Do Unbundling Policies Discourage CLEC Facilities-Based Investment

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Abstract

An expanding economics literature has examined the theoretical linkages between mandatory unbundling in the telecommunications sector and the incentives to invest in facilities by both incumbent local carriers and competitive carriers. Recent empirical evidence that substantiates the theory has emerged. That literature documents CLECs' reluctance to make facilities-based investments instead of availing themselves of incumbents' UNEs at low regulated prices that are based on total element long-run incremental costs (TELRIC). By examining the variation in facilities-based investment in loops across U.S. states and over time, we find that facilities-based line growth relative to UNE growth was faster in states where the cost of UNEs was higher relative to the cost of facilities-based investment.

KEYWORDS: telecommunications, regulation, unbundling

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I. INTRODUCTION

A primary policy objective of the 1996 Telecommunications Act is the promotion of facilities-based competition in the provision of local telecommunications services.[1] When implementing the Act, the Federal Communications Commission (FCC) has sought to preserve the incentives for *both* incumbent local exchange carriers (ILECs) and competitive local exchange carriers (CLECs) to make investments in their own network facilities.[2] Thus, the Commission has recognized that its unbundling decisions must be made in light of their likely effects on long-term, facilities-based competition.[3]

The Commission has acknowledged that mandating unbundling in cases where unbundling is not necessary could produce large social costs because ". . . the greatest benefits may be achieved through facilities-based competition," and only in some circumstances is the use of unbundled network elements (UNEs) "a necessary precondition to the subsequent deployment of self-provisioned network facilities."[4] Additionally, inefficient mandatory unbundling requirements would run afoul of the legislative intent underlying the 1996 Act because Congress "recognized implicitly that the purchase of unbundled network elements would, at least in some situations, serve as a transitional arrangement until fledgling competitors could develop a customer base and complete the construction of their own networks."[5] Proponents of mandatory unbundling argue that unbundled loops by themselves could generate facilities-based investments in the future, but we are unaware of any data that supports this "stepping stone" hypothesis. In particular, they argue that unbundled network elements would, in some situations, serve as a transitional arrangement until fledgling competitors could develop a customer base and complete construction of their own networks.

Notwithstanding the Commission's emphasis on promoting facilities-based competition, its unbundling decisions have encouraged the CLECs to defer pro-

1. *See, e.g.*, Implementation of the Local Competition Provisions of the Telecommunications Act of 1996, Third Report and Order (released Nov. 5, 1999), ¶ 285 (emphasis added) [hereinafter *UNE Remand Order*] ("Goals of the 1996 Act. As noted above, our unbundling analysis takes into account whether unbundling a particular network element is consistent with the goals of the 1996 Act. We find our decision to unbundle [certain local network elements] is consistent with the 1996 Act's goals of rapid introduction of competition and the promotion of *facilities-based* entry.") (emphasis added).

2. *Id*. ¶ 14 ("Specifically, unbundling rules that are based on a preference for development of facilities-based competition in the long run will provide incentives for both incumbents and competitors to invest and innovate, and should allow the Commission to reduce regulation once true facilities-based competition develops.").

3. *Id*. ¶ 7 ("Accordingly, the unbundling rules we adopt in this proceeding seek to promote the development of facilities-based competition.").

4. *Id*. ¶ 5.

5. *Id*. ¶ 6.

competitive facilities-based investments. An expanding economics literature has examined the theoretical linkages between unbundling and the incentives to invest in facilities by both incumbent providers and competitive carriers.[6] Much anecdotal evidence suggesting that low UNE prices discourage facilities-based investment also exists. Recently, empirical evidence has emerged to substantiate the theory that regulated rates can distort investment decisions. Using a cross-sectional dataset, James Eisner of the FCC and Professor Dale E. Lehman of Alaska Pacific University found empirically that decreases in UNE rates cause decreases in facilities based investment.[7] According to Agustin Ros and Karl McDermott of National Economic Research Associates, UNE rates in the Unites States are too high. Using data through 1998, they find that residential rates are inhibiting competition in local exchange markets.[8] James Zolnierek, James Eisner, and Ellen Burton of the FCC have modeled empirically the entry decision of facilities based CLECs as a function of local demographic characteristics.[9] Using data from the first quarters of the years 1996, 1997, 1998, and 1999, they found that facilities based CLEC entry in a given local access and transport area (LATA) was statistically significantly related with the number of households in that LATA and the percentage of households of that LATA in urban areas.[10]

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6. *See* Martin Taschdjian, *From Open Networks to Open Markets: How Public Policy Affects Infrastructure Investment Decisions*, Program on Information Program on Information Resources Policy, Harvard University (November 2000) (concluding that mandatory unbundling has "slowed investment in local networks, thereby limiting the spread of facilities-based competition for most local-access telecommunications services."); Marc Bourreau & Pinar Dogan, *Regulation and Innovation in the Telecommunications Industry,* 25 TELECOMM. POL'Y 167-84 (Apr. 2001); Gary Biglaiser & Michael Riordan, *Dynamics of Price Regulation*, 31 RAND J. ECON. 744-67 (2000); Koji Domon & Koshiro Ota, *Access Pricing and Market Structure,* 13 INFO. ECON. & POL'Y 77-93 (Mar. 2001); Thomas M. Jorde, J. Gregory Sidak, & David J. Teece, *Innovation, Investment, and Unbundling*, 17 YALE J. ON REG. 1 (2000) (concluding that mandatory unbundling will "diminish the incentives of both incumbent local exchange carriers (ILECs) and competitive local exchange carriers (CLECs) to invest in existing and new technologies").

