9 Real Options Applications for Telecommunications Deregulation

Greg Hallman and Chris McClain
PHB Hagler Bailly, Inc. and Vouchsafe, Inc.

Abstract - Competition in local phone markets has not developed as envisioned in the Telecommunications Act of 1996. One reason for the lack of competition is that the prices for unbundled network elements (UNEs) are likely set too low. A major reason for UNE underpricing is that the FCC's TELRIC-based pricing methodology ignores the option component of the CLEC's decision to purchase UNEs from ILECs. A real options framework for pricing UNEs is illustrated that demonstrates how TELRIC-based prices result in underpricing. Additionally, the real options framework suggests policy changes that could mitigate this underpricing problem and enhance local market competition.

> ... I want to state for the record that I am not patient enough to wait ten years to see true competition in this market. Ten years is far too long for small businesses and consumers to wait for the benefits of competition. We want to see competition developing in the short term, and if it doesn't we will need to seriously consider new legislation.
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> U.S. Senator Mike DeWine (R-OH), Opening Statement,
> Antitrust Subcommittee Hearing, September 15, 1998

Since the Telecommunications Act of 1996 (Act) was passed, regulators, policy makers, and some telecommunications industry participants have been disappointed with the seemingly low levels of competition in the U.S. local telecommunications markets. The evidence is not necessarily slanted in favor of those who would call the Act a failure because competition is vigorous for profitable services in business markets. Most incumbent local exchange carriers have already lost about half of their intraLATA toll and switched access market share in business markets. However, it is undeniably true that competition in the industry's most visible markets - those for residential customers and for alternatives to the incumbent's local line services -have been less intense than expected. Indeed, the Federal Communications Commission's (FCC) second survey on the state of local competition indicates that Regional Bell Operating Companies (RBOCs) still provide local line service to 95 to 99 percent of residential customers in the United States.[1] Three

alternative networks to the copper local loop - modified cable TV, wireless local loop, and satellite-based wireless - are emerging, but at slower rates than had been promised by the networks' owners and developers.[2]

When the Act was passed, Congress and the FCC envisioned local competition unfolding faster than long distance competition. Much of the blame for today's local competition predicament may lie with Judge Green's Modified Final Judgement (MFJ), which set up an awkward system of subsidies between artificially high-margin wholesale network access prices and below-cost basic retail line service prices. Low-priced basic line service is at the foundation of the policy of "universal service," which courts and regulators are determined to preserve. The creation of high-margin switched access prices to subsidize below-cost lines may be the most significant reason why the focus of local competition has been on avoiding switched access fees rather than on winning unprofitable local line services. The MFJ did successfully stimulate competition for long distance minutes. AT&T's share of minutes has steadily dropped since 1984, and many alternative long distance networks have been constructed.[3] The pace of build, in fact, continues to increase in long-haul networks, and innovation in network design and protocol, especially those having to do with Internet technologies, continues at a rapid clip.

Why is competition for local line services proceeding more slowly than had been expected? As is typical with any policy-related question, the answer depends on which side of the table you sit. New market entrants blame the incumbents. Alleged slow order processing, slow movement in negotiating interconnection agreements (through which new competitors buy access to incumbents' networks and the "last mile" to homes and businesses), and the slow implementation of necessary systems interfaces on the part of the large incumbent local exchange carriers (ILECs) deny new competitors access to local market dollars. Indeed, it is true that ILEC order processing systems have been complex to build and that interconnection agreements often end up being finalized in the courtroom. New entrants argue that even the slightest delay in providing service to customers who are willing to switch away from the incumbent is enough to spoil a significant percentage of sales. Policy makers at the FCC also appear ready to blame the ILECs for delays. And, the ILECs' successful challenge to the Act's constitutionality in the Eighth Circuit Court of Appeals last year was not received well by Reed Hundt, then chairman of the FCC. Last, potential entrants believe that even with federally mandated resale discounts and cost-based pricing formulas, wholesale prices for local services are too high.

