**(0.15)**
t+7	0.29	0.11	1.29	**-0.37**	**2.68**	-0.29	0.57
	(0.12)	(0.13)	(0.34)	**(0.12)**	**(0.39)**	(0.22)	(0.15)
t+8	0.11	-0.08	1.17	**-0.49**	**2.30**	-0.55	0.43
	(0.13)	(0.14)	(0.33)	**(0.12)**	**(0.42)**	(0.22)	(0.16)
t+9	0.16	0.01	1.03	**-0.52**	**2.67**	-0.60	0.54
	(0.13)	(0.14)	(0.32)	**(0.12)**	**(0.44)**	(0.21)	(0.17)
t+10	0.20	0.03	1.16	**-0.45**	**2.60**	-0.51	0.55
	(0.14)	(0.15)	(0.34)	**(0.12)**	**(0.46)**	(0.22)	(0.17)
t+11	0.31	0.12	1.37	**-0.45**	**3.10**	-0.38	0.65
	(0.14)	(0.16)	(0.36)	**(0.12)**	**(0.49)**	(0.22)	(0.18)
t+12	0.33	0.20	1.08	**-0.43**	**3.11**	-0.37	0.67
	(0.14)	(0.16)	(0.37)	**(0.13)**	**(0.49)**	(0.23)	(0.18)
t+13	0.35	0.18	1.27	**-0.42**	**3.15**	-0.25	0.64
	(0.14)	(0.16)	(0.39)	**(0.13)**	**(0.48)**	(0.24)	(0.18)
t+14	0.42	0.21	1.55	**-0.28**	**2.96**	-0.14	0.68
	(0.15)	(0.16)	(0.38)	**(0.13)**	**(0.51)**	(0.24)	(0.19)
t+15	0.68	0.49	1.76	**-0.13**	**3.67**	-0.03	1.03
	(0.15)	(0.16)	(0.39)	**(0.13)**	**(0.53)**	(0.24)	(0.19)
Number of Observations	822	698	124	646	176	270	552

The standard deviation of the average size premium is in the parenthesis.

The first column shows the average size premium of the 10th decile size portfolio, which is the same as the last column of Table 4.

Column 2 to column 7 use the same dummy variables to separate different states as the corresponding columns in Table 7.

The size premiums are shown in **boldface fonts** if the difference is significant at the 10 percent level using a one-sided t test.