NBER WORKING PAPER SERIES

ASSESSING THE ECONOMIC GAINS FROM TELECOM COMPETITION

Richard N. Clarke
Kevin A. Hassett
Zoya Ivanova
Laurence Kotlikoff

Working Paper 10482
http://www.nber.org/papers/w10482

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
May 2004

Portions of this research have been supported by AT&T. The opinions expressed here do not necessarily reflect the views of AT&T or of the authors' respective institutions. The views expressed herein are those of the author(s) and not necessarily those of the National Bureau of Economic Research.

Assessing the Economic Gains from Telecom Competition
Richard N. Clarke, Kevin A. Hassett, Zoya Ivanova, and Laurence J. Kotlikoff
NBER Working Paper No. 10482
May 2004
JEL No. L10

ABSTRACT

This paper develops and simulates a dynamic model of strategic telecom competition. The goal is to understand how regulatory policy, particularly relative to lease charges for local network elements, affects telecom competition, investment, retail prices, and consumer welfare. The model assumes two products, local voice service and data (broadband), and three types of players – the regional Bell operating companies, referred to as incumbent local exchange carriers (ILECs), cable companies (Cables), and competitive local exchange carriers (CLECs). The game begins with a) ILECs established in each county with respect to the provision of local voice and data services and b) Cables established in roughly half of the counties with respect to the provision of data.There are one-time fixed costs of entering a county, product- and period-specific costs of operating in a county, and marginal costs of supplying each product. Economies of scope reduce the fixed entry and operating costs of supplying both products in a given county at a given point in time. Finally, in supplying telecom services in a given county, CLECs may enter by leasing ILEC infrastructure at specified access rates. The requirement that ILECs allow CLECs to lease their local network facilities was established in the Telecommunications Act of 1996 as part of a quid pro quo that promised ILECs entry into the long distance market. But the ILECs continue to contest the quid. The ILECs support their position by suggesting that leased access reduces telecom investment and output and raises telecom prices. Our model considers the entire range of options available to each of the players, but it reaches the opposite conclusion. Indeed, we find thatif UNE-P rates were set at the Supreme Court-approved total element long-run incremental cost (TELRIC) levels, telecom investment and employment outlays would increase by over one fifth in counties containing the majority of the U.S. population and by over 30 percent in counties containing almost a third of the population. The present value of telecom outlays over the next 5 and 20 years would rise by $71 billion and $155 billion, respectively. On average, the switch from actual to TELRIC UNE rates would lower local phone rates across the country's 3108 counties by $57 per year, generating annual total savings to consumers of $15 billion. Almost two fifths of the population would experience reductions in local phone rates of 20 percent or more. Over one fifth would experience rate reductions of 30 percent or more. These findings of price reductions are based on a fairly conservative parameterization of our model with respect to the specification of true ILEC and CLEC incremental long-run production costs.

Richard N. Clarke
Director of Economic Analysis, AT&T

Kevin A. Hassett
Director of Economic Studies
The American Enterprise Institute

Zoya Ivanova
Ph.D Student, Boston University

Laurence J. Kotlikoff
Department of Economics
Boston University
270 Bay State Road
Boston, MA 02215
and NBER
kotlikof@bu.edu

I. Introduction

A vibrant telecom sector is remarkably important to national economic performance. Two-thirds of U.S. economic growth appears driven by innovations in information technology.[3] And telecom, which plays an essential role in information acquisition and dissemination, accounts for the lion's share of IT investment and innovation. Unfortunately, after booming during the second half of the 1990s, the telecom industry has fallen on hard times.[4]

What explains the decline in the telecom sector? The regional Bell operating companies, referred to as ILECs (incumbent local exchange carriers), blame it on their competitors, known as CLECs (competitive local exchange carriers). The CLECs blame it on the ILECs and the failure of the Federal Communications Commission (FCC) to vigorously enforce the Telecommunications Act of 1996 (TA96). This act required the ILECs to lease, at wholesale rates, telephone lines and the other bottleneck facilities they control to CLECs so that CLECs too could market local voice and broadband services. To ensure ILEC compliance with its provisions, TA96 dangled a very big carrot, namely allowing ILECs to enter the long distance market.

According to the CLECs, the ILECs have used every means at their disposal to stymie competition based on leased access and have failed to comply not only with the spirit, but also with the letter of TA96. For their part, the ILECs claim that competition based on leased access is synthetic and greatly limits their own incentives to invest. While the two sides have been arguing, the FCC has made three decisions that will

---

[3] See Jorgenson, Dale, "Information Technology and the U.S. Economy," *American Economic Review*, vol. 91, no. 1 (March 2001), 1-32. The Commerce Department's estimate of the contribution of information technology to economic growth is smaller.

[4] Extremely recent data may suggest that the industry is starting to rebound.

significantly affect future competition in telecom. The first is to permit all four regional Bell operating companies to enter the long distance market notwithstanding the fact that CLECs have yet to secure more than 15 percent of the local voice market.[5] The second is to reaffirm the role of state public utility commissions (PUCs) in setting conditions under which CLECs can lease either individual ILEC facilities or "platforms" of interconnected ILEC telephone lines, switches, and transport services. This latter option is referred to as *UNE-P*, which stands for unbundled network element platform, because in renting these elements, the CLECs are, in effect, leasing the entire platform of local network voice elements. In providing their final retail voice services under UNE-P, the CLECs bring to these wholesale network-inputs significant customer support and product differentiation.[6]

The alternative to competing for voice services under *UNE-P* is for CLECs to obtain physical access to customer loops by collocating equipment in ILEC central offices. Leasing access in this manner is called *UNE-L (unbundled network element loop)* because it entails disconnecting the telephone line or *loop* from the ILEC's switch and reconnecting it to the CLEC's equipment. This physical re-termination of the loop is called the *hot cut* process. Competing under *UNE-L* turns out to be very difficult, and often impossible, due to an array of significant operational and cost impediments.[7]

---

[5] Federal Communciations Commission, "Federal Communications Commission Releases Data on Local Telephone Competition," Press release, December 22, 2003. available at:

http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-242397A1.pdf

[6] The rental of network services at wholesale rates is routine in the long distance and wireless markets. The main difference is that in long distance and wireless markets, there are competing carriers, whereas in the local voice and broadband market, the ILECs have a virtual monopoly over the transmission infrastructure. Ironically, AT&T is one of the largest CLECs. When the Bell Telephone Company was broken up in 1983 into a single long-distance provider, AT&T was compelled to lease access to its long-distance lines. Today the ILECs are leasing these and other long-distance lines to transmit their customers' voice and data messages. I.e., in the long distance market, both sets of shoes are on different feet.

[7] Operational impediments include the considerable time the ILECs take to implement hot cuts and the mistakes, whether intentional or not, that they make in the process. The costs CLECs face in operating under UNE-L include the significant expense of collocating their equipment in the ILEC central offices, of

The third FCC decision grants ILECs what, over time, could amount to exclusive use of local phone lines to provide high-speed broadband service.[8] Specifically, the FCC has indicated that if ILECs add additional fiber to their transmission networks they are no longer required to unbundle (lease out) the use of that fiber to those CLECs seeking to market broadband under UNE-L.

These three FCC decisions have been made against the backdrop of an intense ILEC-CLEC battle over the proper pricing of UNEs. The ILECs appealed the FCC's *Total Element Long-Run Incremental Cost (TELRIC)* UNE pricing formula all the way to the Supreme Court and lost. But on the heels of the Supreme Court's affirmation of TELRIC, the FCC has opened a proceeding to investigate whether this standard needs to be revised[9] – and the ILECs continue to contest UNE pricing at the state level, particularly in states that have begun lowering their leasing rates toward TELRIC levels. Those states that have dropped their UNE rates have seen a significant increase in *UNE-P* based competition, and their residents have seen their local phone bills drop by as much as one third.[10]

---

renting collocation space from the ILECs, of backhauling loops from the ILEC central offices to their own networks, and of switching transmissions. For CLECs to provide broadband service, they need to have physical access to the loop, which means entering the market under UNE-L. But given the high costs and operational impediments of UNE-L, CLECS that provide broadband under UNE-L typically provision the voice service under UNE-P.

[8] The latter two decisions were part of the FCC's *Triennial Review of UNEs* Order that was announced on February 20, 2003. Subsequently, the FCC issued detailed regulations implementing its February decision. These regulations state that ILECs will no longer be required to unbundle facilities to CLECs for purpose of data transmission to the extent that these facilities are either modernized or expanded to provide high-speed fiber optic capacity.

[9] Federal Communications Commission, *Notice of Proposed Rulemaking in in the Matter of the Review of the Commission's Rules Regarding the Pricing of Unbundled Network Elements and the Resale of Service by Incumbent Local Exchange Carriers,* WC Docket No. 03-173, released September 15, 2003.

[10] See, Braunstein, Yale M. "The Role of UNE-P in Vertically Integrated Telephone Networks: Ensuring Healthy and Competitive Local, Long Distance, and DSL Markets." University of California, Berkeley, May 2003; Michigan Alliance for Competitive Telecommunications press release on "study" – May 15, and 2003 "Consumer Savings from Local Telephone Service Competition in Illinois," released by Illinois Coalition for Competitive Telecommunications, February 2003.

Given the importance of regulatory policy to the telecom industry and the importance of the industry to the economy, it's essential to have a clear understanding of how the telecom sector operates and responds to government actions. This paper seeks to contribute to that understanding by developing and simulating a new dynamic strategic model of telecom entry, pricing, and investment.

Our model features two products -- local voice service and data (broadband) -- and three types of players – ILECs, CABLES, and CLECS. The playing field consists of the 3,108 counties in the continental United States. The game begins with a) ILECs providing both local voice and data services in each county; and b) CABLES providing data service in roughly half of the counties. CLECs must decide if and when to enter each county and what products to market in those counties they enter. Multiple equilibria in the entry game are resolved via a randomization mechanism that selects equilibria with equal probability. Post-entry market supplies and product prices are determined via Cournot competition.

There are one-time fixed costs of entering a county, product- and period-specific costs of operating in the county, and marginal costs of supplying each product. There are also economies of scope that reduce the fixed entry and operating costs of supplying both products in a given county at a given point in time. Finally, in supplying voice in a given county, CLECs can potentially lower their costs by leasing ILEC unbundled network infrastructure at specified access rates.

The model's central message is that TELRIC UNE-based competition can be highly effective in lowering voice and broadband prices, enhancing consumer welfare, and resurrecting telecom investment. But the key to making UNE competition work

appears to be having state PUCs set platform rental rates at true *TELRIC* levels, which, we estimate, averages about $15.10 per line per month.[11] Thus far, only a few state PUCs have set their UNE-P rates close to what we measure to be their own state-specific TELRIC levels. Indeed, average state-specific actual UNE-P rates exceed this estimate of average TELRIC UNE-P rates by 27.9 percent.

Our model indicates that if UNE rates were set at TELRIC levels throughout the country, telecom entry, investment and employment outlays, and output would increase significantly and local voice prices would fall significantly. That is, telecom investment and employment outlays would increase by over 20 percent in counties containing the majority of the U.S. population and by over 30 percent in counties containing almost a third of the population – compared with the outlays that we may expect to occur under a continuation of current above-TELRIC UNE prices. In particular, improved adherence to TELRIC would increase telecom investment outlays by $71 billion over the next 5 years. And the present value of these outlays over the next 20 years would increase by $155 billion.

A switch in each state from current to TELRIC UNE rates would lower local phone prices, on average, across the country's 3108 counties by $57 per household per year for an aggregate savings of $15.0 billion per year. Almost two-fifths of households would experience reductions in local phone rates of 20 percent or more. Over one fifth would experience rate reductions of 30 percent or more.

---

[11] Our rough estimate of TELRIC rates starts with rates calculated from the FCC's 1998 Synthesis Model adjusted to report UNE costs. These rates are then deflated for 5 years at a 5 percent per year to account for intervening reductions in input prices and unit costs. This uniform nationwide calculation provides only a rough index of state-by-state TELRICs and should not be construed to support or impeach more targeted, specific calculations of TELRIC.

The gains from TELRIC-based UNE-based competition are significant across the entire spectrum of counties arrayed by income and population density. Almost a fifth of households in low-income – low-density counties begin to enjoy local voice competition when the switch is made from current to TELRIC UNE rates. And households and business in such counties experience an 8.7 percent reduction in the cost of their local phone service.

These findings are based on a fairly conservative parameterization of our model with respect to the specification of true ILEC and CLEC incremental long-run production costs. With arguably more realistic parameters, the average price of local phone service would fall by more than one third in moving from current to TELRIC UNE rates. And much greater price reductions would arise in the voice market were the government to require *electronic loop provisioning*, under which a customer's local voice transmissions would be switched electronically and instantaneously to CLEC facilities at the same extraordinary low cost as occurs in the long distance market.[12] Our simulations also show significant entry by CLECs in broadband. Indeed, across cross-county average broadband price under TELRIC pricing of UNEs ends up almost 22.9 percent lower than the regulated monopoly price.

In contrast to our findings about the gains from UNE-based competition with *proper* TELRIC pricing, the model indicates that current UNE pricing by some state PUCs is a mixed blessing. PUCs that set UNE prices far above TELRIC can actually end up raising voice prices, lowering demand for telecom services, and reducing telecom investment and employment outlays. The reason stems from our assumption that state PUCs will phase out their regulation of local retail telecom prices at the first sign of

[12] See Kotlikoff, Laurence J., "On the Broadband Mess," *The Milken Review*, First Quarter, 2003.

competition from CLECs. Such eventual regulatory "relief" is one of the long-term goals of TA96. But if wholesale prices for UNEs are set too high, competitors will be unable to provide service economically to all customers, and substantial segments of the market will be served only by a now unregulated monopolist or by an unregulated dominant market player. The resulting "free" market price likely will be higher than the price previously set by the regulators. Stated differently, a regulated monopoly may be preferred to an unregulated duopoly or oligopoly if the ILEC can persuade state PUCs to maintain above-TELRIC UNE prices and, thereby, raise their rivals' costs. Thus, state PUCs should understand that abandoning regulation at the first sign of competition may have very adverse consequences, and that limited competition may be a very poor substitute for full and fair competition.