As one might expect, the incumbents blame their accusers for the delay. ILEC managers suspect that there is gaming by long distance companies. RBOC entry

into long distance markets is contingent on the vague predication that the capability for competition in local markets must be in place. The local market entrants that are most capable of making a significant impact on local share distribution are long distance carriers like AT&T, Sprint, and MCI/Worldcom. However, these companies would like to steer ILEC competition away from their core long distance markets for as long as possible. It is obvious, say the ILECs, that long distance carriers are waiting to enter local markets in the hope that local competition rules will be changed in their favor, making it easier to compete in local markets and further delaying RBOC entry into long distance. In the meantime, other competitive local exchange carriers (CLECs) continue to pick off the ILECs' best local customers, further weakening the incumbents' financial position. In addition, the FCC continues to attempt to drastically reduce the ILECs' surest sources of margin, switched access and intraLATA toll, primarily in response to interexchange carrier pressure. This is paramount to eliminating the franchise upon which ILECs have been built and upon which shareholders have invested their money, leaving ILECs no choice but to fight FCC mandates in the courts.[4]

In addition, the ILECs are under tremendous pressure to continue to innovate in their networks to accommodate demands to transport larger and larger quantities of traffic, primarily data traffic. The Act, however, requires that ILECs lease any new services to competitors at a discount, virtually eliminating any incentive for ILECs to innovate. After all, why innovate when your competitors are given access to your innovation at a discount the instant it hits the market? This point was made effectively by an unlikely spokesperson, C. Michael Armstrong, AT&T chairman and CEO. In response to suggestions that AT&T-TCI should follow the same local competition rules AT&T has advocated for ILECs, he stated that other telecommunications companies should not be given a "free ride" on AT&T's investment in the TCI network. "No company will invest billions of dollars to become a facilities-based broadband services provider if competitors who have not invested a penny of capital, nor taken an ounce of risk, can come along and get a free ride on the investments and risks of others."[5]

Another reason why the pace of local competition is slower than expected could be that the FCC's rules for pricing unbundled network elements (UNEs) are fundamentally flawed. Those rules mandate that UNEs be priced at incremental, forward looking cost, which, ILEC management argues, is equivalent to "giving away the store" to CLECs. To be sure, mispriced UNEs would result in inefficiencies in the market. UNEs priced too low leave ILECs with the unattractive prospect of losing high-revenue customers but still carrying the burden of federally mandated universal service obligations under which incumbents must provide service to high-cost customers at below-cost prices. Under-priced UNEs reduce incentives for com-

petitors to build alternative networks because local services can be provided without the risks of building a network. Excessively low UNE prices deter investment in competitive networks and thwart FCC goals of opening local markets in a nondiscriminatory and economically efficient manner. The competitive stimulus that regulators hoped for when setting UNE prices low has not occurred because of the complex options competitors have available to them when entering local services markets.

This paper explores further the claim that UNEs are mispriced. Although the broad concepts upon which the FCC's UNE pricing methodology are based may be sound, the implementation of those concepts has proven to be a much greater challenge than anyone expected. There has been a movement afoot lately to propose that a modification to the FCC's method is appropriate. The proposed modification would apply real options theory to the calculus of forward looking incremental costs and subsequently, UNE prices. The rationale for this is that the traditional discounted cash flow method of valuing investments like those made in telecommunications networks does not capture the entire present value of those investments. The value of the option that management has to delay, contract, expand or otherwise modify making those investments must be included in decision making.

The research of Dixit and Pindyck demonstrates conclusively that investments that are irreversible and in which a firm can invest in the future as an alternative to investing today can potentially benefit, on a net present value basis, from a premium inherent in management's option to wait to invest.[6] The application of real options techniques to the forward looking cost analysis used to derive UNE prices will enhance the efficiency of local market competition. And proper valuation of the options that competitors consider in entering local markets can enable regulators and public policy makers to establish local competition rules that achieve public policy goals.

1. FCC PRICING METHODOLOGY

There are basically two sets of wholesale prices that are important to competitive local exchange carriers: local resale prices and unbundled network element prices. Setting resale prices is less complex than setting UNE prices. State commissions discount retail prices to the extent that costs are avoided in the provision of a service as wholesale rather than retail. If an ILEC charged $15 per month for a retail flat rate local access line, and it avoided $2 of marketing, advertising or product management costs, and $1 of other strictly retail-related costs, the price of

a resale flat rate local access line would be $12 per month. Although the disputes about what costs are actually avoided in resale versus retail products have been heated, the rules are generally understood and are less subject to dispute than unbundled network element prices. Real options techniques can be applied to the proper setting of the resale discount. But since the resale discount is less controversial, this paper's focus is on UNE pricing.

