

# INVESTMENT IS APPROPRIATELY STIMULATED BY TELRIC

Robert D. Willig<sup>1</sup>

## 1. Introduction

In the debate over the implementation of the Telecommunications Act of 1996, incumbent local exchange carriers (ILECs) have claimed that its requirements suppress incentives for investment in network infrastructure. They argue that they are denied a compensatory (“fair”) return on their investments by the requirement that they unbundle their local networks and lease use of the unbundled network elements (UNEs) at prices based on total element long-run incremental cost (TELRIC). The ILECs further argue that the mandated availability of UNEs at these regulated prices permits competitive local exchange carriers (CLECs) to “free ride” on ILEC networks and discourages CLEC investments, as well their own. Based on their claims that both CLECs’ and their own investments are suppressed, the ILECs argue that policy changes should be made to remove requirements that they provide CLECs with access to TELRIC-priced UNEs.

In sharp contrast, the CLECs assert that the availability of UNEs at TELRIC based prices is necessary for competition. It is this competition that enables them to invest, and that motivates the ILECs to increase their investment in network facilities. The CLECs argue that the competition created by access to UNEs brings about lower prices, better quality and more service, and does not discourage any efficient ILEC investment. Under this view, the previous lack of competition in monopoly local

---

<sup>1</sup> Professor of Economics and Public Affairs, Princeton University.

telephone markets may have dissuaded the ILECs from making certain investments, and the competitive stimulus from CLEC entry under the 1996 Act may have encouraged greater investment by both the ILECs and the CLECs.

These two competing views may be termed the *Investment Deterrence Hypothesis* and the *Competitive Stimulus Hypothesis*, respectively. These hypotheses can be examined from both theoretical and empirical standpoints. I believe that the *Competitive Stimulus Hypothesis* stands on much firmer theoretical ground than the *Investment Deterrence Hypothesis* in this setting. Nonetheless, I recognize that amidst the contention and complex regulatory dynamics that surround local telecommunications today, the question of which hypothesis is correct should be put to a sound empirical test.

This essay concludes both that the *Investment Deterrence Hypothesis* is refuted by the empirical evidence and that the data provide reasonable support for the *Competitive Stimulus Hypothesis*. The analysis shows that there is no valid foundation for the view that investment would be enhanced by any effort to reinterpret current TELRIC rules in a manner that raises UNE prices. To the contrary, the data indicate that higher UNE prices would weaken competition and discourage investment by both ILECs and CLECs.

## **2. Investment Theory**

The *Competitive Stimulus Hypothesis* is far more consistent with economic theory than the *Investment Deterrence Hypothesis* in the setting of local telecommunications today. The availability of UNEs facilitates entry and activity by local telephone competitors, and total industry investment expands as this competition results in lower prices, increased demand, and improved customer choice and service quality.

Indeed, without access to TELRIC-priced UNEs, CLEC investment may well be suppressed because the ILECs enjoy enormous advantages over new entrants as a result of their legacy as protected franchise monopolists that currently serve over 90% of existing demand. ILECs benefit from large economies of scale and scope and enjoy important first mover advantages relative to CLECs with respect to rights-of-way and placement of outside plant and its supporting structures. The ILECs are also protected by sunk cost entry barriers – *i.e.*, competitive facilities-based entry by CLECs would be very risky because much of the costs of local network facilities are sunk, and therefore cannot be recovered if the CLEC ultimately is unable to remain viable in its competition with the incumbents. The economies of scale and scope endemic to local telephony imply that CLEC entry with cost-efficient facilities would be likely to create excess supply and strong pressure to move prices downwards towards marginal costs and below average costs. Thus, without access to UNEs at competitive prices, it is unlikely that CLECs could overcome profitably the daunting barriers to entry, and local telephony would remain the domain of monopoly.

According to the *Investment Deterrence Hypothesis*, the availability of UNEs for lease at TELRIC-based prices discourages ILEC investment by rendering it less profitable than it would be without the unbundling mandate. In this view, unbundling rules compel the ILEC to lease portions of its local exchange network to CLECs at returns that are lower than it could earn if it used this network to provide retail services

directly to customers.<sup>2</sup> The combined return accruing to the ILEC from its local network investment is thereby diminished, and along with this return (it is argued) goes the ILECs' incentive to invest.