This paper reaches its pro-competitive conclusions after considering the empirical evidence, reviewing basic lessons about monopoly behavior, and simulating our model for all 3108 counties in the continental United States.[13] We proceed in section 2 by describing the recent rise and fall of telecom investment. Section 3 considers the argument that the Telecommunications Act of 1996 (TA96) is responsible for the industry's recent distress. Section 4 presents our model. Section 5 delivers findings, and Section 6 concludes.

2. The Telecom Investment Boom and Bust

Table 1 shows total telecom investment since 1990 as well as the investment of the CLECs and ILECs. It is clear that TA96 triggered a huge expansion of investment. It did so by promising CLECs that they would receive access to the *local network* or

[13] Unfortunately, critical data needed to run the model are not available for either Alaska or Hawaii.

components (*elements*) of the local network at a reasonable price and on a timely basis. The local network refers to the local telephone lines, telephone poles, underground conduits, and switches that connect the American public to the outside word.

TA96 expanded use of this vital communications pipeline bottleneck by a) eliminating the ILECs' legal status as monopoly franchises and b) requiring the ILECs to rent access to the local network to incipient, would-be competitors. The act further required the ILECs to rent access to (to *unbundle*) the local network on either a component-by-component basis or on a package-of-components basis as requested by their competitors.[14] Finally, rents were to be set at a compensatory price that included a profit.

During the 1996-2000 telecom investment boom, over a third of gross and over one half of net telecom investment was done by the CLECs even though they were fifteen times smaller than the ILECs when measured in terms of revenues.[15] In 2000, at the peak of the investment boom, CLECs invested $25 billion, which almost matched the $27 billion of new ILEC investment.

Despite investing two-thirds of their revenues, as compared to one quarter by the ILECs, CLECs were able to gain only 8.5 percent of nationwide access lines, and only 4.6 percent of residential and small business lines, by the end of 2000. The explanation for this is straightforward. CLECs concentrated their investment in dense metropolitan

[14] Because local network assets were acquired by the ILECs under concessionary conditions and paid for by the public over decades in the form of high, regulated telephone rates for local and long distance telephone calls, even these "compensatory" rents may be too high.

[15] Hall, Robert E. and William H. Lehr, "Rescuing Competition to Simulate Telecom Growth," mimeo, September 28, 2001. Revenues refer here to receipts earned from operations in the local telecom market.

areas to a) capture scale and density economies and b) bypass ILEC control of the local network by constructing their own pipelines feeding into high-traffic office buildings.[16]

Over the past seven years, state PUCs have adopted a "look-see" approach to lowering UNE-P rates and vigorously enforcing TA96. They have looked to preserve ILEC profitability, while also seeing how much competition their policies would engender. Recently, PUCs in a number of major states, including New York, California, Illinois, and Michigan, have lowered their UNE rates toward TELRIC levels and have required their ILECs to expedite the unbundling process. In these states, CLEC market shares have risen and local voice and broadband retail prices have fallen.[17]

The surge in telecom investment in the last decade was not unique to the United States. According to a recent Organization for Economic Cooperation and Development (OECD) review of telecommunications policy in OECD member nations, "The evidence indicates that opening access networks and network elements to competitive forces increases investment and the pace of development. Nearly all OECD governments have

---

[16] CLECs attribute this need to bypass the ILECs to the fact that the ILECs used and continue to use a variety of mechanisms to restrict or degrade access to the local network. Their proposed list of abuses includes charging exorbitant prices for unbundling their components (*elements*), delaying the transfer (*handoff*) of loops (wires) from their own switches to those of competitors, using slow and error-prone *manual* rather than electronic handoffs, charging high prices to CLECs for renting space in ILEC local service offices to collect these loops, and simply opting to pay fines rather than obey the law. CLECs claim that these ILEC practices have succeeded in killing off the lion's share of their number.

[17] For example, one recent estimate finds that local phone customers that switch to CLEC providers can save $11.40 per month, or almost $137 a year, in California. See http://www.trac.policy.net/proactive/newsroom/release.vtml?id=18900. A study released by the Michigan Alliance for Competitive Telecommunications said consumers in that state saved $72M on local residential phone bills in 2002 because of competition stimulated by reduced UNE-P rates. A similar study in Illinois said consumers spent $131 million less on local residential phone service as competition heated up. See, Braunstein, Yale M. "The Role of UNE-P in Vertically Integrated Telephone Networks: Ensuring Healthy and Competitive Local, Long Distance, and DSL Markets." University of California, Berkeley, May 2003; Michigan Alliance for Competitive Telecommunications press release on "study" – May 15, and 2003 "Consumer Savings from Local Telephone Service Competition in Illinois," released by Illinois Coalition for Competitive Telecommunications, February 2003.

already introduced such policies or taken decisions to introduce such policies, in respect to telecommunications networks."[18]

This evidence notwithstanding, there have been few careful attempts to measure the effects of unbundling on price and investment. One exception -- Willig, Lehr, Bigelow, and Levinson (2002) -- gathered detailed data on ILEC investment and regulatory regimes and found that lower UNE prices are associated with higher ILEC investment in a statistically significant manner --a pattern consistent with the findings presented here, including the fact that the investment boom ended when most of the CLECs exited or were otherwise driven out of the market.

3. The ILEC View

The ILECs have a much different view of the 1996-2001 telecom boom and bust. Their explanation of CLEC business failures is that these companies had bad business plans, over-invested in telecom, and were poorly managed. With respect to their own investment, the ILECs argue that absent TA96 and TELRIC pricing, they would be introducing broadband much more rapidly throughout the country.

This position is set forth in Jorde, Sidak and Teece (2000), Hausman (1997, 1998, 2000, and 20002), Kahn (1998), and Sidak and Spulber (1997). Their framework is given in equation (1), which equates the expected marginal return from investment to its marginal cost.

$$(1) \qquad \lambda_b MR_b MPK_b + \lambda_g MR_g MPK_g = c\,,$$

[18] See Organization for Economic Cooperation and Development (2001), p.4.

where λ_b is the probability of the bad state with low demand and λ_g is the probability of the good state with high demand. In $MR_i MPK_i$, MR_i stands for the marginal revenue product and MPK_i stands for the marginal physical product of capital in state i. The term c is the user cost of capital. Those who suggest that TA96 has lowered ILEC investment make two arguments. First, they claim that MR_i equals the retail price of telecom output in state i and that TA96 lowers retail prices, particularly in states of high demand. Second, they contend that TA96 makes the cost of capital c higher by increasing the risk of ILEC investment. In both cases the level of capital and, thus, investment that satisfies the equation is smaller than would otherwise be the case.

Our principal concern with these studies is that they treat ILECs as ordinary, price-taking competitive firms, rather than as natural monopolists, that control bottleneck infrastructure. In taking this approach, the prior studies ignore the elementary textbook lesson that lowering and fixing the prices that monopolists can charge will induce them to produce *more*, not less, output. The reason is that when confronted with a fixed price, monopolists no longer have an incentive to restrict production in order to jack up prices and profits. Because producing more output entails acquiring more inputs, this means hiring more labor and investing in more capital.

How does this discussion square with equation (1)? It doesn't. In the case of a regulated monopoly, equation (1) doesn't represent the correct framework for determining investment. Even if it did, under monopoly marginal revenue, MR_i, doesn't

equal price, and eliminating monopoly by fixing a lower output price can actually raise marginal revenue.[19]

The third point seemingly missed by the prior studies is that TA96's leased access provisions represent an indirect method of regulating the price telecom monopolists can charge. Instead of simply setting and fixing price, leased access uses competition to do so. In the course of setting a lower price, leased access expands the market, but also may transfer some market share to new entrants. Total market output and capital must increase, but depending on the share captured by CLECs, ILEC capital may go up or down. Leased access also transforms ILECs into wholesale producers with respect to their transactions with the CLECs. And because much of the final output sold by CLECs employs wholesale network inputs purchased from the ILECs, the effect of retail market share loss on ILEC capital investments is likely to be minimal. This point is important in assessing the unbundling simulations presented below.

To summarize, TA96 needs to be understood as part of a general strategy of restraining a natural monopolist from exercising monopoly power. The unbundling requirements of TA96 enforce competitive pricing. While this lowers the prices the ILECs receive for their products, they are still likely to produce and invest more, either directly or through their sale of inputs to the CLECs, as they realize that limiting supply

---

[19] When price is fixed (typically at average cost) via regulation, the monopolist ends up at a corner solution in which marginal cost exceeds marginal revenue with respect to a marginal increase in output and marginal revenue exceeds marginal cost with respect to decrease in output. In the case of a monopolist, MR_i does not simply equal the monopoly product price, P_i^m. Instead, it equals the product $P_i^m\ (1\text{-}1/\varepsilon)$, where ε is the elasticity of demand. Unregulated monopolists operate in regions of the demand curve in which ε exceeds 1. Consequently, marginal revenue is below price. When regulators set a regulated lower price, call it P_i', they also transform the demand curve facing the monopolist into a horizontal line, with $\varepsilon = \infty$. This, in turn, changes marginal revenue from the product $P_i^m\ (1\text{-}1/\varepsilon)$ to P_i'. Hence, leased access can raise ILEC marginal revenue even through it lowers the product price.

to increase prices will no longer work. Thus, when one frames the discussion of TA96 as part of a policy to restrict monopoly power and compares the impact of TA96 with the price fixing and cutbacks in supply that its absence would foster, the conclusion that TA96 stimulates overall telecom output and investment seems unavoidable. Moreover, the proposition, supported by the investment experience reported in Table 1, that it actually stimulates ILEC production and investment is highly plausible.

An additional, but crucial point ignored by the literature claiming that TELRIC pricing is "too low," is that that the TELRIC formula prices unbundled network access at its average cost rather than its much lower marginal cost. Pricing at marginal cost is, of course, more efficient because it equates marginal benefits to marginal costs. In contrast, TELRIC pricing may leave marginal benefits far above marginal costs. Hence, under TELRIC pricing access rates may be set too high, rather than too low. Indeed, TELRIC access rates appear to be far too high since the marginal costs of using many of the elements of the local network are close to zero.

4. Analyzing Telecom Investment as a Dynamic Game

The ability of TA96 to restrain the ILECs from monopolizing the provision of telecom products depends critically on the degree to which the law encourages CLECs to enter and compete in local telecom markets. In this section we develop an economic model that accounts for these factors. Subsequent sections discuss the model's calibration to U.S. county data and present our simulation results.

A serious appraisal of TA96 and its impact on investment, product pricing, and consumer welfare requires a dynamic model that incorporates multiple telecom products,

entry and exit decisions, heterogeneity in local telecom demand, the first-mover advantage of the ILECs, the ability of multiple competitors to unbundle and use the local network pipeline, the cost of unbundling, competition from cable companies, the nature of local telecom competition at any point in time given current entrants, economies of scope in producing and marketing multiple telecom products in the same geographic location, and the option values of both waiting to invest and not waiting to invest.[20] Each of these features is included in our analysis. One added feature that we include in our model but not in the simulations because of computational constraints is economies of scale in entering geographically adjacent markets.

Since the model has a number of features, it may help to present it first informally, the task to which we now turn.

Players, Products, and Location

The model accommodates a variable number of players, products and local markets, which we reference as squares on a grid. In the simulation, however, we posit four players – an ILEC, two CLECs and a Cable— that market two products – local voice and data – in 3108 local telecom markets – the counties in the continental United States. In principal, each player decides each period whether to remain in the squares in which

[20] Hausman's concern about option values affecting telecom investment decisions is certainly appropriate, but there is no way to evaluate TELRIC pricing without a fully articulated dynamic model in which the options available to both the ILECs and CLECs are made explicit. Since Hausman fails to present such a model, he provides no substantiation for his allegation that TELRIC prices are set too low. Furthermore, the TELRIC formula's cost of capital takes into account investor considerations of option values. Finally, many of the points that Hausman makes about CLECs having the option to terminate the purchase of UNE-P service from ILECs are not particularly special to this market. Regardless of what line of business one considers and regardless of whether one is talking about retail or wholesale sales, the reality is that retail telecom customers almost always retain the option of not buying one's product leaving one with unrecoverable sunk costs. Hausman's concerns also seem to pre-date the FCC's issuance of its Triennial Review Order in which is makes clear that it does not intend to require ILECs to provide CLECs access to services and capabilities that may arise from new ILEC investments or technologies.

she has been operating or whether to enter squares in which she hasn't been operating. However, in our specific application of the model only the CLECs make entry and exit decisions.

The Structure of Demand

Demand differs in each square and can change over time. Specifically, we assume that squares can differ in the number of consumers they contain and their average per capita income. Households in these squares are assumed to have Cobb-Douglas preferences defined over communication services and other goods and services. Communication services are, themselves, a composite commodity generated by a Cobb-Douglas production function, whose inputs are the individual telecommunication products sold on the market, e.g., voice and data.

These assumptions greatly simplify the model and the time required for its computation. With Cobb-Douglas preferences, households spend a fixed share of their incomes on communication services each period. And, thanks to the Cobb-Douglas assumption about the production of communication services, households also spend a fixed share of their income each period on each particular telecom product. This feature implies three things. First, there is a unitary elasticity of demand for each telecom product. Second, it becomes computationally simple to calculate total countywide demand for each telecom product once the price of the product is determined; all that is needed is to divide the price of the product by total countywide income. Third, the demand for one telecom product does not depend on the prices of the other telecom products.

The Structure of Supply

Telecom firms are assumed to produce their products at constant marginal cost, but they face two different fixed costs. One is a fixed cost for entering a square (geographic market), which must be paid upon initial entry, but need not be paid again as long as the firm continues to operate in the square. Such fixed entry costs are meant to capture the costs of installing local infrastructure that is incidental to producing telecommunications services in the market in question.

The other fixed cost is a flat operating cost that the firm must pay each period that it operates (produces and sells product) in the square. One can think of these as the overhead costs of management, accounting, billing, providing customer support, advertising, maintaining a fringe benefits program, and the flat costs of renting (either explicitly or implicitly via direct ownership) necessary network facilities.