7. *See*, *e.g*., James Eisner & Dale E. Lehman, Regulatory Behavior and Competitive Entry, Presented at the 14th Annual Western Conference Center for Research in Regulated Industries, June 28, 2001 ("We find states with low UNE prices have less facilities-based entry, with more ambiguous effects on the other two forms of entry.").

8. Agustin J. Ros & Karl McDermott, *Are Residential Local Exchange Prices Too Low?*, in EXPANDING COMPETITION IN REGULATED INDUSTRIES 149-168 (Michael A. Crew ed., Kluwer Academic Publishers 2000).

9. James Zolnierek, James Eisner, & Ellen Burton, *An Empirical Examination of Entry Patterns in Local Telephone Markets*, 19 J. OF REG. ECON. 143 (2001). They also found that entry was statistically significantly related to whether that LATA was served by Ameritech and whether that LATA was served by an independent (non-BOC) local telephone company.

10. *See Id*. at 151 tbl. 4.

This research contributes to the expanding literature on competitive facilities based investment by first using a factor demand approach to model the CLEC investment decision, and then by using a unique dataset of CLEC competition in the years 2000 and 2001 to empirically estimate that investment decision.

The paper utilizes cross-state variation in the price of constructing local phone lines (adding capacity to the industry) relative to leasing UNEs (reselling existing capacity) to identify the sensitivity of CLEC investment in local lines to the UNE rate. Under the 1996 Telecommunications Act, each state's public utility commission (PUC) sets the UNE rate in that state. Because a stated objective of the Act was to encourage facilities-based competition, this paper provides an estimate of the effect of changes in the UNE rates on local line implementation by CLECs.

In Part II, we explain the theory underlying a CLEC's investment calculus and examine how mandatory unbundling encourages CLECs to delay facilities-based investment. We also apply a more advanced theory and show that a CLEC will delay investment if the average annual return is less than the option-value-adjusted weighted average cost of capital.

Part III is the statistical section of the paper. We begin with a standard model of factor demand that we apply to the provision of CLEC end-user service within a state. From that model we derive a regression specification to estimate the output-constant elasticity of substitution between facilities-based investment and UNE leasing. Using E911 data, we find a positive relationship between the log of the ratio of the average level of UNE rates and the cost of facilities based investment and the log of the ratio of facilities based to UNE lines. When the embedded cost is used to proxy for the true cost of facilities based investment, that relationship is significant at the 5 percent level of confidence.[11] Using the FCC's data, we find that the relationship between the log of the ratio of the loop rate and the build-out cost is again positively related to the log of the ratio of facilities-based to UNE lines. Additional analysis is required to render a definitive judgment on the relationship between these variables. Once a facilities-based line is built, its cost is sunk and the cost of "production" is virtually zero. Thus, the cost of a facilities-based line is incorrectly measured whenever the model implies that CLECs should reduce production from facilities-based lines from one period to the next. To account for this potential shortcoming, we proceed by estimating the relationship between the change in facilities-based investment over time and the relative price of facilities-based investment. Our results indicate that facilities-based lines growth relative to UNE growth was faster in states where the cost of UNEs was higher relative to the cost of facilities-based investment. This result is

11. Embedded cost is the historical cost of the incumbent's network, whereas hybrid-cost proxy model (HCPM) cost is an estimate of forward-looking cost of the incumbent's network based on the FCC's hybrid-cost model.

statistically significant at the 5 percent level in all regressions. Furthermore, scatter plots of the dependent variable and the ratios of the loop rate to the cost of building one's own facilities shows that there are no outliers in the regression. Hence, the best argument for maintaining the current unbundling regime—namely, that low UNE rates encourage CLECs to rent at first, and then build facilities once they have some market experience—is not supported by the data.

II. Understanding the CLEC's Investment Decision

The Telecommunications Act of 1996 ("The 1996 Act") added § 251(c)(3) to the Communications Act of 1934,[12] requiring each ILEC to offer competitors access to its network elements on an "unbundled" basis.[13] Section 251(d)(2) of the Act directs the Federal Communications Commission (FCC) to mandate the unbundling of particular network elements under § 251(c)(3) if, "at a minimum,"—(A) access to those elements that are proprietary in nature is *necessary*; and (B) the failure to provide access to a network element would "*impair* the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer."[14] (emphasis supplied)

Through § 251(d)(2), the 1996 Act places crucial importance on the investment decisions of CLECs. The "necessary" and "impair" standards are dependent upon "the services that [a CLEC] *seeks* to offer."[15] When determining whether or not to mandate the unbundling of a given network element, the Act directs the Commission to consider a CLEC's business plan. Thus, the Commission's decision begins with an understanding of why a CLEC chooses to invest, or not to invest, in a given bundle of service offerings.

A. Basic Investment Theory: A CLEC Will Forgo Investing in Its Own Facilities If the Net Present Value of Facilities-Based Investment Is Less Than the Net Present Value of Using UNEs

Like any profit-maximizing firm, a CLEC's investment decision depends on a calculated risk—that is, the CLEC must weigh the probability that it will earn an excess return from the investment against the risk of investment loss. A company will make an investment only if that investment has a positive net present value (NPV), or alternatively, if the average annual rate of return on that investment exceeds some appropriate measure of the firm's weighted-average cost of capital

12. Communications Act of 1934, ch. 652, 48 Stat. 1064.

13. 47 U.S.C. § 251(c)(3) ("An incumbent local exchange carrier shall provide such unbundled network elements in a manner that allows requesting carriers to combine such elements in order to provide such telecommunications service.").

14. *Id*. § 251(d)(2).

15. *Id*. (emphasis added).