The ILECs contend that the TELRIC methodology adopted by the Federal Communications Commission (FCC) to determine the rates that CLECs pay for UNEs does not adequately compensate ILECs for their investments in assets that are long-lived and may be partially or wholly sunk.<sup>3</sup> Although it goes without saying that the ILECs are motivated to seek from regulation more rather than less compensation, the key issue is whether TELRIC compensation provides for efficient investment by the ILECs. By its very definition, TELRIC allows the ILECs to recover their full economic costs, including the risk-adjusted competitive rates of return on capital and forward-looking depreciation with lives that reflect both technological and economic obsolescence.<sup>4</sup> Thus, because TELRIC provides ILECs with the same investment incentives as are faced by participants in competitive markets, the ILECs' *Investment Deterrence Hypothesis* would appear to be either an illogical indictment of investment incentives in competitive markets generally, or just a complaint about the regulatory process constraining their pricing and profits.

---

<sup>2</sup> The proponents of this theory are rarely clear as to whether their retail pricing benchmark is an efficient structure of regulated retail prices, or substantially higher prices that regulation has somehow allowed the ILECs to impose on their captive retail customers.

<sup>3</sup> Reply Affidavit of Jerry A. Hausman, In the Matter of Implementation of Local Competition Provisions in the Telecommunications Act of 1996, CC Docket No. 96-98 (filed May 30, 1996). For a critique of the foregoing, see R. Glenn Hubbard and William H. Lehr, "Capital Recovery Issues In TSLRIC Pricing: Response To Professor Jerry A. Hausman", submitted *ex parte* by AT&T to the FCC, In the Matter of Implementation of Local Competition Provisions in the Telecommunications Act of 1996, CC Docket No. 96-98 (July 18, 1996).

<sup>4</sup> See companion essays by William Baumol, Glenn Hubbard and William Lehr, and Richard Clarke for further elaboration of the compensatory nature of TELRIC.

There is powerful economic logic that goes the other way in showing that competition is an impetus to investment, as compared to monopoly. Consider a monopoly ILEC that does not face mandatory unbundling. Like any rational firm, the firm's investment will be governed by the perspective that the firm will install further units of capital so long as the incremental expected revenues from these units exceed the costs (inclusive of risks) of acquiring them. Because the services produced by this further capital may compete with (and bid down the price for) other services produced by the ILEC's current capital, the profitability of additional investment by the monopoly ILEC is attenuated.

Competition changes the ILEC's perspective on what is profitable. In a competitive environment, new investment by the ILEC doesn't simply have the effect of reducing the profitability of its former production. Rather, this investment may be used as a competitive weapon (*e.g.*, by producing more and higher quality service) to increase the ILEC's overall business by defending and taking market share from its competitors. Due to these potential positive effects of investment on the profitability of an ILEC exposed to competition and the heightened threat of loss of business to rivals, the ILEC (and its rival CLECs) are impelled to lower prices, produce more, innovate and invest more to accomplish these goals. The result is that incentives for investment and innovation are greater under the pressures of a competitive environment.<sup>5</sup>

---

<sup>5</sup> The only set of circumstances under which this comparison might be distorted by CLECs' use of UNEs would be if CLECs' use of UNEs degraded the potential productivity of these facilities in serving the ILECs' customers. I am aware of no evidence that this is the case.

A classic illustration of these investment incentives is provided by the digital subscriber line (DSL) experience of the late 1990s. Prior to the '90s, T1 was the only available technology for data services, and it was controlled by the ILECs. Although the ILECs developed more efficient DSL technologies in the early '90s, they chose not to invest and deploy these innovative technologies because this would bid down the price of their pre-existing monopoly T1 data services. With the advent of competitive cable modem technology in the late '90s and the ability of CLECs to use UNEs to provision their own competitive DSL services, ILEC investment in DSL technology exploded in response.

Thus far, this discussion has focused on the incentives for ILEC investment. I now turn to CLEC investment. When it is economically viable to do so, a CLEC would likely prefer to deploy its own facilities and avoid being dependent on its largest competitor for essential inputs. But because of scale economies, it is not economically practical for CLECs to replicate ILEC networks or, in many instances, even particular portions of the extant networks. UNEs, however, permit CLECs to share incumbent scale economies and provide efficient competition using shared facilities in those many instances where deploying alternative facilities is not economically feasible.

UNEs can facilitate deployment of alternative facilities by CLECs when it is potentially economic to do so. For example, UNEs allow CLECs to acquire a customer base and adequate scale to justify investment in their own facilities and, thus, may allow a CLEC dynamically to overcome sunk cost entry barriers.

Overall, the *Competitive Stimulus Hypothesis* follows naturally from basic economic theory and its understanding of competitive markets. Increased competition enabled by UNEs can be expected to result in lower retail prices both because of efficiency improvements induced by competition and because of the pressure competition places on above-cost pricing. Lower prices result in increased demand. Growing demand will induce additional facilities investment by both ILECs and CLECs. Additionally, in a competitive environment, both the incumbent and the entrant will face enhanced incentives to improve quality and innovate with respect to services, leading to further investment.