We can model economies of scale by specifying that the fixed entry and operating costs for a particular square are lower if the player is already operating in an adjacent square. And we can model economies of scope by assuming that if a player offers more than one product in a square, her fixed costs of entering the square to offer the second product and her fixed operating costs with respect to this second product are lower.

The State of Entry

At the beginning of each period, there is a *state of entry* that indicates which players operated in the square in the previous period. The indicator variables identifying such states of entry represent the model's state variables. The state space that is relevant to entry decisions in any given square can get very large in the presence of economies of

scale. The reason is that the state of entry in one square can affect entry and exit decisions in adjacent squares, which, in turn, affect decisions in squares adjacent to the original adjacent squares, and so on. This implies that the inclusion of scale economies enlarges the state space relevant to entry and exit in a given square to the state of entry in all squares. Since the application of our model treats each of the 3108 counties in the continental United States as a square, incorporating economies of scale would entail evaluating an enormous set of strategies over an enormous set of state variables – something far beyond the capacity of conventional computers.

Entry and Exit Decisions

At the beginning of each period, the players decide whether or not to offer each of the products in each of the squares. The fixed costs they incur for entering a square and offering service may differ across products and, as indicated, be subject to economies of both scale and scope. The fixed operating costs can also be subject to economies of scope, if more than one product is offered by the same player in a given square. The fact that incumbents don't need to pay an entry cost, while new entrants do, captures the advantage of moving first (being an incumbent). In general, entry costs will differ across players and are influenced by regulatory policy.

Players that exit a market are assumed to abandon their infrastructure. Hence, if they choose at a future date to enter a square, they will need to repay the fixed entry cost. This feature may lead players to remain in a square in the short run even if they are losing money on current operations.

Since there are several products per square and many squares, there are many different "in" or "out" entry strategies over which each player must choose. This choice is whittled down by solving for the set of pure strategy Nash equilibria, which, in this setting, refers to the set of strategies in which each player makes an entry decision with respect to each product and each square that generates the largest expected profits, measured in present value, given the entry decisions (i.e., the strategy sets) of the other players. Players consider not just their current profits from entry, but also their future profits because their future profits can be used to amortize their initial fixed entry costs.

Multiple Equilibria

In entry games of this type, multiple Nash equilibria are to be expected. Intuitively, if player A enters a market it may be optimal for player B to stay out. But if player A stays out, it may be optimal for player B to go in. Which outcome arises can be thought of as a fluke of timing since there is nothing in our model that pins down which equilibrium is selected.

Our method of resolving the problem of multiple Nash equilibria in a given period is to assume that each of the Nash equilibria is played with the same probability.[21] The players realize that this randomly determined coordination over particular Nash equilibria will occur not only in the present, but also at every future date. And they take this into account in determining their best current entry/exit strategy for each of the possible current entry/exit strategies of their fellow players.

[21] This assumption that a particular equilibrium among the many available is selected is Aumann's (1974) *correlated equilibrium***.**

Within-Period Product Competition

Once entry and exit decisions have been made, the players operating in a given square play Cournot. Consequently, the more entrants in a given square, the lower are product prices, and the better off are consumers.[22] Another appealing feature of Cournot within-period equilibria is that producers with lower marginal costs produce more output than those with higher marginal costs. Finally, the Cournot Model suggests that the reduction in product prices associated with more competition can lead the ILEC to invest more and produce more output. While the Cournot model has lots of appealing features, the list does not include the ability to consider the bundling of products that players would likely use to achieve a competitive advantage. Such product bundling will be examined in future work.

Option Valuation

The model is solved using dynamic programming, which automatically captures all the options available to the players with respect either to delaying or accelerating their entry/investment decisions.[23] Consequently, it deals explicitly with the concerns raised by Hausman (1998, 2002) that TA96's effects must be evaluated with respect to possible ILEC options to wait to invest. Although our model does not include exogenous pricing uncertainty, future prices are uncertain because of the correlation on randomly selected equilibria. Hence, there can be a value to waiting in order to ascertain whether other firms choose to enter a square.

---

[22] This assumes that new entrants do not have higher marginal costs, on average, than incumbents.

[23] If the last period is set sufficiently far into the future, its choice will not affect the model's predicted current behavior.

The Formal Model

Time runs from $t=1$ to $t=T$. There are Z players, V network inputs, and $F= H \times M$ squares, where H is the number of north-south squares and M is the number of east-west squares. For each product and for each player, there are $N=2^F$ possible states of entry at the beginning of any period, where a state of entry is a description of all the squares in which a player was operating in the previous period.

Entry Space

The possible states of entry of player i with respect to product k at the beginning of any time t are given by the N rows of the $N \times F$ matrix E, with row vector e_i. A value of *0* indicates entry has not yet occurred. A value of *1* indicates entry has occurred. Note that there are F elements in each row vector – one for each square.

(1)

$e_1 = (0,0,0,0,\ldots,0)$
$e_2 = (1,0,0,0,\ldots,0)$
$e_3 = (0,1,0,0,\ldots,0)$
$e_4 = (1,1,0,0,\ldots,0)$
$e_5 = (0,0,1,0,\ldots,0)$
$e_6 = (1,0,1,0,\ldots,0)$
$e_7 = (0,1,1,0,\ldots,0)$
$e_8 = (1,1,1,0,\ldots,0)$
. .
. .
. .
$e_N = (1,1,1,\ldots,1)$

The State of Entry

Let m_{ikt} denote the entry state of player i with respect to product k at the beginning of time t. The value of m_{ikt} is a number ranging from *1* through N indicating which of the

N row vectors of E is applicable. The entry state of all players at the beginning of time t is given by the $Z \times V$ matrix A_t, whose row vectors (one for each player) are given below.

(2) $a_{1t} = (m_{11t}, m_{12t}, \ldots, m_{1Vt})$

$a_{2t} = (m_{21t}, m_{22t}, \ldots, m_{2Vt})$

$\vdots$

$a_{Zt} = (m_{Z1t}, m_{Z2t}, \ldots, m_{ZVt})$

Each element in A_t can take on N different values. Hence, there are N^{ZV} different possible states of nature (A_t matrices) at time t.

Strategies

In each period, each player can play any of the rows of E; i.e., players can stay where they are in terms of entry, chose to leave squares they entered in the past, or choose to enter squares in which they were not operating in the previous period. There are $G = N^V$ different strategies for each player, because there are V products and N possible entry vectors for each product. Index these strategies by g, where $g = 1,\ldots,G$. Let $s_{g(i)t}$ refers to strategy g undertaken by player i at time t, where strategy vector $s_{g(i)t} = (j_{g(i)1t}, j_{g(i)2t}, \ldots, j_{g(i)Vt})$, for $g(i) = 1,\ldots,G$. This vector indicates the entry decisions made by player i at time t for each product given that player i is playing strategy $g(i)$. For example, suppose there are three products ($V = 3$) and consider $s_{g(i)t} = (4,7,2)$. This strategy entails player i entering the market for product *1* in all the squares determined by the row vector e_4, entering the market for product *2* in all the squares determined by the row vector e_7, and entering the market for product *3* in all the squares determined by the row vector e_2.

Determination of Entry at Time T

Entry decisions at time T need to be made for each possible state of the entry matrix A_T. For each such possible state we calculate all pure strategy equilibria at time T. We then assume that each of these equilibria arises at time T with equal probability; i.e., that there is a random correlation mechanism that chooses the equilibrium.

Calculating Pure Strategy Equilibria at Time T

Let $\pi_{it}(s_{g(1)1t}, s_{g(2)2t}, \ldots, s_{g(Z)Zt}; A_t)$ for $g(1) = 1,\ldots,G;\ g(2) = 1,\ldots,G;\ \ldots;\ g(Z) = 1,\ldots,G;$ specify the net income earned by firm i in period t given the state of entry is A_t from playing strategy s_{git} given that player *1* plays $s_{g(1)1t}$, player 2 plays $s_{g(2)2t}$, etc. For $(s_{g(1)1T}, s_{g(2)2T}, \ldots, s_{g(i)iT}, \ldots, s_{g(Z)ZT}; A_T)$ to be a pure strategy at T, it must be the case that,

(3)

$$\pi_{1T}(s_{g(1)T}, s_{g(2)T}, \ldots, s_{g(Z)T}; A_T) \geq \pi_{1T}(s_{jT}, s_{g(2)T}, \ldots, s_{g(Z)T}; A_T), \text{ for all } j \neq g(1).$$

$$\pi_{2T}(s_{g(1)T}, s_{g(2)T}, \ldots, s_{g(Z)T}; A_T) \geq \pi_{2T}(s_{g(1)T}, s_{jT}, \ldots, s_{g(Z)T}; A_T), \text{ for all } j \neq g(2).$$

$$\vdots \qquad\qquad \vdots$$

$$\pi_{ZT}(s_{g(1)T}, s_{g(2)T}, \ldots, s_{g(Z)T}; A_T) \geq \pi_{ZT}(s_{g(1)T}, s_{g(2)T}, \ldots, s_{jT}; A_T), \text{ for all } j \neq g(Z).$$

Determination of Entry at $t<T$

Entry decisions at time t need to be made for each possible state-of-entry matrix A_t. For each possible state-of-entry matrix we calculate all the economy's pure strategy equilibria at time t. As in the case of entry at time T, we assume that each of the time $t<T$ equilibria arise with equal probability.

Calculating Pure Strategy Equilibria at Time *t*

Let $N_t(A_t)$ equal the number of pure strategy equilibria at time t given that the entry state at time t is A_t. Let $n_t = 1,\ldots,N_t(A_t)$ reference these equilibria. Define $V_{it}(A_t)$ as the expected present value of net income earned by firm i calculated at the beginning of time t given the entry state at time t is A_t.

$$(4) \qquad V_{it}(A_t) = \sum_{n_t=1}^{N_t(A_t)} \frac{\pi_{it}(n; A_t) + \delta V_{it+1}(A_{t+1}(n_t))}{N_t(A_t)},$$

where $V_{iT+1}(A_{T+1}) = 0$. The term δ is the discount factor. The index n_t, which references the pure strategy equilibrium played at time t, determines the entry state that will prevail at time $t+1$. Hence, A_{t+1} is written as a function of n_t. For $(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(i)t}, \ldots, s_{g(Z)t}; A_t)$ to be a pure strategy at t, it must satisfy

(5)

$$\pi_{1t}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(Z)t}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{g(1)1t}, s_{g(2)2t}, \ldots, s_{g(Z)Zt})) \geq$$

$$\pi_{1t}(s_{j1t}, s_{g(2)2t}, \ldots, s_{g(Z)Zt}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{j1t}, s_{g(2)2t}, \ldots, s_{g(Z)Zt})), \quad \text{for all } j \neq g(1).$$

$$\pi_{1t}(s_{g(1)1t}, s_{g(2)2t}, \ldots, s_{g(Z)Zt}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(Z)t})) \geq$$

$$\pi_{1t}(s_{jt}, s_{g(2)t}, \ldots, s_{g(Z)t}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{jt}, s_{g(2)t}, \ldots, s_{g(Z)t})), \quad \text{for all } j \neq g(2).$$

$$\vdots \qquad\qquad \vdots$$

$$\pi_{1t}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(Z)t}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(Z)t})) \geq$$

$$\pi_{1t}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{g(Z)t}; A_t) + \delta V_{1t+1}(A_{t+1}(s_{g(1)t}, s_{g(2)t}, \ldots, s_{jt})), \quad \text{for all } j \neq g(Z).$$

The equations defining pure strategy equilibria are the same as those for time T except that the players consider not simply current net revenue from playing a particular strategy, but also the expected present value of future revenue associated with entering

the next period from the entry state to which their own strategic entry decisions as well as those of their competitors lead.

The Structure of Demand and Supply

Assume the utility of agents is Cobb-Douglas in communications, c, and other goods, d, where

(7) $$U(c,d) = c^{\alpha} h^{(1-\alpha)}$$

Each agent's demand for communications is given by $c = \alpha y/p_c$, where y stands for income and p_c stands for the price of communications. Each agent produces communications based on a Cobb-Douglas production function that takes as inputs the V communications products that include local telephone and data. Each agent's production function is given by

(8) $$c = Hq_1^{\beta 1} q_2^{\beta 2} \ldots q_V^{\beta V}, \text{ where } \beta_V = 1 - \sum_{j=1}^{j=V} \beta_j$$

Cost minimization implies that input expenditure shares equal their production coefficients.

(9) $$p_i q_i = \beta_i E$$

The constant returns property means that total costs equal total expenditures. Hence,

(10) $$p_c c = E ,$$

where p_i is the price (user cost) of input i. And since $p_c c = \alpha y$, we have

(11) $$p_i q_i = \beta_i \alpha y$$

or

(12) $$q_i = \beta_i \alpha y / p_i$$

The aggregate demand for telecom input i in the telecom market in question, Q_i, is then,

(13) $$Q_i = \beta_i \alpha Y / p_i ,$$

where Y is aggregate income in the local telecom market.

The Cournot Game

A player j producing telecom input i playing Cournot will set

(14) $$\eta \theta_{ji} = (p_i - mc_{ji}) / p_i ,$$

where η is the inverse demand elasticity in the market for the input, θ_{ji} is the output share of player j in the production of good i, and mc_{ji} is the marginal cost of player j in producing input i. In this model, $\eta = 1$. Summing the above equation over all players j, we have that

(15) $$p_i = \sum_{j=1}^{v_i} mc_{ij} / (v_i - 1),$$

where v_i is the number of players in the market.

Summarizing and Evaluating the Solution

This solution is simple. In each square for each configuration of entrants being considered, we simply add up the marginal costs of the players, divide by one less than their number, and that's the price that will prevail. The formula, $Q_i = \beta_i \alpha Y / p_i$ can be used to determine Q_i, and each entrant j's output can be determined by multiplying $q_j = \theta_j Q_i$, where $\theta_j = (p_i - mc_{ji}) / p_i$. Player j's profit for operating in the square for the period in question is given by $p_i q_j - fec_j - foc_j - mc_j q_j$, where fec_j refers to the fixed cost of entry for

player *j* if she hasn't already entered the market and foc_j stands for player *j's* fixed operating cost.