(WACC).[16] The NPV of a potential investment is defined as the sum of the expected cash flows generated by the asset during each future time period, discounted at the project's WACC.[17]

The NPV methodology requires the firm to estimate the present value of the cash flows produced by the asset during each future time period, discounted at the project's cost of capital. The sum of the discounted cash flows for each time period is the investment's NPV. A potential investment with a positive NPV should be pursued because the future cash flows expected from the investment exceed the firm's initial outlays. Textbook investment theory dictates that, if two investments are mutually exclusive and a company must choose between allocating capital to one or the other, then it should choose the one with the higher NPV.[18]

A CLEC will forgo facilities-based investments so long as it has other opportunities that have higher NPVs. As we explain below, artificially low UNE prices induce CLECs to defer facilities-based investments because the NPV calculations of UNE leasing are higher than the NPV calculations of sinking capital into on-net assets.

B. Advanced Investment Theory: A CLEC Will Delay Investment If the Average Annual Return Is Less Than the Option-Value-Adjusted Weighted Average Cost of Capital

The explanation of the firm's investment decision outlined above explains only part of the CLEC's investment decision. In a world with real options, the CLEC can defer investments and wait for future information about the success or failure of its competitors' investments. A CLEC's opportunity to defer investing in its own facilities is analogous to a call option on traded equities. The CLEC has

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16. RICHARD A. BREALEY & STEWART C. MYERS, PRINCIPLES OF CORPORATE FINANCE 14 (5th ed. 1996).

17. EUGENE F. BRIGHAM & LOUIS C. GAPENSKI, INTERMEDIATE FINANCIAL MANAGEMENT 216 (5th ed. 1996).

18. The WACC calculation is an alternative to the NPV, and the WACC is similarly intended to measure the opportunity cost of capital allocations for budgeting purposes. Generally, the investment calculi are interchangeable. *See* BRIGHAM & GAPENSKI, *supra* note 17, at 187 ("If the [NPV and WACC] methods produced widely varying estimates, then the financial manager would have to use his or her best judgment as to the relative merits of each estimate, and then choose the estimate which seemed most reasonable under the circumstances. In general, this choice would be made on the basis of the financial manager's confidence in the input parameters of each approach."). Uncertainty and risk decrease the value of a project, and investors will be scared away in the absence of an adequate "risk premium" to offset the uncertainty inherent in the investment. Stated differently, the decision to sink capital into a new investment requires an average annual return in excess of the firm's WACC.

an option to invest in a profitable technology if it proves successful, while the CLEC is under no obligation to invest if the technology proves unviable.

In the face of financial uncertainty, mandatory unbundling gives a CLEC a valuable alternative to making facilities-based or "on-net" investments. Because a CLEC can pick and choose from the incumbents' successful sunk investments, it pays for the CLEC to "wait and see" how other investments in that sector have performed before committing to those investments itself.[19]

A compulsory network-sharing regime tips the balance of the CLEC's calculus in favor of waiting. In the world of UNEs, CLECs enjoy the "real options value" of deferred "sunk" investment. Because CLECs can lease UNEs from their incumbent competitors on a month-to-month basis, the traditional textbook analysis of the NPV of a prospective investment is an inadequate representation of the CLEC's investment decision.[20] Rather, to account for the value afforded the CLEC by shifting the burden of exploring uncertain new technologies onto the shoulders of the ILECs, we need to employ an options-based expanded NPV analysis.[21]

Real options theory explains two important aspects of CLECs' investment decisions. First, the forward-looking total element long-run incremental cost (TELRIC) methodology used by regulators to establish UNE rates produces artificially low UNE prices by neglecting to incorporate the real options value of CLECs' deferment of sunk investments.[22] Second, because CLECs have the option of demanding below-cost UNEs from ILECs, CLECs have incentives to continue to defer making facilities-based investments in their own networks.

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19. For an application of real options analysis to telecommunications investment, see THE NEW INVESTMENT OF REAL OPTIONS AND ITS IMPLICATIONS FOR TELECOMMUNICATIONS ECONOMICS (James Alleman & Eli Noam eds. 1999); Jerry A. Hausman & J. Gregory Sidak, *A Consumer-Welfare Approach to the Mandatory Unbundling of Telecommunications Networks*, 109 YALE L.J. 417 (1999).

20. *See* AVINASH K. DIXIT & ROBERT S. PINDYCK, INVESTMENT UNDER UNCERTAINTY 153 (Princeton University 1994). The authors have estimated that the markup on the cost of capital that is necessary to account for the sunk nature of investment varies from investment to investment, but is often at least two hundred percent. Stated differently, any project entailing significant sunk costs that yielded an expected return of between 100 and 200 percent of the cost of capital would no longer be justified. If a CLEC is considering sinking an enormous amount of capital into its own facilities today, but the firm can only expect a return of 150 percent, the firm is better off delaying its investment and waiting for better information or future technologies that promise higher returns.

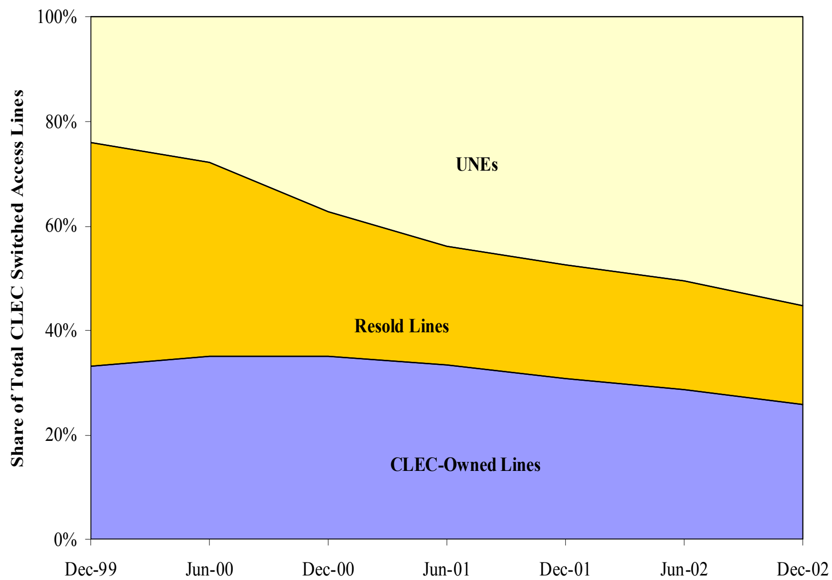
21. *See* Lenos Tigeorgis, *Real Options: A Primer, in* THE NEW INVESTMENT THEORY OF REAL OPTIONS AND ITS IMPLICATIONS FOR TELECOMMUNICATIONS ECONOMICS 3, 3-4 (James Alleman & Eli Noam eds. 1999).