### **3. The Historical Record**

The theory behind the *Competitive Stimulus Hypothesis* is borne out by a rigorous econometric empirical analysis of CLEC and ILEC investment behavior since the passage of the Telecommunications Act in 1996. But before describing the econometrics, it is useful to review summary data on the recent history of telecommunications investment. The attached chart shows the course of investment by ILECs in local telecommunications for the 1992-2001 period,<sup>6</sup> and by the CLECs over the 1996-2002 period.

[Insert Chart here]

The first point to note is that over the half decade prior to the '96 Act, investment by the monopoly ILECs was stagnant. With the advent of the Act, it accelerated markedly for

---

<sup>6</sup> Although 2002 data are also available from BellSouth, SBC and Verizon, due to accounting irregularities, Qwest has not yet filed audited financial reports with the FCC for 2002.

four years, then in 2000 began to tail off. CLEC investment followed the same pattern – dramatic growth for the first four years after the Act, then a decline.

Some analysts have looked at this history and focused on only the most recent several years. From evidence of the decline that occurred since 2000, they have concluded that CLECs' use of UNEs priced at TELRIC was the cause of this fall-off.<sup>7</sup> Other analysts have focused on evidence of the stagnancy of ILEC investment in the pre-competitive era and the flowering of investment immediately following the Act. They have concluded that CLEC competitive pressure affirmatively stimulated investment.<sup>8</sup> The later tail-off in investment is ascribed to transition towards a more sustainable long-run path, and it is observed that despite this tail-off, net telecommunications plant remains well above its levels prior to the '96 Act.<sup>9</sup>

#### 4. Empirical Tests and Results

I now discuss empirical research that I have performed, along with studies performed by others, that address the issue of whether the availability of UNEs at TELRIC-based prices enhances or detracts from telecommunications investment.

---

<sup>7</sup> See, for example, J. A. Eisenach and T. M. Leonard, *Telecom Deregulation and the Economy: The Impact of UNE-P on Jobs, Investment and Growth*, Progress & Freedom Foundation, Progress On Point, Release 10.3 (January 2003).

<sup>8</sup> See, for example, Phoenix Center for Advanced Legal and Economic Studies, "The Truth about Telecommunications Investment," Phoenix Center Policy Bulletin, No. 4, June 24, 2003.

<sup>9</sup> Nortel chief executive Frank Dunn also agrees that telecommunications capital spending rose to unsustainable levels in the late '90s. "Everybody is looking for this big capital spending to start again. Well it's not going to happen. What was spent in 1999-2000 was unaffordable. Carriers were running to some 20 to 22 percent of their revenue in capex spending. ... There is no business model that could afford that kind of spending. So we're back down to the low teens. And, historically, that's where this industry has always been. And that's where it should be." *Reuters*, "Nortel CEO Sees No Surge in Telecoms Spending," November 17, 2003.



### A. My Own Analysis

As discussed above, the *Investment Deterrence* and *Competitive Stimulus Hypotheses* make different predictions regarding the effect of UNE prices on ILEC investment. In an analysis that I developed with several co-authors, we employed a state-by-state cross section of data to carry out regression analyses to test which of these two hypotheses has greater empirical support.<sup>10</sup> The cross-sectional variation in the terms and conditions at which UNEs are available in the different states allows us to determine the linkages among the availability of UNEs, CLEC competitive activity and ILEC investment in network infrastructure.

This analysis employed standard econometric tools that are widely accepted in the field. We used a variety of these techniques to estimate directly how ILEC network investment is positively influenced by competition from CLECs – and to measure how CLEC entry is positively influenced by the availability of UNEs. The directions and magnitudes of these impacts are estimated controlling for state-by-state variations in other supply and demand influences on CLEC activity and ILEC investment. This research design avoids the ambiguity of time series analysis of investment that is unable to control for all of the other forces likely to bear on the recent progress of local telecommunications investment.

---

<sup>10</sup> See, “Stimulating Investment and the Telecommunications Act of 1996,” by Robert D. Willig, William H. Lehr, John P. Bigelow and Stephen B. Levinson, October 2002, attached to *ex parte* letter of Joan Marsh, AT&T, to Marlene Dortch, FCC, In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, (October 11, 2002).