It is now generally agreed that the most effective method of entering local markets is to lease lines connecting customers to switches and to purchase and install switches. This is being called the "smart-build" model. The lines may be unbundled network loops from an ILEC or lines from another competitor. FirstWorld Communications, Inc. started to install fiber in local markets, but then adopted the "smart-build" model and "the economics look a whole lot better," according to Sheldon Oringer, FirstWorld's president and CEO. "It doesn't take a whole lot of capital," he goes on to say, "to move forward with a switch-based plan."[7] A great deal of analysis has been done by competitive local exchange carriers (CLECs), ILECs, and Wall Street analysts that demonstrates that combining an incumbent's unbundled local loop with a CLEC switch provides CLECs with an attractive vehicle through which to avoid paying switched access charges to ILECs and offer high-margin value added services – call waiting and caller ID, for example – at low operating costs. The unbundled loop is the only portion of ILEC networks that is a critical ingredient in the "smart-build" model, and its pricing is a key determinant of the model's profitability.

In order for competitive markets to evolve, prices for unbundled loops must be set at levels that market participants would pay in a competitive market. The FCC determined that in order for UNE prices to be economically efficient, they would have to be set at forward looking economic cost, calculated using a total element long-run incremental cost (TELRIC) method. TELRIC attempts to capture the costs for all inputs to supply an unbundled network element on a long run, forward looking, least cost, incremental basis. Firms buying UNEs priced at TELRIC (correctly calculated) can, in theory, rest assured that they are paying prices that are economically efficient and that imitate prices that a new market entrant might endure if entering a competitive market.

Unsurprisingly, ILECs claim that UNE prices are too low. They note, for instance, that the sale of UNEs at incremental cost by definition leaves ILECs with no margin to cover the overhead costs associated with running the business. CLECs, on the other hand, claim that UNE prices are too high, citing especially high nonrecurring charges that ILECs demand to cover costs generated by new processes and procedures required to provision a UNE. At first blush it may be unclear

which party is correct. If prices are too high and do not imitate competitive prices (ostensibly giving ILECs an advantage), local markets should observe quite a bit of competitive network build to capture local profits. If prices are too low (which would give CLECs a short-term advantage), CLECs should be winning large numbers of local customers using UNEs. However, as noted earlier, there has been little competition in residential local markets, and there has been little competitive network build.

2. UNE PRICES APPEAR TO BE TOO LOW

The only viable competitive local network technologies now appear to be cable TV, wireless local loop, and some adaptation of global satellite. Low investment levels in alternative local networks is a sure indication that UNE prices are too low. Although the FCC's rules were meant to jump start competition by allowing competitors to use discounted resale lines or unbundled network elements priced at incremental cost to enter the market quickly, the concept of the Act was not to price UNEs in a way that deterred competitive build. TELRIC pricing rules, unfortunately, have had that effect. If it were less expensive for a CLEC to build its own facilities in local markets than to buy UNEs, CLECs would inarguably build networks. However, there has been little network build. Probably the primary reason TELRIC-based prices did not accomplish Congress' and the FCC's goals is that they do not accurately reflect the investment decisions that telecommunications firms face when evaluating network build opportunities. In short, TELRIC-based prices are inaccurate because they are set without consideration for the value of the options new entrants have for entering local markets.

Because TELRIC methods are forward looking, cost analysts using the method are required to make estimates of many future parameters. For example, projections of future network factor prices must be made. Levels of demand and type of demand must be taken into account so that the network's capabilities reflect market expectations. Engineering design and the expenses associated with provisioning and running a network must be predicted. One characteristic that is common to all of these parameters is that they are dynamic. Factor prices, demand levels, engineering design specifications, and operating expenses, to name only a few relevant parameters, all change over time. Any firm making an investment decision of the sort that CLECs and ILECs face would need to estimate the degree of change in all of them. In fact, this is common practice in finance departments in all telecommunications companies when three- to five-year business plans are developed. TELRIC, however, calls for these variables to be static. It is fairly simple, in fact, to compile a laundry list of TELRIC's shortcomings. Some of the items that would be included in that list are:

- TELRIC assumes that prices, output levels, and expenses remain static over time.
- Depreciation is based on accounting methods that allocate costs arbitrarily over time, do not calculate economic depreciation, and include depreciation improperly in pricing formulas.
- Quantities do not rely at all upon demand elasticities or market shares, and are constant throughout time.
- There are no economies of scale or scope, no technological substitution, and no factor price considerations in TELRIC's engineering design and relationships.
- Rate base calculations are without dynamics, including input and output price, and discount and interest rate dynamics.
- Investments are assumed to be one-time with static factor prices, constant capacity, no differentiated risk, and no real options.
- There are no competitive impacts or market share losses due to changes in price.[8]

Clearly these are major weakness in TELRIC methodology. Perhaps with the best of intentions, it has oversimplified the investment decision-making process.