22. *See* Jerry Hausman, *The Effect of Sunk Costs in Telecommunications Regulation*, *in* THE NEW INVESTMENT THEORY OF REAL OPTIONS AND ITS IMPLICATIONS FOR TELECOMMUNICATIONS ECONOMICS 191-204 (James Alleman & Eli Noam eds. 1999). These UNE rates are often set even below TELRIC estimates. See our discussion below.

C. The Composition of CLEC Investment Over Time

One way to measure the effect of UNEs on the method of CLEC entry is through time-series analysis. Figure 1 demonstrates that CLECs are increasingly relying on UNE-P as their preferred mode of entry.

FIGURE 1: CLECS ARE INCREASINGLY RELYING ON UNE-P AS THEIR PREFERRED MODE OF ENTRY



Source: FCC, LOCAL TELEPHONE COMPETITION: STATUS AS OF DECEMBER 31, 2002, at 6 (tbl. 3) (rel. June 12, 2003).
Note: UNEs include UNE-loops and UNE-platform.

The Y-axis is the share of total CLEC switched access lines: the sum of the shares across all types is 100 percent. The X-axis is the date. Whereas CLECs relied on UNEs for 23.9 percent of their lines in December 1999, by December 2002, UNE lines accounted for 55.4 percent of all CLEC lines.[23] Of all UNE lines in December 2002, 70.5 percent were acquired in combination with the ILEC's switch.[24] The availability of wholesale access appears to have discouraged CLECs from investing in their own facilities (including switches) over time. In Part III, we attempt to estimate the magnitude of this effect.

23. FCC, LOCAL TELEPHONE COMPETITION: STATUS AS OF DECEMBER 31, 2002, at 6 (tbl. 3) (rel. June 12, 2003) (available at http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/lcom0603.pdf).
24. *Id*. (tbl. 4).

III. THE ECONOMIC IMPACT OF UNE PRICING ON CLEC INVESTMENT

The CLECs' open recognition of their incentives to defer costly facilities-based investments should not be surprising. Moreover, we should not be shocked that venture capitalists sometimes discourage CLECs from making on-net investments because up-front capital costs affect the company's year-end bottom line. But even more convincing than anecdotal evidence is the systematic distortion of CLECs' investment decisions revealed through econometric analysis. Here, we employ a statistical model to better gauge the effects of UNE pricing on CLECs' investment decisions.

To test the effect of UNE pricing on CLEC investment, we first model the CLEC investment decision based on a constant elasticity of substitution (CES) production function. The unit of output is an access line (as opposed to a phone call) to a home or office. The firms' investment decision requires a choice between two inputs: (1) a leased UNE line or (2) constructing a facilities-based line. We assume a constant returns to scale (CRS) technology and estimate an equation implied by the fact that the marginal rate of technical substitution equals the ratio of the factor prices when firms minimize costs. We apply the model to two datasets: (1) the E911 dataset for 2000 and 2001 compiled by the incumbent carriers, and (2) a dataset compiled from the FCC's Reports on Local Competition between 2002 and 2003.

A. A Simple Model of Factor Demand

We consider the choice to build facilities or lease facilities from an ILEC to be a choice between two factors in a production function for the CLECs'. Formally, let U denote a UNE-based loop, let F be a facility-based loop. The variable x denotes a unit of CLEC service to an end user. Let l represent the cost of leasing a UNE line, and let r represent the build-out cost within the particular state.

We use a constant elasticity of substitution (CES) production function to model CLEC output within a state. The production function for CLEC service within the state is then:

[1] $$x = \gamma[\delta U^{-\rho} + (1-\delta)F^{-\rho}]^{-v/\rho},$$

where γ is the efficiency parameter, ρ is the substitution parameter, and δ is the distribution parameter. Equation [1] is homogenous of degree v. For simplicity, we assume constant returns to scale technology, and set v equal to one.[25] For any

25. The constant returns to scale assumption implies that the CLEC's cost will approach the ILEC's cost as the number of homes served by the CLEC increases. Because a CLEC would not enter a neighborhood to serve one or two homes, we believe this assumption is a reasonable

one firm, γ can be eliminated from the function by a suitable choice of units in which to measure CLEC output. Equation [1] simplifies to:

[2] $$x^{-\rho} = \delta U^{-\rho} + (1-\delta)F^{-\rho}.$$

Totally differentiating [2] and solving for the derivative of statewide CLEC output with respect to UNE loops and facilities-based loops yields:

[3] $$f_U = \frac{\partial x}{\partial U} = \delta\left(\frac{x}{U}\right)^{1+\rho} \text{ and}$$

[4] $$f_F = \frac{\partial x}{\partial F} = (1-\delta)\left(\frac{x}{F}\right)^{1+\rho}.$$

Taking the ratio of [3] to [4] yields the *MRTS*, $\frac{f_U}{f_F}$, which is given in [5].