As explained in greater detail in the Technical Appendix to this essay, our results unambiguously refute the *Investment Deterrence Hypothesis* and provide strong support for the *Competitive Stimulus Hypothesis*. Overall, we estimated that each 1% *reduction* in UNE rates corresponds with rigorous statistical significance to approximately a 2.1% to 2.9% *increase* in ILEC investment. Thus, raising TELRIC or restricting access to UNEs, as the ILECs advocate, would *both* reduce the competitive alternatives available to consumers *and* reduce the ILECs' capital spending on their own networks.

### **B. Complementary Analyses**

Numerous other empirical studies have similarly concluded that the availability of UNEs at TELRIC has not impeded telecommunications investment.

One study by the Phoenix Center examined data from the Commerce Department's Bureau of Economic Analysis (BEA), and found that an additional \$267 billion in telecommunications industry capital spending was generated between 1996 and 2001.<sup>11</sup> That is, the BEA reported total telecommunications investment of \$572 billion during the period 1996-2001, compared to investment of only \$305 billion that would have been expected based on historic investment levels from the fifteen years preceding the '96 Act. According to this Phoenix study:

Plainly, investment by telecommunications firms skyrocketed after the passage of the 1996 Act. From 1980 through 1995, investment by telecommunications firms grew at an annual rate of 2.8%, with average investment level of about \$38.8 billion. After the 1996 Act, investment by telecommunications firm[s] has grown at an average annual rate of 22.3%, with \$95.3 billion invested annually (on average) for a total of about \$572 billion during this time.

---

<sup>11</sup> Phoenix Center for Advanced Legal and Economic Studies, "The Truth about Telecommunications Investment," Phoenix Center Policy Bulletin, No. 4, June 24, 2003.

A second Phoenix study used a model that regressed indicators of UNE competition and RBOC size on net investment by state, and demonstrated that the RBOCs invested more heavily in their networks in states where the competition they faced was most intense.<sup>12</sup> This study found that net investment by BellSouth, SBC and Verizon increased on average by \$759 for every UNE-P access line leased by a CLEC.

The study further concluded:

... UNE-P competition is shown to positively affect BOC net investment. So, while BOC net investment may be down relative to previous years due to economic conditions and other factors, *UNE-P itself exerts a positive influence on investment*. Thus, it appears that factors other than UNE-P are fully responsible for the lower investment levels by the BOCs in 2002. In fact, UNE-P competition is shown to offset investment reductions in 2002 by about 50%.<sup>13</sup>

The empirical model estimated in this Phoenix study provoked a debate among several economic analysts.<sup>14</sup> The Phoenix Center responded to these criticisms by observing:

In their review of BULLETIN NO. 5, HHB recommend three major changes to our empirical model. First, HHB suggest making the empirical model dynamic by including the existing capital stock in the regression and lagged values of some explanatory variables. Second, they recommend letting the cost of capital vary by Bell Company. Third, they propose estimating the models using weighted least squares where all variables are weighted by (the inverse of) access lines. Many of our new empirical models incorporate these suggestions, and in some cases adopt more dynamic specifications than proposed by HHB. In every

---

<sup>12</sup> Phoenix Center for Advanced Legal and Economic Studies, “Competition and Bell Company Investment in Telecommunications Plant: The Effects of UNE-P,” Phoenix Center Policy Bulletin, No. 5, July 9, 2003, updated September 17, 2003. The study is based on 2002 data filed by BellSouth, SBC and Verizon with the FCC. Qwest had not yet filed its 2002 financial data at the time of the study.

<sup>13</sup> *Ibid.* at p. 14.

<sup>14</sup> See, Declaration of Thomas W. Hazlett, Ph.D., Arthur M. Havenner, Ph.D., and Coleman Bazelon, Ph.D., on Behalf of Verizon Communications, Inc., Reply Comments of Verizon Telephone Companies in Support of Petition for Expedited Forbearance from the Current Pricing Rules for the Unbundled Network Element Platform, WC Docket No. 03-157 (filed September 2, 2003); and Declaration of R. Carter Hill, Ph.D., on Behalf of Z-Tel Communications, Inc., In the Matter of Petition for Forbearance From the Current Pricing Rules for the Unbundled Network Element Platform, WC Docket No. 03-157 (September 18, 2003).

instance, these changes *affirm and, in many cases, strengthen* the conclusion that Bell Company investment is positively related to UNE-P competition.<sup>15</sup>

Another study has examined the state-by-state leased element purchases by a major CLEC, AT&T, and compares the level of these purchases with the extent to which AT&T has deployed its own local network facilities in that state.<sup>16</sup> This analysis finds that no matter what measure of AT&T investment deployment is used (*i.e.*, number of local switches, number of switch terminations or route miles of local fiber), there is a significant positive relationship between AT&T's use of leased network elements and its investment in its own local network facilities.