A shortcoming of this method of modeling demand is that the solution is not well defined in the case of a monopolist because the demand elasticity for each telecom input equals unity. We assume that when there is a single player supplying an input in a given market, the player is forced by regulators to price at levels that roughly match current actual circumstances.

The model's solution has the property that a player's profits in producing one telecom input don't depend on the amount of the other telecom inputs she supplies in the market (square). The reason is that the demand curve for input *i* depends only on its own price and not on the prices of the other inputs. Were this not the case, a Cournot player in a square supplying more than one input would have to consider how her supply of one input altered the price and thus demand for the other input(s) she supplies.

5. Calibration

To focus the model on the current policy debate, we assume that in each county there are two markets, local *voice* and *data*, and that the ILEC offers both of these services in each county in the initial period. We also assume that cable companies have entered some, but not all counties, to offer CATV service – and if they are offering CATV service in a county, they also offer data in that county. Because of franchise limitations, cable companies are assumed never to enter additional counties, nor to exit counties. Our procedure for specifying which counties are served by cable companies is to use FCC statistics that report the percentage of zip codes in each state having particular

numbers of broadband providers.[24] We assume these statewide percentages of zip codes apply similarly to the counties in a state and thus infer the percentage of counties in each state having two or more broadband providers. This percentage is then assumed to be the percentage of counties served by a cable provider. Next, we rank the counties in each state by population density and, starting with the county with the highest density, we work down the ranking until we have selected enough counties to account for the specified percentage of counties with a cable provider. Thus, for Alaska, the FCC report indicates that 22 percent of the Alaska's zip codes have two or more broadband providers. We then assume that the 22 percent of Alaska's counties with the highest population density have a cable provider.

In addition to the ILEC and cable company providers of voice or data services in a square, we assume that there are two identical CLECs, which decide individually whether to enter one or both of these product markets in each particular square.

When the ILEC is the sole provider of voice in a particular county, we assume, to repeat, that the price for voice is set via regulation. We refer to this regulated price as the *regulated monopoly price*. The same assumption is made with respect to the price of data in counties in which the ILEC is the sole provider of data. However, if one or more competitors enter a county in either voice or data or both, we assume that prices are set according to Cournot competition.

Interestingly, there is no guarantee that Cournot competition will generate lower prices than those currently set by regulators. The prices that emerge in a county with one or more competitors will depend on the precise number of competitors and their marginal

[24] "FCC Releases Data on High-Speed Services for Internet Access," FCC Press Release, July 10, 2003. Available at: http://www.fcc.gov/Bureaus/Common_Carrier/Reports/FCC-State_Link/IAD/hspd0603.pdf.

costs of production. Since the marginal costs facing CLECs depend on the UNE rates set by state PUCs, PUCs should be aware that if they set their UNE rates too high, they may be leaving consumers facing higher telecom prices under "competition" than under regulated monopoly. This, in fact, is what we find in a minority of counties in states with particularly high UNE rates.

We assume that preferences of residential consumers for communication services are identical across all counties. However, total residential consumer demand in each county will differ based on the county's number of households and average level of household income. Our county counts of total households and our county averages of household income come from the 2000 U.S. Census (available at http://www.factfinder.census.gov).

Households are assumed to spend three percent of their income on communication services. This percentage accords with findings from the Consumer Expenditure Survey and is used to identify the model's Cobb-Douglas preference parameter. Of the total expenditure on communication services, we assume that 70 percent is spent on local voice and 30 percent is spent on data.[25]

Another component of demand for communication services in each county is business demand, which we assume is inelastic. Hence, in each county we add a fixed level of expenditure by businesses on voice and data services to the respective household demands for those services. We determine these fixed expenditures in the following manner. The PACE Report details total business lines per state,[26] and a 2002 *Commerce*

[25] "Consumer Telecom Spending Increases by 6% from Previous Year," TNS Telecoms Report, July 15, 2003, posted at http://www.tnstelecoms.com/press-7-15-03.html.

[26] The "UNE-P Fact Report: January 2003" by the PACE Coalition is available at http://www.pacecoalition.org/UNEPfactreport_1_2003/

Capital Markets report provides estimates of business revenues per line per ILEC provider.[27] We multiply each state's total business lines by the state's ILEC's business revenue per line to arrive at our estimate of total voice business expenditures by state. We allocate this overall state expenditure across the counties in the state based on the cross-county distribution of total state employment, where our county employment data are taken from the 2000 U.S. Census.[28]

We follow the same county-allocation procedure with respect to our estimate of total business spending on broadband in each state. This estimate is determined by multiplying our estimate of each state's total business voice expenditure by the nation-wide ratio of total business broadband spending to total business voice spending. Our estimate of total business broadband spending comes from data reported in an ISP-Planet article posted at http://www.isp-planet.com/research/2002/cable_020524.html. This article indicates that small businesses are spending about $2.3 billion in 2002 on broadband and that they account for 34 percent of the total business broadband market. Dividing $2.3 billion by .34 gives $6.8 billion, which is our estimate of total business broadband spending in 2002. Our measure of total business voice spending is determined by simply adding together our state estimates of business voice spending.

[27] See Exhibit 6 in Anna Maria Kovacs, Kristin L. Burns, and Gregory S. Vitale, "The Status of 271 and UNE-Platform in the Regional Bells' Territories," *Commerce Capital Markets, Inc.* November 8, 2002. Although this report's authors note numerous weaknesses in the development of this business revenues number and suspect that their estimates are much too high, we are not aware of a superior public estimate for this figure.

[28] We received these data via a special request made to the U.S. Census Department.

Incorporating Current Policy

To accommodate current policy, we expanded our model to allow CLECs to decide each period whether or not to operate in a county under UNEs. Recall that to offer *voice*, CLECs purchase a platform of local network elements from ILECs at wholesale rates and add to it their own marketing and customer support to create retail voice services to sell to the public. This does not require CLECs to collocate in ILEC central offices in order to access physically the local phone line (loop). Such collocation and physical connection to the customer's loop is, however, required for the CLEC to be able to offer broadband.

When a CLEC decides to offer data, it has the option of offering voice as well. Because CLECs are more than willing to provide both data and voice services over the loops they access from the ILEC, we assume that when offering data, CLECs need pay only a single entry fee and a single fixed annual operating fee to enter a county and be able to provide both voice and data; i.e., we assume strong economies of scope in providing both products. The result is that CLECs that enter a local market to offer data also choose to provide voice. But given the prohibitive operational and cost impediments enumerated above in backhauling voice signals from a collocation into the CLEC's own network, we assume, realistically, that such CLECs return the voice signal to the ILEC switch from this collocation point and offer voice under UNE-P. As discussed in the calibration section, we add an additional marginal cost to account for data-providing CLECs' extra costs to offering voice.

All players (ILEC and CLECs) must cover their fixed operating costs in each period they are present in a square -- regardless of whether they are offering just voice, or voice and data.

Additional Parameters

We assume that the regulated monopoly price for voice in each state is set at the average residential revenue per line per state, which, across all states, averages roughly $29.[29] We set the regulated monopoly price for data at $50 based on our sense of the average broadband price that would prevail around the country in the absence of any competition. We set the ILEC's marginal cost of providing voice at $5. Note that this is the ILEC's short-run marginal network costs for providing an extra voice line of service. We treat the ILEC's ongoing marketing, customer support, and sales costs in a given county as fixed operating costs that total $50 per household times the number of households in the county.

Our source for each state's actual UNE-P rates is the above-referenced 2002 Ex Parte submission. Our source for state-specific TELRIC UNE-P rates are the TELRIC rates calculated from the UNE version of the FCC's 1998 Synthesis Model, with a 5 percent annual adjustment to reflect intervening reductions in input prices and unit costs.

State-specific actual and TELRIC UNE-P rates are reported in Table 2. Consider first current UNE-P rates, and note the wide range in values, from a low of $12.42 in Indiana to a high of $45.64 in West Virginia. About three-fifths of the states are setting

[29] See Ex Parte submission from Joan Marsh, AT&T, to Secretary, FCC, WC Docket No. 01-338, September 25, 2002. These data were collected at a time when there was relatively little voice competition in the country.

UNE-P rates from $18 to $25. Only 7 states have UNE-P rates that are reasonably close to the national weighted average TELRIC rate of $15.10.

Next consider the true TELRIC UNE-P rates. These range in value from a low of $9.45 in Washington, D.C. to a high of $27.39 in Missouri. Thirty-eight states, including the District of Columbia, have true TELRIC rates below $18. In only 5 states do TELRIC rates exceed $22. While TELRIC UNE-P prices are, on average, 27.9 percent lower than current UNE prices, five states – Indiana, Kentucky, Maine, Missouri, and Vermont have set current UNE-P rates below the TELRIC levels, with the difference reaching as high as $1.74 in Indiana. On the other hand, current UNE-P prices exceed their corresponding TELRIC levels by $6 or more in 34 states, including Washington, D.C. The largest differential -- $21.75 -- arises in the case of West Virginia, where the current UNE –P rate is $45.64 even though the true TELRIC UNE-P rate is only $23.89.

CLECs that provide voice-only services using UNEs are assumed to face a marginal cost equal to the UNE-P (whether actual or TELRIC) rate plus $5 to cover customer support costs. Such CLECs incur no fixed entry cost, but do need to pay fixed operating costs on an ongoing basis for marketing, sales, and customer support, which we also take as $50 per household times the number of households. CLECs that operate in a given county (square) to provide data and voice are assumed to face a marginal cost for offering voice equal to the prevailing UNE-P rate plus $5 for customer support costs plus $5 for additional costs of interfacing with the ILECs to hand back the voice portion of the signal. The marginal cost of providing data is set at $20 for both the local ILEC and cable companies and at $25 for CLECs, where the difference reflects the higher CLEC costs for acquiring and transporting the data signal to their network.

The fixed cost faced by a CLEC to enter a county and operate under UNE-L is set at $75 times the number of households in the county. And the CLEC's fixed operating cost each year under UNE-P is, again, set at $50 times the number of households in the county. Note that CLECs that enter under UNE-L and UNE-P to market both voice and data incur only a single fixed entry cost and need pay only a single annual fixed operating cost.

The final parameter we need to discuss is the choice of discount rate applicable to CLEC decision-making. We use an 11 percent real discount rate. This seems, if anything, to be on the low side, given the considerable risks of new carriers entering and competing in the telecom market with its ever-changing policies and policymakers. Were we to use a higher discount rate, our model would likely generate less data entry than we report. The reason is that for CLECs to enter providing data, they need to recoup their fixed entry costs. But the higher the discount rate, the smaller will be the present value of the future profits from entry that need to be set against the immediate cost of entry.

6. Findings

We now present two sets of findings, one from running the model based on the actually prevailing UNE rates and the other based on running the model assuming each state adopts completely TELRIC UNE rates. To limit the paper's length, we show only aggregate results in most tables. However, we discuss some of the state-specific results in the text. The state-specific results for all tables are posted at http://econ.bu.edu/kotlikoff.

The Effect of UNE-P Rates on Voice and Data Prices

Table 3 shows the impact on voice and data prices of introducing UNE-P competition under both actual and TELRIC rates. The top set of results is for the entire country. The next set of results divides counties into four groups based on whether their levels of per capita income are higher or lower than average, and whether their population density is higher or lower than average. HYHD stands for high income, high density. HYLD stands for high income, low density. LYHD stands for low income, high density. And LYLD stands for low income, low density.

Average Voice Prices Across the Country[30]

Table 3's results compare our measure of the regulated monopoly price with the prices that prevail under the two UNE pricing regimes. Each of the regulated monopoly prices reported in the table represents a household weighted average of the counties included in average. Our association of regulated monopoly prices for voice with the average state voice prices that prevailed in 2000 is admittedly arbitrary since these figures come from a period marked by some, albeit very limited, competition. In any case, these state averages range from $28 to $31 per line per month, with the national average voice price equaling $28.93. In the case of data, we've assumed, to repeat, a regulated monopoly price of $50 per month per broadband connection. Since the model's terminal date of year 20 is set to limit computation time and is, in that sense, arbitrary, we focus here on prices and entry that arise in the initial year following the introduction of either actual or TELRIC UNE-P rates.

[30] All of the calculated figures in this paper should be only taken as suggestive of the model's results based on a uniform nationwide parameterization. We have not attempted to capture all of the influences surrounding these competitive interactions.

First consider UNE-P competition based on the actual UNE rates now being set by state PUCs. According to our model, this policy actually *raises* the nationwide average voice price by $1.68 relative to the regulated monopoly price.[31] This reflects the point we made above that if UNE rates are set too high, they will deliver prices that are higher than those arising under regulated monopoly.

Next consider the impact of switching from current to TELRIC UNE-P rates. This lowers the nation's average voice price by 15.5 percent from $30.61 to $25.86. Note that the average voice price is now lower than the regulated monopoly price, by 10.6 percent.

Table 3's next set of results, which break out prices based on county income and density, show that counties of all income and density levels stand to gain from switching from current to TELRIC UNE pricing. The largest gains arise in counties with the highest densities and highest levels of per capital income. In counties with high per capita income and high density, the potential gain is 22.6 percent. For counties with low density and low income per capita, the potential gain is 8.7 percent.

Voice Prices in Individual States

Under current UNE rates, voice prices range from a low of $23.09 in Illinois to a high of $42.21 in South Dakota. These differences partly reflect the relative sizes of the markets in the particular counties in the two states, but they are primarily the

[31] Recall that this assumes no retail rate regulation. The model's predicted increase over time in the average voice price reflects the 20-year length of the model. As this terminal date for competition and entry approaches, CLECs become more willing to enter both voice and data as opposed to just voice because they know that in the future there will be less entry given that competitors will have less time to recoup their fixed entry costs. As indicated above, the marginal costs that CLECs face for voice given that they are offering data are assumed to be $5 higher than under just voice, which explains the higher equilibrium prices generated in the Cournot quantity setting game.

consequence of the UNE rates set by those states. As indicated in table 2, the Illinois current UNE rate is $12.69, while South Dakota's is $34.82. Only three states -- California, Illinois, Indiana, and Michigan – have voice prices that fall below $25 per line when current UNE rates are run through the model.[32] At the other extreme, three states -- Idaho, South Dakota, and Wyoming – have current UNE prices above $38. By way of comparison, voice prices under a TELRIC UNE rate regime range between $21.52 in Illinois and $36.78 in Wyoming.