[5] $$MRTS = \frac{f_U}{f_F} = \frac{1-\delta}{\delta}\left(\frac{F}{U}\right)^{1+\rho}.$$

Solving [5] for F / U and taking the derivative of that ratio with respect to the *MRTS* yields:

[6] $$\frac{\partial \log(F/U)}{\partial \log(f_U / f_F)} = S_{FU} = \frac{1}{1+\rho}.$$

From the cost minimization problem within the particular state one can generate the first order conditions: $f_U = l / p_x$ and $f_F = r / p_x$. Therefore, the *MRTS* is equal to the ratio of factor prices for the cost-minimizing firm. Substituting l / r for MRTS in [6], we find that a log-log linear equation that regresses the ratio of line utilization to the ratio of factor prices will yield an estimate of the direct elasticity of substitution.

starting point. Strong returns to scale, by contrast, would explain why a CLEC might prefer UNEs at small penetration levels, but might prefer to build their own facilities if and when it reaches (or can be assured of reaching) very large penetration levels.

B. The Statistical Model

Based on the theoretical discussion above, we begin our statistical analysis by estimating the following regression equation from a cross section of state data:

$$[7] \qquad log(F_i)\text{-}log(U_i) = a + b*[log(UPrice_i) - log(FCost_i)] + e_i$$

where *i* is a geographic (state) index. The variables in equation [7] are as follows:

F = CLEC facilities based lines
U = UNE lines
UPrice = Statewide average UNE loop rate
FCost = Statewide average of facilities-based cost[26]
u = random disturbance term

In [7], the regression coefficient *b* would be our estimate of the direct elasticity of substitution.[27]

C. Data Sources

For the monthly UNE price per line we use the average UNE loop rate as determined in proceedings supervised by each state's Public Utilities Commission (PUC) and published by the National Regulatory Research Institute (NRRI).[28] The NRRI study contains the relevant rates that CLECs must pay to operate UNE loops in the 50 states, plus the District of Columbia. Some of the rates are final, and others were under ongoing negotiation as of the July 2001 NRRI study, but all rates are the best available representation of the UNE cost in the respective state.

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26. For completeness we use two different measures of facilities-based cost: (1) the embedded (backward-looking) cost of the existing network, and (2) the forward-looking cost of the hypothetical efficient network as modeled by the FCC's hybrid cost proxy model (HCPM).

27. As the statistical model suggests, we assume that the UNE rates are exogenous with respect to the choice of inputs by the CLECs. Although CLECs might wish to alter the number of facilities-based lines built to influence the regulators in setting UNE rates, we do not believe that they have the ability to do so. Hence, we do not expect the coefficients will be biased due to this potential endogeneity.

28. These rates were compiled in a National Regulatory Research Institute (NRRI) study. *See* Billy Jack Gregg, *A Survey of Unbundled Network Element Prices in the United States* (Spring 2001); Billy Jack Gregg, *A Survey of Unbundled Network Element Prices in the United States* (Feb. 2003) *available at* www.nrri.ohio-state.edu/programs/telcom/pdf/UNEMatrix50701.pdf. We exclude from the analysis states that do not publish their average UNE rates. These states are Alaska, Arkansas, California, Colorado, Florida, Hawaii, Louisiana, Missouri, North Dakota, New Mexico, Ohio, Rhode Island, South Carolina, and South Dakota.

For the estimate of the cost of building loops, we use the loop rates based on embedded costs from FCC ARMIS reports.[29] These data reflect the actual expenses incurred by ILECs over time to build their networks in each state. The variance in these estimates reflects differences in population density, topography, and state or regulations that govern the placement of outside plant. Unfortunately, there are no estimates of embedded costs by density zone; therefore, we use statewide averages.[30] CLECs will build out the most attractive portions of each state first. We also use HCPM estimates of the costs of building loops.[31]

We estimate the number of CLEC facilities-based lines in each state as the difference between the number of CLEC total lines from the E911 database (exclusive of resale) and the number of UNE loops, including those provided with a total platform or UNE-P. Resale lines are excluded because both of these types of lines are listed as ILEC lines in the E911 database. Thus, our model focuses on a CLEC's incentive to lease UNE loops relative to investing in its own facilities-based network, a decision that most CLECs face. For each state, the number of E911 lines and the number of UNE loops for 2000 and 2001 were provided by the regional Bell operating companies (RBOCs) that provide local telephone service in that state. For states where more than one RBOC operates, we subtract the *sum* of the UNE loops across each RBOC in that state from the number of CLEC lines in the E911 database. In various FCC proceedings, AT&T and other CLECs have questioned whether any of the E911 listings are for CLEC special access lines.[32] But a CLEC rarely buys special access service from an ILEC to connect a private branch exchange (PBX) to its own local switch.[33] In addition to the E911 data, we also use data on CLEC UNE and facilities-based lines from the FCC as of

29. Professor Dale Lehman provided embedded cost data.

30. There may be some variation in embedded costs due to different growth rates across states. Rapidly growing states will have a newer telephone plant, on average, and therefore greater nominal embedded costs due to the effects of inflation on outside plant construction costs. On the other hand, newer switching facilities will generally have lower costs.

31. Professor Dale Lehman provided HCPM.

32. *See*, *e.g.*, AT&T Comments in FCC Triennial Review at 13-14 (Month 2002).