Finally, empirical findings that competitive access to network elements stimulates rather than deters investment are not unique to just the U.S. experience with unbundling. The Organization for Economic Cooperation and Development (OECD) has found that in the thirty developed countries that constitute its membership, “the evidence indicates that opening access networks, and network elements, to competitive forces increases investment and the pace of development.”<sup>17</sup> The OECD also notes that, “to date the major criticisms of unbundling or line sharing are that such policies allegedly discourage investment in new infrastructure. No evidence has been forwarded to substantiate this claim.”<sup>18</sup>

---

<sup>15</sup> Phoenix Center for Advanced Legal and Economic Studies, “UNE-P Drives Bell Investment: A Synthesis Model,” Phoenix Center Policy Bulletin, No. 6, September 17, 2003, p. 4.

<sup>16</sup> Declaration of Richard N. Clarke, attached to Reply Comments of AT&T Corp., In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, (filed July 17, 2002).

<sup>17</sup> Organization for Economic Cooperation and Development, *The Development of Broadband Access in OECD Countries*, October 29, 2001, p. 4. (“*OECD Report*”).

<sup>18</sup> *OECD Report*, p. 15.

### C. Dissenting Analyses

John Haring *et al.* purport to explain the relationship between ILEC investment and UNE pricing by regressing RBOC net plant in a state on the number of RBOC loops, the number of unemployed persons in the state, real gross state product, and the product of the number of RBOC loops and the UNE loop price for zone 1.<sup>19</sup> This relationship has neither any basis nor any meaningful interpretation in economic theory. In fact, Haring, *et al.* have effectively performed the equivalent of a regression tautology. These authors use RBOC net plant in a state as the dependent variable, but then employ an equation where that dependent variable is a function of loops. They then examine whether total net plant is larger when the aggregate value of loops is larger (assuming loops are valued at the zone 1 UNE loop price). Not surprisingly, they find that this is the case. This analysis is flawed because loops constitute a significant portion of net plant, so the result will likely be a positive relationship as a matter of arithmetic rather than as a policy-relevant causal relationship. Further, use of net plant as the dependent variable is flawed because the relevant issue is how the availability of UNEs affects *investment*. Investment is the *change* in net plant rather than the simple level of net plant.

Another flawed study was prepared directly by BellSouth, SBC and Verizon to examine the relationship between total ILEC investment per line and CLEC UNE-P lines

---

<sup>19</sup> John Haring, Margaret L. Rettle, Jeffrey H. Rohlf, and Harry M. Shooshan III of Strategic Policy Research, “UNE Prices and Telecommunications Investment,” attached to the Reply Comments of Qwest, In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, (July 17, 2002).

per 1000 RBOC access lines.<sup>20</sup> The authors' chief result is their finding that RBOC investment per line does not increase when the number of CLEC UNE-P lines increases. They conclude from this that there is no relationship between UNE unbundling and ILEC investment. This conclusion, however, is not supported by the regressions estimated in the report. First, it appears that the authors make the same mistake as Haring, *et al.*, in that they conflate the *stock* of capital per line with investment (which is the *change* in the stock of capital per line). Second, the RBOC authors fail to control for other significant factors that could reasonably influence the relationship between ILEC capital per line and the proportion of lines served by CLECs using UNE-P. Such factors include demand conditions, the cost of telecommunications infrastructure or the effects of regulation. As a matter of basic econometrics, the omission of such highly relevant variables means that the estimates obtained are likely biased and unreliable. Third, the data relied upon for this analysis are incomplete and severely flawed.<sup>21</sup>

## 5. Conclusions

The results of the empirical analyses reported here should come as welcome news for regulators and policymakers. Had the *Investment Deterrence Hypothesis* found valid empirical support, policymakers and regulators would face an uncomfortable trade-off between the pro-competitive dictates of the Telecommunications Act and the growth-promoting effects of investment. Fortunately, the empirical evidence we have studied

---

<sup>20</sup> “UNE-P and Investment,” Prepared for and Submitted by BellSouth, SBC, and Verizon, In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, (July 17, 2002).

<sup>21</sup> See, C. Michael Pfau, “Correcting the RBOCs’ Empirical Analyses of the Linkage Between UNE-P and Investment,” *ex parte* letter from Joan Marsh, AT&T to Ms. Marlene Dortch, Secretary, FCC in CC Docket No. 01-338, filed October 16, 2002.

supports the *Competitive Stimulus Hypothesis* that the efficiency-enhancing effects of competition also promote investment. Therefore, no such trade-off is necessary.

Regulatory policies that support access to unbundled network elements encourage both competition and investment.