According to the model, some states would experience particularly large voice price reductions in moving from current to TELRIC UNE rates. In Massachusetts, for example, the price reduction is 39.9 percent. In South Dakota, the reduction is 25.9 percent. And in the state of Washington, it's 27.8 percent.

Data Prices

Turning to data prices, note that regardless of whether UNE-P is priced at actual or TELRIC rates, there is sufficient CLEC entry to substantially lower broadband prices. In the case of current UNE pricing, the resulting data price is $37.41, which is 25.2 percent below the regulated monopoly price. In the case of TELRIC UNE-P pricing, the data price is slightly higher -- $38.56, but this is still 22.9 percent below the regulated monopoly price. In contrast to UNE voice pricing, there are much larger differences in data pricing across regions that are distinguished by per capita income and density.

Interestingly, low density-low income counties experience particularly low data prices under TELRIC UNE rates -- $37.85 per month compared with $39.43 per month in

[32] The Indiana PUC has recently raised its UNE rates significantly. See http://www.in.gov/iurc/press/2004/42393_010504.pdf

the high density-high income counties. The explanation here appears to lie in the fact that cable companies aren't competing in the low-density counties. Consequently, there is sufficient profit opportunity for two CLECs to enter a number of such counties, which lowers the data price by a greater percentage.

There is a significant spread across states in data prices. For example, under the policy of current UNE rates, data prices range from $33.04 in Kansas to $41.85 in West Virginia.

Consumer and Business Voice Savings from Implementing TELRIC UNE-P Rates

Table 4 shows for each state and all states combined the annual local voice savings accruing to consumers and businesses associated with switching from current to TELRIC UNE rates. The table assumes that states with UNE rates below our TELRIC proxy will not adjust upward their UNE rates.

Totaled across all the states, the annual savings is just shy of $15 billion. That's a lot of money. Indeed, it exceeds the gross domestic product of most countries. Those states whose UNE rates are the farthest from TELRIC levels and have the largest markets obviously have the most to gain from lowering their rates. Texas, New York, and Massachusetts stand to gain $1.9 billion, $1.8 billion, and $1.1 billion, respectively. But smaller, less populated, and less wealthy states, like Oklahoma, also could do very well by changing their UNE pricing policy. Oklahoma's potential gain is $129 million.

The Nature of Entry

Table 5 examines the structure of competition in the voice market and, thus, the entry that arises, under actual and TELRIC UNE-P regimes.[33] The results clearly indicate that there is significantly more entry and competition under TELRIC pricing. In the case of current UNE rates, 36.2 percent of households end up where they started – living in counties with no competition and being forced to purchase voice services from the ILEC. The introduction of TELRIC pricing cuts the percentage of households without choice almost in half. Now, only 19.3 percent of households live in non-competitive counties. Furthermore, in the actual UNE rate regime, only 11.6 percent of households live in counties that experience entry by two CLECs, whereas this figure rises to 17.6 percent when TELRIC rates are substituted.

As one would expect, entry and competition is most pronounced in the high income/high-density counties. In the case of TELRIC pricing, 99.0 percent of all households in such counties experience entry by at least one CLEC, and 29.1 percent experience entry by two CLECs.[34]

On the other hand, because the rich, dense markets already enjoy some competition under current UNE-P rates, movement to TELRIC pricing is relatively more important for low-income, low-density counties in generating competition. Indeed,

---

[33] There are a couple of counties in which ILECs stop providing service in the short run. That's why the row percentages in Table 4 may not always sum to 100 percent.

[34] The dynamics of entry shown in Table 5 are also quite interesting. There is much more entry in the medium and long runs than in the short run. This additional entry occurs lonly when the CLEC offers data in addition to voice. The reason is that the CLECs realize that early entry, while it offers a longer period to recoup the fixed cost of entering for data, is also riskier because the likelihood that competitors will enter in the future is higher. This likelihood of future entry declines the closer the players get to the model's 20-year end date as potential competitors realize that there is too little time to recoup their investments. Stated differently, the barrier to entry represented by the fixed entry cost is a greater obstacle to entry when this cost much be amortized over only a few years.

TELRIC pricing raises the fraction of households in such counties that can enjoy the fruits of competition from 44.3 percent to 62.2 percent.

For individual states, the structure of competition can differ dramatically, particularly with current UNE rates. At one extreme is Arizona in which there is essentially no entry under current UNE rates.[35] At the other extreme are California, Michigan, and Washington D.C., in which essentially all households experience competition. With TELRIC UNE pricing, the share of Arizona residents that enjoy a choice in providers rises from less than 1 percent to 83.6 percent.

Table 6 provides further information about the nature of entry. It shows the type of CLEC entry under both current and TELRIC UNE-P rates. In the table "Voice Only" stands for only one CLEC entering under for voice. "Combined" stands for one CLEC entering for both voice and data. "Combined/Voice" stands for two CLECs, one of which enters for both voice and data and the other of which enters just for voice. "Voice/Voice" stands for two CLECs, both of which enter just for voice. "Combined/Combined" stands for two CLECs, both of which enter for both voice and data. And "No CLECs" refers to counties with no CLEC entry.

The table shows that pricing UNEs at TELRIC rather than actual rates increases overall CLEC entry, particularly for voice. With TELRIC UNE pricing, over two-fifths of households live in counties with one CLEC that offers voice. But almost one half of households live in counties in which one or more CLECs offer both voice and data. Interestingly, the model generates no cases in which two CLECs enter just to provide voice.

---

[35] Since this paper was developed, the Arizona PUC has reduced its UNE rates, and entry may be occurring.

The table also indicates more entry by CLECs into data markets in low-density-low-income counties due to the absence of competition from cable companies. This explains why the move to TELRIC pricing ends up lowering data prices by more in low-density-low-income counties than in high-density-high-income ones.

CLEC Shares in Voice and Data Markets

Tables 7 and 8 show the CLEC shares of the voice and data markets, respectively. According to the model, with current UNE rates, CLECs have 10.7 percent of the voice market and 13.1 percent of the data market. The respective voice and data market shares reported by the FCC in mid 2003 are 14.7 percent and 6.6 percent.[36] So our model, while in the same ballpark with respect to the actual and predicted levels of these shares, does not fit the data perfectly.

According to the model, the move to true TELRIC pricing raises our model's CLEC voice market share from 10.7 percent to 16.5 percent. On the other hand, it lowers the CLEC data market share from 13.1 percent to 12.1 percent. The CLEC voice share depends significantly on the type of county being considered. In the case of high-income - high-density counties, the model predicts a 14.8 percent CLEC share with current UNE-P rates and a 21.6 percent share with TELRIC UNE-P rates. For low-income – low density counties, the CLEC voice share is 6.7 percent under current UNE-P rates and 13.2 percent under TELRIC rates. Hence, in low-income – low-density counties competition is relatively more sensitive to the level of UNE-P rates.

[36] http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-242397A1.pdf and http://hraunfoss.fcc.gov/edocs_public/attachmatch/DOC-242398A1.pdf

The Distribution of Price Changes Across Households

Table 9 shows the share of households experiencing particular voice-price changes relative to the regulated monopoly price under the current UNE-P regime. In the current UNE-P regime, almost two fifths of households end up facing a *higher* voice price than the regulated monopoly price. Indeed, over a quarter of the households experience price increases in excess of 20 percent. For the roughly three fifths of households who see their prices fall, the declines are generally modest. Fewer than 6 percent of all households experience voice price reductions greater than 20 percent. These nation-wide results mask, however, major differences across states in the treatment of households. In some states, like Louisiana, all households experience price hikes, while in other states, like Illinois, all households experience price cuts.

As Table 10 shows, this heterogeneity is much less pronounced in the case of TELRIC UNE-P rates. In this case, almost all households experience price reductions in voice relative to the regulated monopoly price. To be precise, more than a quarter of households experience price reductions in excess of 20 percent, and almost three fifths of households enjoy voice price cuts of 10 percent or more. As in the case of current UNE-P rates, households in different states have quite different experiences. In New York, almost four-fifths of households enjoy a 30 to 40 percent reduction in voice prices, whereas in Arkansas almost two thirds of households experience a modest price increase compared to the regulated monopoly price.

Table 11 shows the distribution of price changes from implementing TELRIC rather than current UNE-P rates. Almost two-fifths of households see their voice bills fall by at least 20 percent, and over one fifth experience a 30 percent or greater reduction

in these bills. In certain states, the price reductions are really big. In Massachusetts and Maryland, for example, over three-fifths of households experience voice price reductions ranging from 40 to 50 percent.

Changes in Investment and Hiring Outlays

Our next two Tables, 12 and 13, consider how the two UNE pricing regimes affect outlays on investment and new hiring over 1, 5, and 20 years relative to the level of these cost outlays that would have occurred with no competition (no CLEC entry). The results are again displayed on a household-weighted basis. Outlays refer here to all cost expenditures, whether these expenditures are entry costs, operating costs, or marginal costs. These outlays will finance either new investment or the purchase of additional labor services. In the case of 5-year and 20-year cost outlays, total outlays over those periods are measured in present value.

According to table 12, most households – about two thirds of the total -- live in counties that experience increased spending on investment and new hiring in response to CLEC voice entry based on current UNE prices. For example, 29.2 percent of households live in counties that enjoy a 30 percent or greater hike in telecom cost outlays in the first year after current UNE rates are introduced. Going out 20 years, 17.1 percent of households live in such counties.

While the table indicates a positive outlay response in those counties containing most of the nation's households, some counties experience a reduction in outlays from the introduction of UNE-based voice competition. The reason is that the price increases that arise in certain high UNE rate counties lead to cut backs in ILEC cost outlays that

more than offset the increase in CLEC outlays. These results, should, again be taken with a grain of salt since they may simply reflect our overstatement of true TELRIC rates in the states in question.

Table 13 shows that with TELRIC UNE rates, there is also much more telecom investment and hiring expenditures than with no competition. There is also somewhat more of such expenditures than arises under current UNE rates. In particularly, substantially fewer counties experience reductions in telecom investment and hiring outlays. Table 14 presents the absolute present value dollar outlays on investment and hiring occurring over specified numbers of years under the regulated monopoly structure and under policies of actual and TELRIC UNE rates. The table shows that TELRIC rates promote the greatest investment and hiring. Over a 20 years period, the present value of investment is almost one quarter higher than with the ILECs having exclusive control of the market. This 20-year outlay total is almost 5 percent higher with TELRIC UNE rates than with actual UNE rates. The absolute numbers are also important. According to the table, over a five-year period, the emergence of competition should mean $71 billion more telecom investment than under the monopoly structure that prevailed prior to the Telecom Act of 1996. Over 20 years, competition should add $155 billion to aggregate investment.

Conclusion

Our conclusions number five. First, there is strong empirical evidence that telecom competition promotes telecom investment. Second, there are solid theoretical arguments to explain that outcome. Third, the policy debate on telecom investment and

regulation has been framed within a static model that fails to capture the dynamic and highly uncertain entry, pricing, and investment game being played by the ILECs, CLECs, and cable companies. Consequently, it is difficult to assess the relevance of many prior telecom studies to the actual telecom market. Fourth, a model rich enough to capture the complexities of the telecom industry must a) be solved on the computer and b) carefully calibrated if it is to provide real insight into the policies and other factors affecting that critical market. We view this paper as a first step in that direction. Fifth, our model indicates that were UNE rates set at their proper TELRIC level throughout the country, telecom entry, investment and employment outlays, and output would increase significantly and local voice prices would fall dramatically. To be precise, telecom investment and employment outlays would increase by over one fifth in counties containing the majority of the U.S. population and by over one third in counties containing almost one third of the population.

References

Aumann, Robert, "Subjectivity and Correlation in Randomized Strategies," *Journal of Mathematical Economics*, 1: 67-96, 1974.

Barnett, William P., and Glenn R. Carroll. "How Institutional Constraints Affected the Organization of Early U.S. Telephony." Journal of Law, Economics, and Organization 9:98-126, 1993

Hall, Robert E., "Rescuing Competiton to Stimulate Telecom Growth," mimeo, Stanford University, September 28, 2001.

Hausman, Jerry, "The Effect of Sunk Costs in Telecommunications Regulation," mimeo, MIT, October 2, 1998.

Hausman, Jerry, "The Effect of Mandatory Unbundling on Investment in Broadband and Other New Technologies," mimeo, MIT, April 21, 2002.

Hubbard, Glenn R. and William Lehr, "Telecommunications, the Internet, and the Cost of Capital," mimeo, Columbia University, May 4, 2000.

McDonald, Robert and Daniel Siegel, "The Value of Waiting to Invest," *Quarterly Journal of Economics*, 101, November 1986, 707-23.

Jorde, Thomas M., J. Gregory Sidak, and David J. Teece, "Innovation, Investment, and Unbundling," *Yale Journal of Regulation*, 17 (1), Winter, 2000.

Kotlikoff, Laurence J., "On the Broadband Mess," *The Milken Review*, First Quarter 2003.

Organization for Economic Cooperation and Development, "The Development of Broadband Access in OECD Countries," October 29, 2001.