33. AT&T argues that it is forced to buy special access in this circumstance (as opposed to a local loop) because of the local traffic requirements. If the traffic is between a PBX and a CLEC's local switch, however, then AT&T's argument is invalid. A CLEC could, for instance, connect the PBX with two separate trunks—one obtained as a loop to connect to the CLECs' own local switch, and a second obtained as special access to connect to the IXC's point of presence (POP). Even in situations where there is only enough traffic to justify one trunk, if that trunk connects a PBX to a CLEC local switch it will in virtually all cases meet the local traffic threshold needed to purchase an unbundled loop as opposed to special access service. The trunks that do not meet this threshold are used solely or predominantly for long-distance traffic for which an E911 entry does not typically exist. Therefore, our analysis is unaffected. We should thus be permitted to assume that CLECs have used UNEs as opposed to services where they have been permitted to do so.

December 31, 2001, June 30, 2002, and December 31, 2002.[34] Therefore, we are able to perform our analyses on two separate datasets and compare the results for robustness.

The analysis is performed at the state level for two years (2001 and 2002), which requires the UNE loop rate and the average cost data to be weighted by the number of lines. UNE loop rates vary by density zone within a state. Ideally, the entire analysis could be performed at the density-zone level, but the number of facilities-based CLEC lines—the key dependent variable—is not available at a density-zone level. To the extent that more CLEC lines are attracted to areas within states with lower UNE loop prices, the weighted average price would be reduced, which might bias the results.

Because an investment in local phone lines is sunk and long-lived, current investment decisions should be based on current and expected future UNE rates. Because UNE rates are established through regulated arbitration proceedings, these rates could change if regulators are persuaded that current rates are not accurate reflections of forward-looking costs. In fact, UNE loop rates have been reduced in more than half of the lower 48 states and raised slightly in only five states since 2001.[35] Thus, the estimation based on 2001 UNE rates may understate the substitution parameter. Although it is presumably not possible to estimate expectations of future UNE rates, we can substitute the latest (July 2003) rates to see how actual changes in PUC arbitrations or regulation affect our results. Below we present estimates based on UNE prices that correspond to facilities-based and UNE loop numbers for that year, and note the regression results obtained when one uses July 2003 rates as a proxy for the expected future UNE rate.

Summary statistics for each of our variables for the pooled 2000 and 2001 cross sections are shown in Table 1.

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34. FCC reports produced before December 31, 2001 did not contain information on both CLEC facilities-based and UNE loops. Therefore, our analysis must be limited to the three most recent Reports.

35. Billy Jack Gregg, Survey of Unbundled Network Element Prices in the United States, National Regulatory Research Institute, January 2001 and July 2003.

TABLE 1: REGRESSION DATA USING E911 LINE DATA

Variable	Mean	Standard Deviation	Min	Max
E911 FB Lines	258,234.5	274,338.5	2,238	1,201,379
E911 UNE Loops	231,005	467,705.2	458	2,119,712
UNE Price	15.18	4.00	8.2	27.41
Cost	21.17	4.27	13.28	32.68
log(FB lines)	11.70	1.53	7.71	14.00
log(UNE lines)	11.03	1.74	6.13	14.57
log(FB)-log(UNE)	0.67	0.99	-1.44	2.80
log(UNE Price)	2.69	0.27	2.10	3.31
log(Cost)	3.03	0.19	2.59	3.49
log(UNE Price)-log(Cost)	-0.35	0.25	-.92	0.19

Note: There were 100 potential observations. We exclude from the analysis states that do not publish their average UNE rates. These states are Alaska, Arkansas, California, Colorado, Florida, Hawaii, Louisiana, Missouri, North Dakota, New Mexico, Ohio, Rhode Island, South Carolina, and South Dakota. In addition, we are unable to obtain line data for Connecticut and West Virginia in 2000 and 2001 and all US West states and Maine in 2001. Thus, we have a total of 56 observations.

TABLE 2: REGRESSION DATA USING FCC LINE DATA

Variable	Obs.	Mean	Standard Deviation	Min	Max
FB Lines	99	166,57	183,813	6,224	891,032
UNE Loops	99	318,03	458,839	7,391	2,152,34
UNEPrice	99	13.88	3.28	4.29	21.98
Cost	99	19.14	3.94	7.64	27.03
log(FB lines)	99	20.05	2.88	13.28	28.08
log(UNE lines)	99	11.53	1.02	8.76	13.70
log(FB)-log(UNE)	99	11.91	1.24	8.91	14.58
$[log(FB)\text{-}log(UNE)_t]– [log(FB)\text{-}log(UNE)_{t-1}]$	99	-0.39	1.07	-2.66	2.51
log(UNE Price)	68	-0.20	0.40	-1.55	0.78
log(Cost)	99	2.60	0.28	1.46	3.09
log(UNE Price)-log(Cost)	99	-0.33	0.21	-0.74	0.35
log(UNE Price)-log(HCPM)	99	-0.39	0.23	-1.13	0.19
Population (k)	99	7,036	6,140.44	572.0	33,871.7

D. Regression Results

We apply the generalized least squares technique to estimate equation [7], which adjusts the standard errors for autocorrelation and cross-sectional correlation, to states where we have data on CLEC lines. We are unable to obtain line data for Connecticut and West Virginia in 2000 and 2001, and all USWest states and Maine in 2001.[36] Table 3 presents the regression results using E911 data, and Table 4 presents regressions obtained from analysis on the FCC data.

36. These states include Arizona, Iowa, Idaho, Minnesota, Montana, Nebraska, Oregon, Utah, and Washington. In total, we have 65 observations.