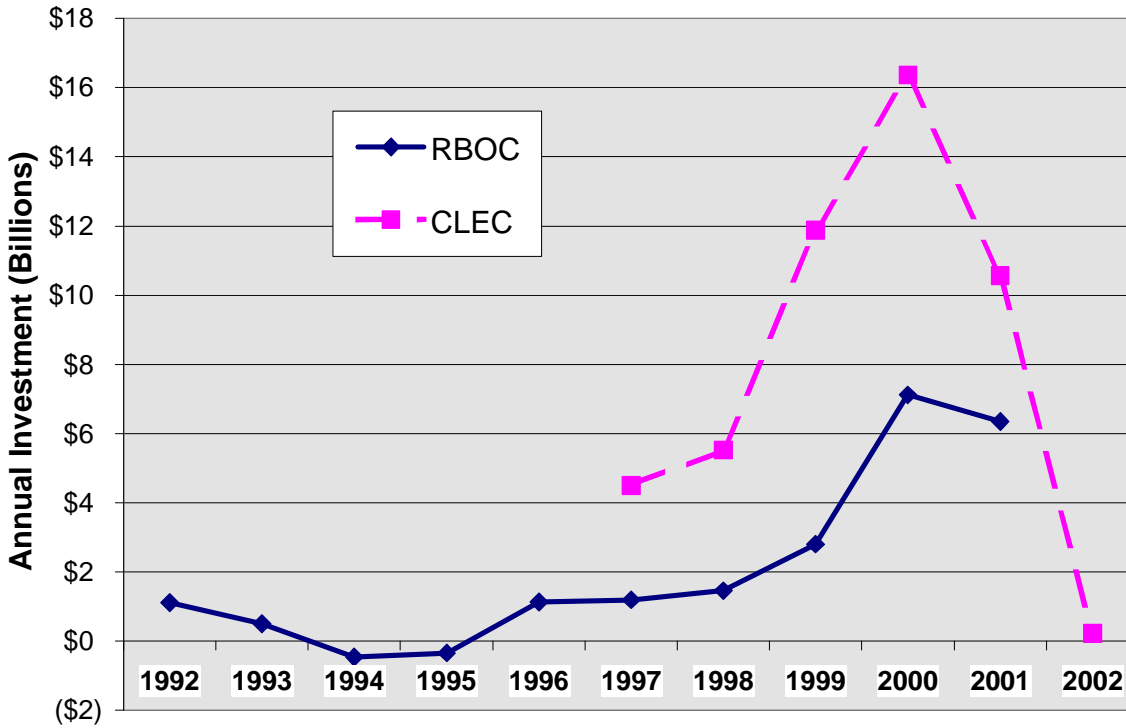
Regulators may take further comfort that this empirical conclusion is also consistent with sound economic theory. As a general matter in economics, competitive markets produce greater output, which leads to greater investment, at lower prices than their monopolistic counterparts. So, policy mechanisms like the provision of UNEs at TELRIC-based prices, which encourage competition, should also encourage investment. This mechanism forms the basis for recent work by Kotlikoff and Hassett in which they analyze a dynamic and strategic model of entry and competition in telecommunications-related markets.<sup>22</sup> They find, among other things, that telecommunications competition stimulates investment, a conclusion that is consistent with our finding of empirical support for the *Competitive Stimulus Hypothesis*. The significance they attach to that finding for future economic growth is consistent with our finding that the elasticity of ILEC investment with respect to UNE prices is such that a 1% reduction in UNE prices may be expected to lead to an increase in ILEC investment of between 2.1 and 2.9%.

---

<sup>22</sup> Kevin A. Hassett and Laurence J. Kotlikoff, “The Economics of Telecom Investment,” mimeo (September 2002).

Chart

History of RBOC and CLEC Investment: 1992 - 2002



Data sources:

- RBOC investment data is year over year change in net plant from RBOC ARMIS reports to the FCC.
- CLEC data are cumulative capital expenditures from 2003 Association for Local Telecommunications (ALTS) Report, reduced by 10% annual depreciation.



### Technical Appendix

#### **Overview of Our Empirical Analysis**

The empirical analysis in my work with Lehr, Bigelow and Levinson proceeded in two stages. First, to distinguish between the competing predictions made by the two hypotheses, we conducted an analysis of the “reduced-form” relationship between ILEC investment and UNE prices. To the extent that this relationship is positive, *i.e.* if higher UNE prices are associated with greater ILEC investment, the *Investment Deterrence Hypothesis* is supported. To the extent that this relationship is negative, *i.e.*, if lower UNE prices are associated with greater ILEC investment, the *Competitive Stimulus Hypothesis* is supported. Second, to examine more rigorously the linkages suggested by the *Competitive Stimulus Hypothesis* among UNE prices, CLEC participation in local telephone markets and ILEC investment, we conducted a further set of “structural form” regressions.