Table 1
Telecom Gross Investment, 1992-2002

(billions of dollars)

Year	CLECs	ILECs	Total
1992	Na	17.5	17.5
1993	Na	17.5	17.5
1994	Na	17.5	17.5
1995	Na	18.0	18.0
1996	Na	20.8	20.8
1997	5.0	21.5	26.5
1998	9.2	22.2	31.4
1999	16.8	22.8	39.6
2000	21.7	27.8	49.5
2001	12.3	28.1	40.4
2002	10.7*	24.2*	34.9*

Source: ARMIS data provided by William Lehr. ILEC investment includes investment by
Estimate for CLECs provided by William Lehr.
Estimate for ILECs based on a May 8, 2002 Banc of America Securities.
Na – not available, * indicates preliminary estimate for the year from those sources

Table 2

Actual and TELRIC UNE Rates by State

State	Actual UNE-P Rates	TELRIC UNE-P Rates	Difference Between Actual and TELRIC Rates	Percentage Difference Between Actual and TELRIC Rates
National Average*	**$20.95**	**$15.10**	**$5.85**	**25.27**
AL	$22.11	$21.13	$0.98	4.43
AR	$19.28	$18.06	$1.22	6.33
AZ	$25.49	$12.52	$12.97	50.88
CA	$13.30	$12.29	$1.01	7.59
CO	$22.40	$14.11	$8.29	37.01
CT	$21.54	$15.41	$6.13	28.46
DC	$16.52	$9.45	$7.07	42.80
DE	$21.12	$14.31	$6.81	32.24
FL	$24.52	$13.24	$11.28	46.00
GA	$22.48	$14.61	$7.87	35.01
IA	$24.59	$14.70	$9.89	40.22
ID	$26.56	$16.94	$9.62	36.22
IL	$12.69	$11.30	$1.39	10.95
IN	$12.42	$14.16	- $1.74	- 14.01
KS	$18.90	$15.24	$3.66	19.37
KY	$19.19	$21.05	- $1.86	(9.69)
LA	$24.68	$18.05	$6.63	26.86
MA	$24.71	$11.79	$12.92	52.29
MD	$23.62	$13.01	$10.61	44.92
ME	$22.08	$22.19	- $0.11	- $0.50
MI	$13.90	$13.86	$0.04	0.29
MN	$23.89	$13.79	$10.10	42.28
MO	$19.83	$15.16	$4.67	23.55
MS	$25.69	$27.39	- $1.70	- 6.62
MT	$32.61	$21.26	$11.35	34.81
NC	$22.08	$15.00	$7.08	32.07
ND	$30.86	$16.34	$14.52	47.05
NE	$28.19	$16.19	$12.00	42.57
NH	$23.38	$17.18	$6.20	26.52
NJ	$14.24	$12.04	$2.20	15.45
NM	$27.26	$16.06	$11.20	41.09
NV	$30.28	$19.19	$11.09	36.62
NY	$18.12	$10.76	$7.36	40.62
OH	$13.84	$12.75	$1.09	7.88
OK	$23.24	$16.33	$6.91	29.73
OR	$22.75	$13.40	$9.35	41.10
PA	$20.47	$13.49	$6.98	34.10
RI	$19.52	$12.96	$6.56	33.61
SC	$24.89	$17.95	$6.94	27.88
SD	$34.82	$17.18	$17.64	50.66

TN	$20.26	$17.79	$2.47	12.19
TX	$20.74	$12.87	$7.87	37.95
UT	$19.01	$12.44	$6.57	34.56
VA	$23.09	$13.75	$9.34	40.45
VT	$23.94	$24.37	($0.43)	(1.80)
WA	$19.93	$12.39	$7.54	37.83
WI	$20.99	$13.23	$7.76	36.97
WV	$45.64	$23.89	$21.75	47.66
WY	$30.20	$22.63	$7.57	25.07

* Weighted by the number of households in each state.

Table 3

The Impact of Actual and TELRIC UNE Rates on Retail Voice and Data Prices

State	Year	Voice Market			Data Market		
		Monopoly	Actual UNE-P	TELRIC UNE-P	Monopoly	Actual UNE-P	TELRIC UNE-P
All states	1	**$28.93**	**$30.61**	**$25.86**	**$50.00**	**$37.41**	**$38.56**
(3108 counties)	5		**$31.78**	**$25.92**		**$35.47**	**$36.77**
	20		**$31.92**	**$25.94**		**$34.78**	**$36.16**
HYHD counties	1	$28.56	$29.97	$23.19	$50.00	$36.68	$39.43
(222 counties)	5		$30.90	$23.12		$34.43	$36.86
	20		$30.96	$23.12		$33.27	$35.88
HYLD counties	1	$28.21	$29.41	$25.06	$50.00	$37.64	$38.94
(301 counties)	5		$30.68	$25.13		$36.05	$37.90
	20		$30.75	$25.18		$35.54	$37.09
LYHD counties	1	$29.49	$31.05	$27.42	$50.00	$37.43	$37.67
(186 counties)	5		$32.48	$27.48		$35.23	$36.02
	20		$32.69	$27.48		$34.82	$35.80
LYLD counties	1	$29.26	$31.61	$28.85	$50.00	$38.41	$37.85
(2399 counties)	5		$32.90	$29.12		$37.09	$36.90
	20		$33.11	$29.17		$36.80	$36.58
Alabama	1	$30.29	$33.17	$32.86	$50.00	$37.38	$37.23
(67 counties)	5		$35.26	$34.76		$35.08	$34.80
	20		$35.38	$34.85		$34.95	$34.68
Arizona	1	$29.76	$29.83	$23.92	$50.00	$40.02	$42.72
(15 counties)	5		$38.39	$23.82		$34.03	$34.93
	20		$38.39	$23.82		$34.03	$34.93
Arkansas	1	$28.22	$32.96	$31.79	$50.00	$35.16	$35.40
(75 counties)	5		$33.38	$32.31		$34.82	$34.59
	20		$33.53	$32.45		$34.45	$34.37
California	1	$25.17	$23.70	$22.64	$50.00	$39.51	$40.68
(58 counties)	5		$23.79	$22.64		$38.07	$36.57
	20		$23.79	$22.64		$34.34	$35.69
Colorado	1	$29.76	$35.55	$25.53	$50.00	$34.28	$37.99
(63 counties)	5		$36.88	$24.86		$32.97	$34.87
	20		$36.98	$24.87		$32.87	$34.17

Connecticut	1	$29.37	$35.79	$26.76	$50.00	$33.28	$37.31
(8 counties)	5		$36.46	$25.49		$32.58	$33.55
	20		$36.46	$25.49		$32.58	$32.86
DC	1	$28.78	$28.78	$19.45	$50.00	$40.00	$40.00
	5		$28.78	$19.45		$40.00	$40.00
	20		$28.78	$19.45		$40.00	$40.00
Delaware	1	$28.78	$34.19	$25.64	$50.00	$34.47	$39.21
(3 counties)	5		$34.19	$25.75		$34.47	$37.64
	20		$34.19	$25.75		$34.47	$37.64
Florida	1	$30.29	$31.87	$26.97	$50.00	$38.59	$39.24
(67 counties)	5		$35.51	$26.62		$35.64	$37.91
	20		$35.51	$26.65		$35.64	$37.51
Georgia	1	$30.29	$34.81	$27.24	$50.00	$34.96	$37.44
(159 counties)	5		$35.97	$27.13		$33.76	$36.25
	20		$36.09	$27.15		$33.63	$34.01
Idaho	1	$29.76	$38.12	$31.28	$50.00	$35.76	$35.47
(44 counties)	5		$38.90	$31.44		$35.27	$34.92
	20		$38.90	$31.51		$35.27	$34.48
Illinois	1	$28.40	$23.09	$21.52	$50.00	$41.30	$39.60
(102 counties)	5		$23.00	$21.47		$34.24	$38.28
	20		$23.00	$21.47		$33.38	$34.20
Indiana	1	$28.40	$23.32	$26.68	$50.00	$39.30	$37.48
(92 counties)	5		$23.26	$26.80		$38.77	$34.43
	20		$23.28	$26.80		$37.37	$34.12
Iowa	1	$29.76	$36.35	$27.92	$50.00	$35.94	$36.81
(99 counties)	5		$38.00	$27.91		$34.68	$34.82
	20		$38.20	$27.91		$34.53	$33.80
Kansas	1	$28.22	$32.86	$27.41	$50.00	$33.04	$33.66
(105 counties)	5		$33.24	$27.50		$32.54	$33.17
	20		$33.24	$27.50		$32.54	$33.08
Kentucky	1	$30.29	$31.68	$32.46	$50.00	$39.62	$39.48
(120 counties)	5		$33.01	$34.06		$37.09	$37.42
	20		$33.06	$34.25		$37.00	$37.17
Louisiana	1	$30.29	$36.63	$32.40	$50.00	$35.20	$34.25
(64 parishes)	5		$37.74	$32.48		$34.31	$34.01
	20		$37.98	$32.48		$34.12	$34.01

Maine	1	$30.92	$34.68	$34.56	$50.00	$35.85	$36.09
(16 counties)	5		$35.18	$35.06		$35.24	$35.48
	20		$36.07	$36.17		$34.16	$34.16
Maryland	1	$28.78	$35.70	$24.24	$50.00	$34.93	$39.70
(24 counties)	5		$36.44	$24.24		$34.37	$39.67
	20		$36.44	$24.24		$34.37	$39.67
Massachussetts	1	$30.92	$36.28	$21.82	$50.00	$35.43	$39.94
(14 counties)	5		$39.28	$21.82		$32.87	$39.08
	20		$39.68	$21.82		$32.53	$39.08
Michigan	1	$28.40	$24.65	$24.51	$50.00	$37.68	$37.75
(83 counties)	5		$24.41	$24.37		$34.23	$34.38
	20		$24.42	$24.38		$32.99	$33.07
Minnesota	1	$29.76	$34.99	$25.33	$50.00	$36.33	$38.86
(87 counties)	5		$37.13	$25.24		$34.58	$36.81
	20		$37.23	$25.29		$34.49	$36.52
Mississippi	1	$30.29	$34.29	$35.13	$50.00	$37.98	$37.89
(82 counties)	5		$38.03	$39.54		$35.29	$35.15
	20		$38.36	$39.71		$35.05	$35.05
Missouri	1	$28.22	$33.42	$28.18	$50.00	$34.79	$35.66
(115 counties)	5		$34.08	$27.87		$34.05	$34.01
	20		$34.19	$27.88		$33.92	$33.81
Montana	1	$29.76	$32.45	$32.92	$50.00	$40.37	$37.61
(56 counties)	5		$39.91	$34.69		$37.24	$35.56
	20		$41.05	$34.69		$36.76	$35.56
Nebraska	1	$29.76	$35.20	$30.44	$50.00	$38.66	$37.98
(93 counties)	5		$35.25	$30.81		$38.64	$36.05
	20		$35.25	$30.81		$38.64	$36.05
Nevada	1	$25.17	$25.44	$25.29	$50.00	$40.06	$40.06
(17 counties)	5		$25.44	$25.49		$40.06	$39.89
	20		$25.44	$25.49		$40.06	$39.89
New Hampshire	1	$30.92	$34.66	$30.62	$50.00	$36.60	$36.44
(10 counties)	5		$37.29	$30.91		$33.97	$33.03
	20		$37.95	$30.91		$33.30	$33.03

New Jersey	1	$28.78	$25.08	$22.06	$50.00	$39.52	$39.83
(21 county)	5		$25.11	$22.06		$36.35	$38.97
	20		$25.11	$22.06		$35.54	$38.32
New Mexico	1	$29.76	$31.68	$30.66	$50.00	$39.95	$35.23
(33 counties)	5		$38.00	$30.76		$36.16	$34.58
	20		$38.36	$30.76		$35.95	$34.58
New York	1	$30.92	$30.82	$22.87	$50.00	$37.71	$40.61
(62 counties)	5		$31.00	$22.87		$35.62	$39.30
	20		$31.02	$22.87		$35.54	$39.30
North Carolina	1	$30.92	$32.56	$29.14	$50.00	$37.83	$37.21
(100 counties)	5		$33.44	$29.13		$36.86	$36.10
	20		$33.69	$29.13		$36.58	$35.52
North Dakota	1	$29.76	$37.28	$30.50	$50.00	$39.56	$37.12
(53 counties)	5		$40.54	$30.72		$38.05	$36.10
	20		$40.54	$30.77		$38.05	$35.84
Ohio	1	$28.40	$26.63	$23.83	$50.00	$37.50	$39.12
(88 counties)	5		$26.69	$23.82		$35.80	$39.08
	20		$26.69	$23.82		$35.76	$39.08
Oklahoma	1	$28.22	$34.21	$29.81	$50.00	$35.26	$34.24
(77 counties)	5		$36.14	$29.99		$33.82	$33.80
	20		$36.26	$29.99		$33.73	$33.80
Oregon	1	$29.76	$32.55	$26.20	$50.00	$37.52	$37.57
(36 counties)	5		$34.40	$26.17		$35.78	$35.84
	20		$34.58	$26.17		$35.62	$35.84
Pennsylvania	1	$28.78	$30.85	$27.15	$50.00	$38.37	$38.61
(67 counties)	5		$31.49	$27.13		$37.66	$38.29
	20		$32.24	$27.13		$36.81	$38.29
Rhode Island	1	$30.92	$31.64	$26.18	$50.00	$38.19	$35.02
(5 counties)	5		$31.95	$26.18		$37.54	$35.02
	20		$34.07	$26.18		$33.14	$35.02
South Carolina	1	$30.29	$33.03	$32.06	$50.00	$38.51	$35.66
(45 counties)	5		$36.56	$32.38		$35.76	$34.76
	20		$37.08	$32.45		$35.35	$34.55
South Dakota	1	$29.76	$42.21	$31.29	$50.00	$38.44	$37.79
(66 counties)	5		$44.12	$31.74		$37.74	$36.41
	20		$45.14	$31.74		$37.36	$36.41