TABLE 3: E911 CLEC LINE REGRESSIONS, DEPENDENT VARIABLE: LOG(FB LINES)-LOG(UNE LOOPS)

Variable	Coefficient (Z-Stat)	Coefficient (Z-Stat)	Coefficient (Z-Stat)
Eq. 1:			
log(UNEPrice)-log(LoopCost)	1.61 (12.65)	1.57 (11.67)	1.40 (7.52)
Population	---	---	$2.5x10^{-6}$ (6.69)
Metro Population	---	-0.001 (-0.22)	-0.005 (-1.03)
Constant	1.04 (18.57)	1.14 (2.86)	1.31 (3.08)
Chi-Squared	160.09	158.04	8.62
Regression P-Value	0.00	0.00	0.03
Eq. 2:			
log(UNEPrice)- log(HCPM)	0.024 (0.17)	-.27 (1.67)	0.39 (2.12)
Population	---	---	$-9.94x10^{-6}$ (-0.29)
Metro Population	---	0.007 (1.25)	0.001 (0.18)
Constant	0.61 (6.19)	-0.07 (-0.15)	0.46 (0.91)
Chi-Squared	0.03	2.86	4.97
Regression P-Value	0.86	0.24	0.17

TABLE 4: FCC CLEC LINE REGRESSIONS, DEPENDENT VARIABLE: LOG(FB LINES)-LOG(UNE LOOPS)

Variable	**Coefficient (Z-Stat)**	**Coefficient (Z-Stat)**	**Coefficient (Z-Stat)**
Eq. 1:			
log(UNEPrice)-log(LoopCost)	0.74 (6.71)	0.90 (5.45)	0.75 (5.08)
Population	---	---	6.22×10^{-7} (8.23)
Metro Population	---	0.024 (4.38)	0.009 (2.62)
Constant	-0.10 (-1.38)	-1.94 (-4.26)	-0.93 (-2.89)
Chi-Squared	45.03	45.93	129.35
Regression P-Value	0.00	0.00	0.00
Eq. 2:			
log(UNEPrice)- log(HCPM)	0.52 (6.19)	0.78 (6.14)	.74 (4.6)
Population	---	---	6.6×10^{-7} (7.84)
Metro Population	---	0.033 (5.39)	0.008 (2.18)
Constant	-0.14 (-1.83)	-2.54 (-5.66)	-0.83 (-2.52)
Chi-Squared	38.29	46.06	92.29
Regression P-Value	0.00	0.00	0.00

As Table 3 shows, there is a positive relationship between the log of the ratio of the average level of UNE rates and the cost of facilities based investment and the log of the ratio of facilities based to UNE lines. When the embedded cost is used to proxy for the true cost of facilities based investment, that relationship is significant at the 1 percent level of confidence. However, when HCPM is used to proxy for the cost of facilities-based investment, the coefficient on the investment on the price ratio is insignificant statistically unless both population and metro population are added to the regression. When only metro population is added to the regression, the investment coefficient is negative, but insignificant at the 5 percent level of confidence.

In Table 4, we find, using the FCC's data on UNE and facilities based investment, that the relationship between the log of the ratio of the loop rate and the build-out cost is positively related to the log of the ratio of facilities-based to UNE lines. That relationship is significant statistically at the 1 percent level of confidence in all regressions. While the combined results in Tables 3 and 4 indicate that a positive relationship exists between facilities based investment relative to UNE investment and the relative price of facilities-based investment one would require additional information to render a definitive judgment on the relationship between these variables.[37] However, once a facilities-based line is built, its cost is sunk and the cost of "production" is virtually zero. Thus, the cost of a facilities-based line is incorrectly measured whenever the model implies that CLECs should reduce production from facilities-based lines from one period to the next. To account for this potential flaw in the model, we proceed by estimating the relationship between the change in facilities-based investment and the relative price of facilities-based investment. In particular, we estimate the following relationship:

[8]
$$[\log(F_{it}) - \log(U_{it})] - [\log(F_{it-1}) - \log(U_{it-1}) = a + b*[\log(UPrice_i) - \log(FCost_i)] + e_i$$

We would expect the coefficient *b* to be positive, indicating that in states the UNE prices that are high relative to the cost of investment, facilities based lines would, over time, grow relative to UNE lines. Tables 5 and 6 presents these results.

37. We repeated the regressions in Table 3 and Table 4 using the current (2003) average loop rate as the relevant price of UNE lines. The logic of these regressions being that CLECs might respond to the future expectations of UNE prices rather than the current prices themselves. These regressions did not improve upon the results presented in Table 3 and Table 4. In particular, the estimated coefficient on the relative price variable was statistically insignificant in all regressions.

TABLE 5: FCC CLEC LINE REGRESSIONS USING EMBEDDED COST, DEPENDENT VARIABLE: CHANGE IN LOG(FB LINES)-LOG(UNE LOOPS)

Variable	Coefficient (Z-Stat)	Coefficient (Z-Stat)	Coefficient (Z-Stat)
log(UNEPrice)-log(LoopCost)	0.662 (22.81)	0.673 (5.24)	0.64 (5.91)
Population	---	---	-1.85×10^{-7} (-5.34)
Metro Population	---	-.008 (-6.53)	-0.006 (-7.21)
Constant	0.03 (2.08)	0.66 (6.51)	0.52 (6.52)
Chi-Squared	520.22	72.43	125.49
Regression P-Value	0.00	0.00	0.00

TABLE 6: FCC CLEC LINE REGRESSION USING HCPM, DEPENDENT VARIABLE: CHANGE IN LOG(FB LINES)-LOG(UNE LOOPS)

Variable	Coefficient (Z-Stat)	Coefficient (Z-Stat)	Coefficient (Z-Stat)
log(UNEPrice)- log(HCPM)	0.96 (100.54)	0.83 (37.49)	0.84 (27.29)
Population	---	---	-1.21×10^{-7} (-5.44)
Metro Population	---	-.007 (-17.2)	-.005 (-15.49)
Constant	0.20 (50.81)	0.67 (19.39)	0.58 (16.21)
Chi-Squared	10107	1437	912
Regression P-Value	0.00	0.00	0.00

The results in Table 5 indicate that facilities-based lines growth relative to UNE growth was stronger in states where the cost of UNEs was higher relative to the cost of facilities-based investment. This result is statistically significant at the 1 percent level in all regressions. Curiously, the coefficients on metro population and population are negative in all regressions in Table 5. Upon careful reflection, this result makes sense when one considers that rapid early growth in facilities-based investment would have occurred in the most densely populated states.