#### **Specification of the Reduced-Form Regression**

The first analysis we performed of the relationship between UNE prices and ILEC investment is based on a reduced-form specification of the determinants of ILEC investment. A reduced-form specification is one that is derived from a more complex set of simultaneously interacting relationships. In a reduced-form specification, interactions between variables that exert mutual effects on one another are pushed into the background and the relationship to be estimated is a straightforward one between predetermined independent (or “exogenous”) variables and a single dependent (or

“endogenous”) variable. By contrast, structural-form relationships embody the interactions between endogenous and exogenous variables explicitly, have meaningful behavioral interpretations, and generally must be viewed as a system of relationships. Their interaction, however, is more complex. Reduced-form relationships are simpler because a variety of behavioral relationships have been subsumed into them.<sup>23</sup>

In the analysis developed in the paper, the reduced-form relationship is between ILEC investment as the dependent variable, and a group of exogenous variables that influence ILEC investment either directly or indirectly through their effects on CLEC activity. The reduced-form relationship takes the form:

$$\left( \begin{array}{c} ILEC \\ Investment \end{array} \right) = R \left( \begin{array}{c} Demand \\ Factors \end{array}, \begin{array}{c} Current \\ Revenue \end{array}, \begin{array}{c} ILEC Cost of \\ Investment \end{array}, \begin{array}{c} CLEC Cost of \\ Participation \end{array}, \begin{array}{c} Regulatory \\ Regime \end{array} \right)$$

The Demand Factors, ILEC Cost of Investment, and Regulatory Regime variables are included to control for the effects of other factors on ILEC investment decisions –

---

<sup>23</sup> For example, in the standard economic model of a competitive market, the quantity demanded of a good is determined by its price, the levels and distribution of income of its consumers, the prices of substitute and complementary goods, and parameters that reflect tastes. Likewise, the quantity supplied of a good is determined by its price, the prices of goods and services used to produce the good, and parameters describing the technology for producing the good. In the marketplace, the price of the good is determined by simultaneous operation of the demand relationship, the supply relationship, and the equilibrium condition that the quantity demanded should be equal to the quantity supplied. In this model the demand relationship and the supply relationship interact simultaneously to determine two variables, *i.e.*, the quantity of the good changing hands in the market and the market price. The values of these two “endogenous” variables are simultaneously determined by the demand and supply relationships and the values of the predetermined or exogenous variables such as income, prices of substitutes and complements, taste parameters, prices of factors of production, and technology parameters. If one knew the demand and supply relationships, one could use them to calculate the market equilibrium price as a function of the exogenous variables. The resulting relationship is called a “reduced form,” because the simultaneous interaction of multiple relationships and variables has been reduced to a single relationship between the endogenous dependent variable and the exogenous independent variables.

that is, factors not associated with UNE-based unbundling requirements. Demand factors and the level of current revenue (an indication of current market prices) are included because they may be expected to influence ILEC investment directly, inasmuch as increased demand or higher prices should be expected to encourage investment, and indirectly, because they may have the same effect on CLEC activity. The cost to an ILEC of its own investment should certainly influence the level of ILEC investment. Variables relevant to describing the nature of the regulatory regime are also included because the character of regulation may be expected to have an effect on ILEC investment.

The CLEC Cost-of-Participation variable is the variable whose coefficient provides the basis for distinguishing between the two competing hypotheses. According to the *Investment Deterrence Hypothesis*, increases in UNE prices, which increase the cost of CLEC participation via UNEs, should increase ILEC investment. That is, higher UNE prices render UNE-based entry less economically viable for CLECs, thereby alleviating the risk of alleged “free-riding” by CLECs. According to the *Investment Deterrence Hypothesis*, this should increase the ILEC’s incentive to invest. In contrast, the *Competitive Stimulus Hypothesis* predicts that higher UNE prices will reduce ILEC investment because less economically-viable network element unbundling reduces CLEC competitive activity and the spur that such activity would otherwise provide for ILEC investment.

Thus, empirically one may distinguish between these two hypotheses by examining the sign and the level of statistical significance of the estimated coefficient on the CLEC Cost-of-Participation variable.