Tennessee	1	$30.29	$33.39	$32.04	$50.00	$35.66	$35.05
(95 counties)	5		$34.05	$32.18		$34.61	$34.42
	20		$34.13	$32.18		$34.54	$34.42
Texas	1	$28.22	$33.92	$24.03	$50.00	$33.50	$36.98
(254 counties)	5		$34.68	$23.81		$32.74	$34.65
	20		$34.77	$23.81		$32.65	$33.57
Utah	1	$29.76	$32.99	$22.90	$50.00	$34.26	$39.55
(29 counties)	5		$33.57	$22.90		$33.24	$35.22
	20		$33.80	$22.90		$32.82	$35.22
Vermont	1	$30.92	$33.97	$33.50	$50.00	$38.42	$38.99
(14 counties)	5		$37.94	$38.33		$34.71	$34.71
	20		$37.94	$38.33		$34.71	$34.71
Virginia	1	$28.78	$32.14	$26.60	$50.00	$38.26	$40.07
(135 counties/cities)	5		$32.60	$26.53		$37.89	$39.70
	20		$33.01	$26.60		$37.57	$39.39
Washington	1	$29.76	$32.39	$23.38	$50.00	$36.38	$39.76
(39 counties)	5		$34.19	$23.27		$33.77	$39.67
	20		$34.19	$23.32		$33.77	$39.59
West Virginia	1	$28.78	$34.36	$30.83	$50.00	$41.85	$41.71
(55 counties)	5		$35.81	$31.09		$41.62	$41.58
	20		$35.93	$31.09		$41.60	$41.58
Wisconsin	1	$28.40	$32.61	$24.13	$50.00	$35.97	$39.29
(72 counties)	5		$35.23	$24.11		$33.39	$38.27
	20		$35.44	$24.11		$33.18	$37.80
Wyoming	1	$29.76	$40.45	$36.78	$50.00	$34.73	$32.84
(23 counties)	5		$44.35	$36.78		$32.84	$32.84
	20		$44.35	$36.78		$32.84	$32.84

Table 4

Annual Consumer and Business Voice Savings from Switching from Actual to TELRIC UNE Rates

(in millions)

All States	$14,984.5
Alabama	12.2
Arizona	334.6
Arkansas	26.4
California	540.1
Colorado	487.4
Connecticut	389.7
DC	66.1
Delaware	76.6
Florida	824.6
Georgia	618.8
Idaho	69.8
Illinois	324.6
Indiana	0.0
Iowa	229.1
Kansas	157.5
Kentucky	0.0
Louisiana	140.1
Maine	1.5
Maryland	733.9
Massachusetts	1,067.2
Michigan	21.4
Minnesota	537.9
Mississippi	0.0
Missouri	293.9
Montana	0.0
Nebraska	76.3
Nevada	4.2
New Hampshire	58.9
New Jersey	443.3
New Mexico	16.5
New York	1,759.3
North Carolina	280.6
North Dakota	42.2
Ohio	414.6
Oklahoma	129.2
Oregon	230.9
Pennsylvania	501.9
Rhode Island	63.8
South Carolina	36.1
South Dakota	57.8
Tennessee	72.7
Texas	1,932.3
Utah	213.9
Vermont	2.9
Virginia	485.4
Washington	626.7
West Virginia	48.0
Wisconsin	518.8
Wyoming	14.9

Table 5

Competitive Structure in the Voice Market

		Actual UNE rate			TELRIC UNE rate		
		percent of households with			percent of households with		
	year	**ILEC only**	**ILEC & CLEC**	**ILEC & 2 CLECs**	**ILEC only**	**ILEC & CLEC**	**ILEC & 2 CLECs**
All states	1	36.48%	51.85%	11.57%	19.29%	63.28%	17.37%
(3108 counties)	5	20.94%	58.60%	20.43%	13.51%	61.08%	25.16%
	20	19.01%	58.76%	22.22%	13.47%	55.43%	31.10%
HYHD counties	1	15.22%	64.55%	20.24%	1.00%	69.90%	29.09%
(222 counties)	5	3.76%	59.36%	36.88%	0.00%	61.83%	38.17%
	20	3.09%	57.76%	39.16%	0.00%	49.78%	50.22%
HYLD counties	1	33.56%	60.01%	6.43%	13.95%	77.92%	7.66%
(301 counties)	5	16.52%	74.44%	9.04%	10.14%	73.93%	15.93%
	20	15.35%	71.95%	12.70%	9.33%	69.58%	21.09%
LYHD counties	1	53.12%	43.69%	2.86%	32.46%	58.22%	9.31%
(186 counties)	5	31.69%	59.52%	8.79%	23.70%	55.57%	20.11%
	20	28.06%	61.39%	10.55%	24.32%	53.60%	22.08%
LYLD counties	1	55.70%	36.85%	7.45%	37.72%	52.72%	9.52%
(2399 counties)	5	39.43%	51.46%	8.99%	26.55%	61.37%	11.70%
	20	36.79%	53.76%	9.45%	26.14%	60.97%	12.88%

Table 6

Type of CLEC Entry

		Actual UNE Rate						TELRIC UNE Rate					
		Percentage of Households in Counties with CLECs Entering As						Percentage of Households in Counties with CLECs Entering As					
State	**Year**	**V only**	**D only**	**V and D**	**V and V**	**D and D**	**no CLECs**	**V only**	**D only**	**V and D**	**V and V**	**D and D**	**no CLECs**
All states	1	**17.59%**	**34.26%**	**6.36%**	**0.00%**	**5.22%**	**36.58%**	**43.99%**	**19.30%**	**12.44%**	**0.00%**	**4.93%**	**19.35%**
(3108 counties)	5	**8.82%**	**49.77%**	**15.69%**	**0.00%**	**4.74%**	**20.97%**	**36.23%**	**24.85%**	**22.18%**	**0.00%**	**2.28%**	**13.76%**
	20	**7.04%**	**51.73%**	**17.48%**	**0.00%**	**4.74%**	**19.01%**	**30.30%**	**25.13%**	**28.82%**	**0.00%**	**2.28%**	**13.47%**
HYHD counties	1	27.83%	36.71%	14.17%	0.00%	6.06%	15.22%	66.17%	3.74%	25.67%	0.00%	3.42%	1.00%
(222 counties)	5	11.19%	48.17%	31.30%	0.00%	5.58%	3.76%	57.09%	4.74%	38.06%	0.00%	0.11%	0.00%
	20	8.91%	48.84%	33.57%	0.00%	5.58%	3.09%	45.04%	4.74%	50.11%	0.00%	0.11%	0.00%
HYLD counties	1	30.29%	29.72%	2.92%	0.00%	3.51%	33.56%	63.47%	14.45%	4.67%	0.00%	2.99%	14.42%
(301 counties)	5	27.69%	46.75%	6.48%	0.00%	2.56%	16.52%	55.67%	18.26%	13.80%	0.00%	2.13%	10.14%
	20	24.02%	47.93%	10.14%	0.00%	2.56%	15.35%	50.51%	19.07%	18.95%	0.00%	2.13%	9.33%
LYHD counties	1	10.62%	32.97%	0.71%	0.00%	2.16%	53.54%	32.39%	25.83%	4.47%	0.00%	4.85%	32.46%
(186 counties)	5	5.12%	54.41%	7.39%	0.00%	1.40%	31.69%	20.46%	33.98%	21.24%	0.00%	0.00%	24.32%
	20	3.36%	58.03%	9.14%	0.00%	1.40%	28.06%	19.62%	33.98%	22.08%	0.00%	0.00%	24.32%
LYLD counties	1	3.74%	33.58%	0.37%	0.00%	7.05%	55.27%	13.68%	39.04%	1.58%	0.00%	7.94%	37.77%
(2399 counties)	5	2.20%	49.61%	1.98%	0.00%	6.97%	39.24%	11.49%	49.87%	4.13%	0.00%	7.57%	26.93%
	20	1.74%	52.29%	2.44%	0.00%	6.97%	36.55%	10.31%	50.66%	5.31%	0.00%	7.57%	26.14%

"V" denotes "voice"
"D" denotes "data"

Table 7

The CLEC Share of the Voice Market

State	Year	Actual UNE Rates						TELRIC UNE Rates					
		V onDy	D onDy	V and D	V and V	D and D	**Total share**	V onDy	D onDy	V and D	V and V	D and D	**Total share**
All states	1	**3.71%**	**4.77%**	**1.36%**	**0.00%**	**0.82%**	**10.66%**	**9.75%**	**3.13%**	**2.73%**	**0.00%**	**0.91%**	**16.51%**
(3108 counties)	5	**1.89%**	**6.87%**	**3.31%**	**0.00%**	**0.73%**	**12.79%**	**8.10%**	**4.01%**	**4.94%**	**0.00%**	**0.41%**	**17.46%**
	20	**1.50%**	**7.14%**	**3.69%**	**0.00%**	**0.73%**	**13.06%**	**6.83%**	**4.05%**	**6.20%**	**0.00%**	**0.41%**	**17.49%**
HYHD counties	1	5.81%	5.03%	3.04%	0.00%	0.95%	**14.83%**	14.68%	0.59%	5.68%	0.00%	0.62%	**21.57%**
(222 counties)	5	2.36%	6.53%	6.59%	0.00%	0.86%	**16.34%**	12.76%	0.76%	8.26%	0.00%	0.02%	**21.80%**
	20	1.88%	6.62%	7.07%	0.00%	0.86%	**16.43%**	10.06%	0.76%	10.95%	0.00%	0.02%	**21.79%**
HYLD counties	1	6.51%	4.07%	0.59%	0.00%	0.59%	**11.76%**	13.85%	2.27%	1.01%	0.00%	0.53%	**17.65%**
(301 counties)	5	5.95%	6.37%	1.36%	0.00%	0.40%	**14.08%**	12.21%	2.88%	2.91%	0.00%	0.38%	**18.38%**
	20	5.17%	6.53%	2.14%	0.00%	0.40%	**14.24%**	11.10%	2.99%	4.02%	0.00%	0.38%	**18.49%**
LYHD counties	1	2.28%	4.67%	0.15%	0.00%	0.34%	**7.44%**	7.16%	4.18%	0.91%	0.00%	0.94%	**13.20%**
(186 counties)	5	1.13%	7.63%	1.55%	0.00%	0.19%	**10.51%**	4.61%	5.46%	4.51%	0.00%	0.00%	**14.59%**
	20	0.74%	8.15%	1.94%	0.00%	0.19%	**11.03%**	4.43%	5.46%	4.70%	0.00%	0.00%	**14.59%**
LYLD counties	1	0.82%	4.76%	0.08%	0.00%	1.10%	**6.75%**	3.08%	6.28%	0.34%	0.00%	1.61%	**11.31%**
(2399 counties)	5	0.48%	6.95%	0.43%	0.00%	1.08%	**8.95%**	2.61%	7.98%	1.09%	0.00%	1.35%	**13.04%**
	20	0.38%	7.31%	0.53%	0.00%	1.08%	**9.31%**	2.35%	8.10%	1.35%	0.00%	1.35%	**13.15%**

"V" denotes "voice"
"D" denotes "data"

Table 8

The CLEC Share of the Data Market

State	Year	Actual UNE Rates				TELRIC UNE Rates			
		D onDy	V and D	D and D	Total share	D onDy	V and D	D and D	Total share
All states	1	**8.47%**	**2.32%**	**2.34%**	**13.13%**	**4.98%**	**4.35%**	**2.80%**	**12.13%**
(3108 counties)	5	**12.06%**	**4.33%**	**2.07%**	**18.45%**	**6.27%**	**5.49%**	**1.29%**	**13.05%**
	20	**12.51%**	**4.03%**	**2.07%**	**18.61%**	**6.33%**	**6.65%**	**1.29%**	**14.27%**
HYHD counties	1	8.47%	5.11%	2.16%	**15.75%**	0.86%	9.02%	1.95%	**11.83%**
(222 counties)	5	11.12%	8.83%	1.89%	**21.83%**	1.09%	8.91%	0.06%	**10.07%**
	20	11.27%	7.75%	1.89%	**20.91%**	1.09%	11.57%	0.06%	**12.72%**
HYLD counties	1	6.94%	1.10%	1.85%	**9.89%**	3.41%	1.84%	1.66%	**6.91%**
(301 counties)	5	10.87%	1.76%	1.31%	**13.94%**	4.29%	3.82%	1.17%	**9.28%**
	20	11.14%	2.35%	1.31%	**14.81%**	4.48%	4.39%	1.17%	**10.04%**
LYHD counties	1	7.61%	0.31%	0.90%	**8.82%**	5.96%	1.35%	2.77%	**10.08%**
(186 counties)	5	12.56%	1.70%	0.47%	**14.73%**	7.84%	5.07%	0.00%	**12.91%**
	20	13.39%	2.11%	0.47%	**15.97%**	7.84%	5.10%	0.00%	**12.94%**
LYLD counties	1	9.70%	0.16%	3.99%	**13.85%**	10.94%	0.60%	4.49%	**16.03%**
(2399 counties)	5	13.46%	0.54%	3.94%	**17.94%**	13.46%	1.19%	4.28%	**18.94%**
	20	14.10%	0.56%	3.94%	**18.61%**	13.65%	1.24%	4.28%	**19.16%**

"V" denotes "voice"
"D" denotes "data"