Indeed, competitive access providers (CAPs) provided facilities-based service in the most urban areas in the United States before the 1996 Act. Finally, scatter plots of the dependent variable and the ratios of the loop rate to the cost of building one's own facilities shows that there are no outliers in the regression. Figures 2 and 3 graphically illustrate this fact.

FIGURE 2: RELATIONSHIP BETWEEN THE CHANGE IN THE FACILITIES BASED TO UNE LOOPS AND THE PRICE RATIO

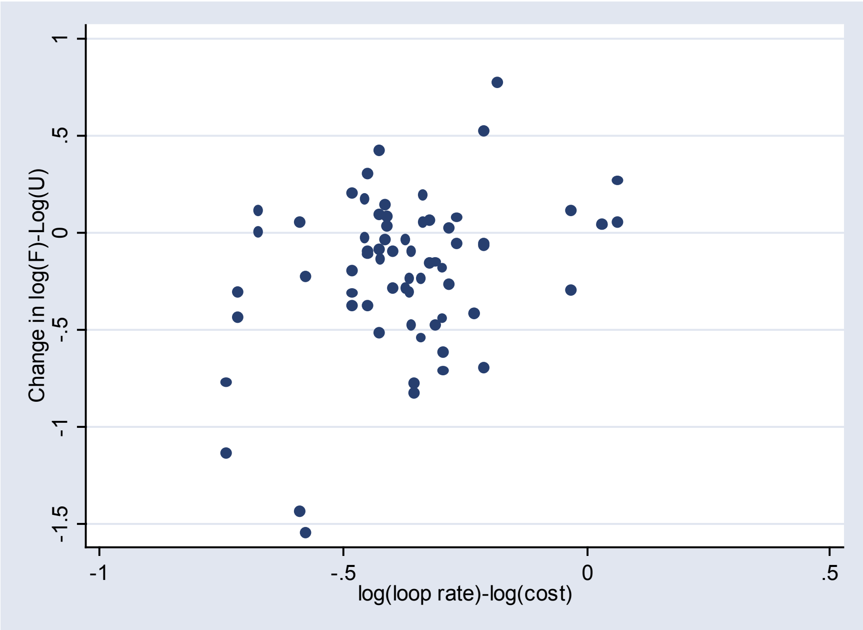
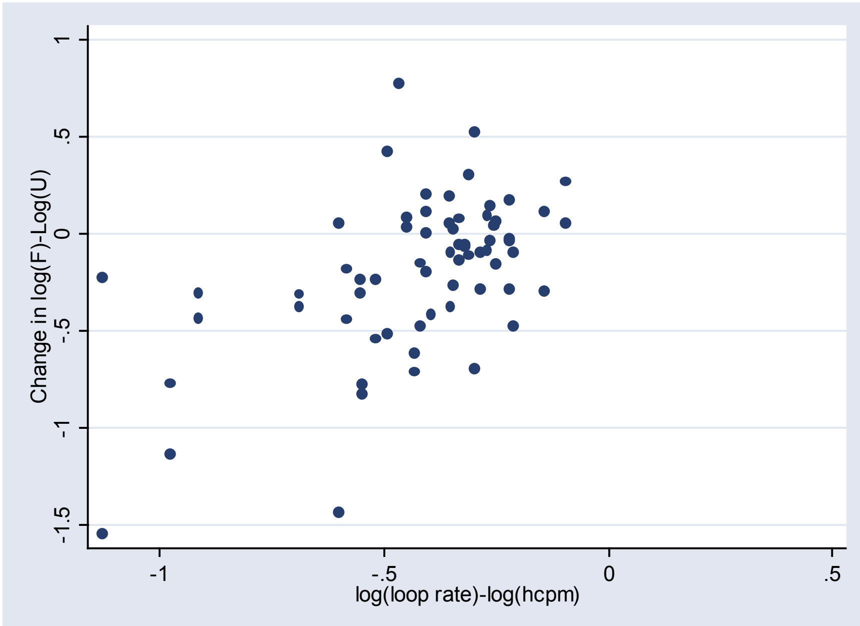


FIGURE 3: RELATIONSHIP BETWEEN THE CHANGE IN THE FACILITIES BASED TO UNE LOOPS AND THE PRICE RATIO WITH HCPM



Figures 2 and 3 suggest that the best argument for upholding the unbundling regime—namely, that low UNE rates encourage CLECs to rent at first, and then build facilities once they have some market experience—is undermined by data.

IV. CONCLUSIONS

Our results demonstrate that the share of CLEC lines that are facilities-based is lower in states where the UNE rental rates are lower, which suggests that unbundling decreases facilities-based competition in the short term. That model cannot rule out the possibility, however, that low UNE rates encourage CLECs to rent at first, and then build facilities once they have some market experience. But the notion that low UNE rates stimulate future facilities-based investment appears to be undermined by other results. In particular, a regression of the *change* in facilities-based investment over time indicates that facilities-based lines growth relative to UNE growth was faster in states where the cost of UNEs was higher relative to the cost of facilities-based investment. Based on this initial evidence, we believe that the burden of proof should now shift to the competitive local exchange carriers. If there is no evidence that low UNE rates stimulate facilities-based CLEC investment in future periods, then the entire unbundling experiment should be reconsidered.

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