### Specification of the Structural-Form Regressions

In order to test directly the *Competitive Stimulus Hypothesis*, we used a structural approach. The *Competitive Stimulus Hypothesis* does not merely predict the negative relationship between UNE pricing and ILEC investment confirmed in the previous section. That prediction is based on further empirically testable predictions that the level of CLEC competition will be negatively related to UNE pricing and that the level of ILEC investment will be positively related to the level of CLEC competitive activity. Thus, according to the full economic structure of the *Competitive Stimulus Hypothesis*, it is the combination of these two effects that gives rise to the overall negative relationship observed between ILEC investment and UNE pricing.

In order to investigate empirically these two effects, we employ a specification that looks beyond the summary relationships embodied in the reduced-form. This specification involves a system of two equations. The first,

$$\left( \begin{array}{c} ILEC \\ Investment \end{array} \right) = f \left( \begin{array}{c} Demand \\ Factors \end{array}, \begin{array}{c} Current \\ Revenue \end{array}, \begin{array}{c} ILEC \\ Investment \end{array}, \begin{array}{c} Cost \\ of \\ Investment \end{array}, \begin{array}{c} Regulatory \\ Regime \end{array}, \begin{array}{c} CLEC \\ Activity \end{array} \right),$$

posits that ILEC investment is a function of demand factors, current revenue, the cost of investment to ILEC firms, the form of the regulatory regime, and the level of competitive activity by CLEC firms. This equation reflects the direct determinants of the ILECs' behavior.

The second equation reflects the determinants of the behavior of CLECs. It takes the form:

$$\begin{pmatrix} \text{CLEC} \\ \text{Activity} \end{pmatrix} = g \begin{pmatrix} \text{Demand} & \text{Current} & \text{CLEC Cost of} \\ \text{Factors} & \text{Revenue} & \text{Participation} \end{pmatrix}.$$

In this equation the cost of participation to a CLEC is measured by the UNE prices.

Taken together, these two equations form a system that determines two endogenous variables, ILEC investment and CLEC activity, as functions of the exogenous variables. In this system, support for the *Competitive Stimulus Hypothesis* would take the form of a finding that CLEC Cost-of-Participation is negatively related to CLEC activity in the second equation and that the level of ILEC investment is positively related to the level of CLEC activity in the first equation.

## Results

We found statistical evidence that the relationship between UNE pricing and ILEC investment is negative and, therefore, that the empirical evidence refutes the *Investment Deterrence Hypothesis* and is consistent with the *Competitive Stimulus Hypothesis*. Our reduced-form regressions are statistically significant and explain a large share of the variation in the dependent variable, ILEC investment. Moreover, the estimated effects of various other independent control variables include statistically significant estimates that are consistent with the underlying economic theory.

Having found confirmation of the *Competitive Stimulus Hypothesis*' prediction in the first stage, we also tested directly the mechanism of *the Competitive Stimulus Hypothesis* using “structural-form” relationships. According to the *Competitive Stimulus*

*Hypothesis*, lower UNE prices lead to greater CLEC activity, and greater CLEC activity leads to greater ILEC investment. We therefore estimate the effect of UNE prices on CLEC activity and the effect of CLEC activity on ILEC investment. Again, we found a negative relationship between UNE prices and CLEC activity, *i.e.*, that higher UNE prices lead to less CLEC activity, and a positive relationship between CLEC activity and ILEC investment, *i.e.*, that greater CLEC activity leads to greater ILEC investment. Notably, these results are obtained from regressions that are themselves statistically significant, explain a high share of the variation in the dependent variable and produce estimates consistent with economic theory.<sup>24</sup>

---

<sup>24</sup> An earlier version of the analysis described above (which was based on a less complete data set) was included in a filing to the FCC in the *Declaration of Robert D. Willig on Behalf of AT&T*, In the Matter of Review of the Section 251 Unbundling Obligations of Incumbent Local Exchange Carriers, CC Docket No. 01-338, (April 5, 2002).

The principal challenge made to that earlier analysis was that it relied on UNE-P rates from June 2002 to explain CLEC activity and ILEC investment from earlier periods. The results we report in this analysis were obtained using UNE price data from a variety of sources compiled at various times between 1996 and 2002. Our data include UNE-P rates compiled by AT&T in 2002 as well as Regulatory Research Associates *TeleFOCUS* estimates from August 2000; the National Regulatory Research Institute's estimates from Spring 2001 and July 2002; and the loop proxy rates established by the FCC in its August 1996 *First Report and Order* in CC Docket No. 96-98. We have continued to find empirical support for the *Competitive Stimulus Hypothesis* and support adequate to reject the *Investment Deterrence Hypothesis* using UNE price data from as early as 1996 as well as with data from 2002. Thus, our conclusions are not dependent on the time at which the UNE-P rates were compiled.