Table 9

Change in Voice Price Relative to the Regulated Monopoly Price

Assuming Actual UNE Rates

State	Year	Percentage of Households in Counties Where Price Has Changed by:											
		-(30-20)%	-(20-10)%	-(10-0)%	0-10 %	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	>100%
All states	1	**5.58%**	**7.41%**	**49.29%**	**3.76%**	**6.83%**	**18.67%**	**7.40%**	**0.44%**	**0.21%**	**0.17%**	**0.01%**	**0.12%**
(3108 counties)	5	**5.81%**	**7.62%**	**33.53%**	**5.16%**	**8.87%**	**23.94%**	**13.47%**	**0.77%**	**0.45%**	**0.20%**	**0.01%**	**0.16%**
	20	**5.81%**	**7.62%**	**31.60%**	**5.24%**	**9.26%**	**25.05%**	**13.79%**	**0.79%**	**0.47%**	**0.21%**	**0.01%**	**0.16%**
HYHD counties	1	7.95%	11.27%	39.77%	2.95%	7.51%	22.71%	7.41%	0.42%	0.00%	0.00%	0.00%	0.00%
(222 counties)	5	7.95%	11.75%	27.83%	3.18%	9.07%	27.33%	12.47%	0.42%	0.00%	0.00%	0.00%	0.00%
	20	7.95%	11.75%	27.16%	3.18%	9.07%	27.55%	12.91%	0.42%	0.00%	0.00%	0.00%	0.00%
HYLD counties	1	6.75%	9.12%	52.75%	1.97%	4.06%	16.49%	7.60%	0.48%	0.07%	0.68%	0.02%	0.00%
(301 counties)	5	7.36%	8.85%	35.37%	3.70%	5.21%	24.67%	12.66%	1.39%	0.07%	0.68%	0.02%	0.00%
	20	7.36%	8.85%	34.20%	3.70%	6.15%	24.83%	12.74%	1.39%	0.07%	0.68%	0.02%	0.00%
LYHD counties	1	4.19%	6.69%	54.72%	6.35%	3.71%	15.74%	8.19%	0.00%	0.00%	0.00%	0.00%	0.00%
(186 counties)	5	4.92%	6.83%	33.00%	10.36%	6.24%	20.60%	17.13%	0.92%	0.00%	0.00%	0.00%	0.00%
	20	4.92%	6.83%	29.38%	10.36%	7.23%	23.18%	17.18%	0.92%	0.00%	0.00%	0.00%	0.00%
LYLD counties	1	2.76%	1.59%	58.07%	3.38%	9.36%	15.70%	6.66%	0.83%	0.77%	0.41%	0.03%	0.46%
(2399 counties)	5	2.81%	1.58%	42.05%	4.22%	11.98%	21.38%	12.13%	0.97%	1.65%	0.50%	0.03%	0.57%
	20	2.81%	1.58%	39.41%	4.51%	12.29%	22.88%	12.59%	1.04%	1.73%	0.56%	0.03%	0.58%

Table 10

Change in Voice Price Relative to the Regulated Monopoly Price Assuming TELRIC UNE Rates

		Percentage of Households in Counties Where Price Has Changed by:							
State	**Year**	**-(40-30)%**	**-(30-20)%**	**-(20-10)%**	**-(10-0)%**	**0-10 %**	**10-20%**	**20-30%**	**30-40%**
All states	1	**5.48%**	**19.17%**	**33.71%**	**29.12%**	**8.39%**	**2.96%**	**0.56%**	**0.56%**
(3108 counties)	5	**5.48%**	**19.57%**	**34.57%**	**24.33%**	**9.91%**	**4.10%**	**0.83%**	**0.96%**
	20	**5.48%**	**19.57%**	**34.57%**	**24.29%**	**9.99%**	**4.21%**	**0.91%**	**0.98%**
HYHD counties	1	8.70%	32.55%	51.14%	5.36%	1.53%	0.46%	0.25%	0.00%
(222 counties)	5	8.70%	32.55%	54.01%	2.16%	1.73%	0.46%	0.38%	0.00%
	20	8.70%	32.55%	54.01%	2.16%	1.73%	0.46%	0.38%	0.00%
HYLD counties	1	2.40%	15.61%	50.50%	19.73%	7.99%	2.45%	0.07%	0.77%
(301 counties)	5	2.40%	15.61%	51.32%	17.19%	9.25%	2.80%	0.07%	1.37%
	20	2.40%	15.61%	51.32%	16.38%	9.25%	2.80%	0.88%	1.37%
LYHD counties	1	4.32%	12.19%	24.26%	42.96%	12.67%	3.23%	0.00%	0.38%
(186 counties)	5	4.32%	13.88%	22.56%	37.24%	14.73%	5.97%	0.00%	0.68%
	20	4.32%	13.88%	22.56%	37.86%	14.73%	5.97%	0.00%	0.68%
LYLD counties	1	2.56%	5.87%	10.52%	55.77%	15.34%	6.71%	1.67%	1.52%
(2399 counties)	5	2.56%	5.92%	10.52%	48.66%	18.51%	8.49%	2.46%	2.54%
	20	2.56%	5.92%	10.52%	48.23%	18.78%	8.89%	2.51%	2.59%

Table 11
The Change in Voice Prices in Switching from Actual to TELRIC UNE Rates

State	Year	Percentage of Households in Counties Where Price Has Changed by								
		-(50-40)%	-(40-30)%	-(30-20)%	-(20-10)%	-(10-0)%	0-10 %	10-20%	20-30%	30-40%
All states	1	**3.09%**	**18.16%**	**16.84%**	**8.28%**	**46.98%**	**4.85%**	**0.57%**	**0.45%**	**0.63%**
(3108 counties)	5	**7.80%**	**23.29%**	**11.65%**	**7.02%**	**44.22%**	**4.66%**	**0.16%**	**0.07%**	**0.86%**
	20	**7.91%**	**23.43%**	**11.83%**	**7.94%**	**43.25%**	**4.65%**	**0.11%**	**0.05%**	**0.82%**
HYHD counties	1	5.75%	30.29%	18.30%	3.58%	39.73%	2.13%	0.22%	0.00%	0.00%
(222 counties)	5	11.71%	36.39%	8.19%	2.64%	39.11%	1.96%	0.00%	0.00%	0.00%
	20	11.84%	36.64%	8.06%	2.68%	39.11%	1.67%	0.00%	0.00%	0.00%
HYLD counties	1	1.54%	19.43%	9.33%	14.34%	45.86%	6.73%	0.79%	0.30%	1.21%
(301 counties)	5	3.96%	28.77%	5.78%	7.92%	46.66%	5.67%	0.00%	0.00%	1.23%
	20	3.96%	29.05%	5.73%	7.78%	45.77%	6.47%	0.00%	0.00%	1.23%
LYHD counties	1	2.29%	8.47%	19.82%	10.92%	51.13%	4.80%	0.08%	0.75%	1.32%
(186 counties)	5	9.58%	12.92%	14.43%	9.25%	46.17%	4.95%	0.00%	0.00%	2.08%
	20	9.58%	12.92%	14.48%	12.84%	43.16%	4.95%	0.00%	0.00%	2.08%
LYLD counties	1	0.21%	7.49%	14.97%	11.12%	54.54%	8.43%	1.46%	0.91%	0.82%
(2399 counties)	5	1.60%	11.22%	15.91%	11.48%	49.27%	8.19%	0.61%	0.26%	1.01%
	20	1.79%	11.28%	16.69%	11.84%	48.56%	8.36%	0.42%	0.18%	0.88%

Table 12
Change in Investment and Hiring Outlays Relative to the Monopoly Level with Actual UNE Rates

		Percentage of Households in Counties Where Investment Has Changed by:															
State	Year	-(50-40)%	-(40-30)%	-(30-20)%	-(20-10)%	-(10-0)%	0-10 %	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	>100%
All states	1	**0.00%**	**0.00%**	**30.35%**	**5.80%**	**0.31%**	**8.47%**	**10.03%**	**16.00%**	**15.81%**	**5.70%**	**3.72%**	**1.58%**	**0.12%**	**0.09%**	**0.50%**	1.44%
(3108 counties)	5	**0.00%**	**0.06%**	**15.07%**	**6.05%**	**0.61%**	**8.46%**	**21.55%**	**30.43%**	**10.40%**	**4.30%**	**1.03%**	**0.05%**	**0.82%**	**0.91%**	**0.25%**	0.00%
	20	**0.00%**	**0.04%**	**13.16%**	**5.53%**	**1.02%**	**3.02%**	**25.66%**	**34.67%**	**11.07%**	**3.57%**	**0.20%**	**0.15%**	**1.20%**	**0.61%**	**0.09%**	0.00%
HYHD counties	1	0.00%	0.00%	13.56%	1.66%	0.00%	13.74%	16.76%	21.93%	20.65%	5.64%	4.24%	1.71%	0.00%	0.00%	0.00%	0.11%
(222 counties)	5	0.00%	0.00%	2.50%	1.26%	0.48%	12.76%	20.64%	42.95%	12.64%	4.96%	1.71%	0.00%	0.00%	0.11%	0.00%	0.00%
	20	0.00%	0.00%	1.83%	1.26%	0.38%	1.34%	28.41%	48.28%	13.81%	4.58%	0.00%	0.00%	0.00%	0.11%	0.00%	0.00%
HYLD counties	1	0.00%	0.00%	21.22%	12.34%	0.00%	11.60%	16.48%	10.75%	20.58%	3.38%	1.62%	0.05%	0.15%	0.10%	0.77%	0.96%
(301 counties)	5	0.00%	0.00%	5.01%	14.09%	0.24%	11.46%	30.40%	28.73%	6.50%	1.58%	0.00%	0.19%	0.90%	0.39%	0.50%	0.00%
	20	0.00%	0.00%	3.98%	11.37%	1.04%	9.41%	30.03%	34.61%	5.72%	1.86%	0.00%	0.19%	0.90%	0.73%	0.17%	0.00%
LYHD counties	1	0.00%	0.00%	41.93%	10.16%	1.03%	5.24%	5.38%	19.40%	7.54%	7.20%	1.70%	0.00%	0.00%	0.00%	0.00%	0.00%
(186 counties)	5	0.01%	0.00%	20.49%	10.73%	1.03%	3.43%	29.76%	23.34%	9.53%	1.70%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	20	0.00%	0.01%	16.86%	10.16%	1.81%	4.02%	29.85%	26.07%	10.77%	0.45%	0.00%	0.00%	0.00%	0.00%	0.00%	#VALUE!
LYLD counties	1	0.00%	0.00%	49.07%	6.27%	0.28%	2.15%	1.61%	5.81%	13.91%	5.26%	5.32%	3.21%	0.40%	0.29%	1.59%	4.83%
(2399 counties)	5	0.00%	0.23%	32.89%	6.75%	0.56%	5.21%	13.08%	17.96%	8.99%	6.38%	1.20%	0.14%	2.76%	3.07%	0.77%	0.00%
	20	0.00%	0.15%	30.27%	6.22%	1.32%	2.65%	16.49%	21.27%	8.92%	5.23%	0.75%	0.49%	4.14%	1.84%	0.27%	0.00%

Table 13
The Change in Investment and Hiring Outlays Relative to the Monopoly Level with TELRIC UNE Rates

		Percentage of Households in Counties Where Investment Has Changed By														
State	**Year**	-(50-40)%	-(40-30)%	-(30-20)%	-(20-10)%	-(10-0)%	0-10 %	10-20%	20-30%	30-40%	40-50%	50-60%	60-70%	70-80%	80-90%	90-100%	>100%
All states	1	**0.00%**	**0.00%**	**14.04%**	**5.17%**	**0.06%**	**9.48%**	**21.40%**	**19.23%**	**9.61%**	**12.66%**	**4.05%**	**1.43%**	**0.55%**	**0.05%**	**0.18%**	**2.01%**
(3108 counties)	5	**0.01%**	**0.40%**	**8.50%**	**4.92%**	**0.12%**	**1.96%**	**21.88%**	**30.27%**	**20.09%**	**8.14%**	**1.33%**	**0.16%**	**0.20%**	**1.06%**	**0.90%**	**0.06%**
	20	**0.00%**	**0.29%**	**8.34%**	**4.80%**	**0.24%**	**1.39%**	**17.87%**	**33.59%**	**25.73%**	**4.61%**	**0.86%**	**0.07%**	**0.34%**	**1.47%**	**0.36%**	**0.03%**
HYHD counties	1	0.00%	0.00%	0.23%	0.77%	0.00%	15.97%	26.48%	35.39%	6.18%	11.16%	3.72%	0.00%	0.00%	0.00%	0.00%	0.11%
(222 counties)	5	0.00%	0.00%	0.00%	0.00%	0.00%	2.38%	23.20%	39.89%	23.74%	10.68%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%
	20	0.00%	0.00%	0.00%	0.00%	0.00%	2.30%	19.14%	43.02%	31.52%	3.90%	0.00%	0.00%	0.00%	0.00%	0.11%	0.00%
HYLD counties	1	0.00%	0.00%	4.38%	9.57%	0.00%	4.42%	44.02%	16.62%	8.42%	7.27%	2.55%	0.31%	0.00%	0.22%	0.14%	1.63%
(301 counties)	5	0.00%	0.00%	1.04%	9.56%	0.29%	3.04%	43.60%	22.43%	13.01%	4.74%	0.31%	0.00%	0.36%	0.86%	0.77%	0.00%
	20	0.00%	0.00%	0.24%	9.09%	1.27%	1.65%	36.45%	28.34%	18.55%	2.17%	0.24%	0.15%	0.21%	1.29%	0.33%	0.00%
LYHD counties	1	0.00%	0.00%	22.30%	10.16%	0.00%	7.88%	19.29%	9.35%	13.47%	11.36%	6.19%	0.00%	0.00%	0.00%	0.00%	0.00%
(186 counties)	5	0.00%	0.62%	13.54%	10.16%	0.00%	0.33%	20.80%	32.67%	13.83%	8.04%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	20	0.00%	0.35%	13.81%	10.16%	0.00%	0.00%	17.25%	33.07%	19.78%	5.58%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
LYLD counties	1	0.00%	0.00%	31.23%	6.20%	0.23%	2.62%	8.09%	3.85%	11.96%	17.82%	3.23%	5.19%	2.05%	0.10%	0.64%	6.74%
(2399 counties)	5	0.04%	0.97%	19.60%	6.44%	0.35%	2.34%	13.67%	16.13%	22.18%	5.48%	4.81%	0.57%	0.63%	3.63%	2.93%	0.23%
	20	0.00%	0.79%	19.05%	6.15%	0.48%	1.08%	10.38%	21.38%	24.30%	5.66%	3.11%	0.21%	1.21%	5.02%	1.07%	0.12%

Table 14
Present Value of Investment and Hiring Outlays Made by Specified Years

State	Year	Actual UNE Rates	TELRIC UNE Rates	Monopoly
All states	1	$ 82,958,140,000	$ 87,898,900,000	**$ 72,467,040,000**
(3108 counties)	5	$ 349,427,220,000	$ 367,314,900,000	**$ 296,763,220,000**
	10	$ 560,126,980,000	$ 585,532,900,000	**$ 471,994,980,000**
	20	$ 758,641,820,000	$ 791,788,900,000	**$ 636,569,420,000**