Another defining feature of TELRIC that appears to fall short of ideal is that it relies on discounted cash flow (DCF) methods. In short, TELRIC-based prices reflect the discounted net present value of an investment in the local network made sometime in the future. Although DCF methods are frequently used by business decision-makers, they alone are not appropriate for the purpose of pricing UNEs.

Making the simplifying assumption that the TELRIC method is a satisfactory way to estimate the incremental costs of constructing telecommunications networks (although the authors do not feel it to be appropriate), TELRIC-based prices should exactly equal the discounted net present value of an investment made in building a network (see Relationship A below). In other words, a new entrant into the local market would be indifferent between building its own network or leasing it from an ILEC. If investors are indifferent, one would expect to see an equal mix between customers served by CLEC facilities and those served using ILEC UNEs. The evidence shows that there is not an equal mix between the two types of service provision.

TELRIC price = Cost to build (Relationship A)

Still, using this simplifying assumption, there is a way to account for this disparity. CLECs purchasing UNEs incur costs in addition to UNE lease prices because there are transaction costs when buying UNEs from ILECs. CLECs must negotiate contracts, participate in arbitration proceedings, set up departments to interface with ILEC wholesale operations, and invest in computer systems to ensure compatibility with ILEC operations support systems. In addition, having to rely on a competitor as a supplier brings with it some costs. These are real costs, and many CLECs would agree that they are significantly higher than expected when CLECs drafted their business plans. Now that CLECs have had two years to estimate these costs accurately, which the authors will assume are now known to be fairly high, and if TELRIC-based prices exactly equal the discounted net present value of investing in a network, one should again expect to see more build (see Relationship B).

TELRIC Price + ILEC Transaction Costs > Cost to Build
(Relationship B)

Once again, prices based on TELRIC seem to result in irrational investment decisions on the part of CLECs. Assuming CLEC managers are not irrational, the only way one can account for this is that there must be another cost on the right side of Relationship B that is unaccounted for in this simple analysis.

There is, in fact, a cost that has not yet been unaccounted for in this analysis. When a telecommunications firm is making a decision on whether or not to build a network, it faces various degrees of uncertainty. Many sources of uncertainty are obvious. Will there be sufficient demand to justify capital outlays? What customer segments will be targeted? Where are they located? What demand is there to satisfy? Will that demand change over time? What technology should be deployed (CDMA vs. TDMA and IP vs. circuit switched, for example)? What competitive response can be expected? Any financial analyst evaluating this investment would need to address these sorts of questions.

Typically, strategic planners and financial analysts would account for uncertainty by changing the discount rate in their NPV calculations. Indeed, the discount rate is the primary variable through which uncertainty or risk is measured and applied to the analysis using discounted cash flow methods. Discount rates can be estimated in a variety of fashions, each of which has proponents and each of which employs a large amount of time in corporate finance departments. That so much energy is expended in calculating discount rates is an indication of how complex a

variable it is. Indeed, cash flows in DCF analyses are projected with certainty, and DCF relies almost exclusively on the discount rate to factor uncertainty into analyses of future projects.

How is this relevant to the discussion about TELRIC-based prices? TELRIC methods rely on estimating, as closely as possible, the net present value of constructing a network in the future based on DCF methods. However, of late, there has been quite a bit of research in finance that challenges the validity of the DCF and NPV approach to evaluating projects.[9] If DCF opponents are correct, DCF does not accurately measure the true present value of many future projects because it does not accurately reflect the effects of uncertainty on a project's value. DCF, by necessity, assumes that uncertainty or risk decreases the value of a project. Larger payoffs are required (i.e., a risk premium) to reward an investor for increased risk. In general, this phenomenon can be reflected in the following way:

↑ Uncertainty ➔ ↑Discount Rate ➔ ↑NPV

(Relationship C)

3. OPTIONS THEORY APPLICATIONS TO DCF/NPV AND UNE PRICES

It is not difficult to illustrate that DCF methods fall short of accurately reflecting the complete value of a project when uncertainty exists. Dixit and Pindyck offer the following simple example to illustrate how DCF methods are inadequate for evaluating many investments under uncertainty, as well as the need to include the value of the option to wait to invest in a project.[10]

Dixit and Pindyck propose to evaluate a firm's decision to invest in a factory that produces widgets. They assume that the factory cannot produce anything but widgets once it is built. In other words, factory costs are sunk after the factory is built. Factory output is limited to exactly one widget per year. The cost of building the factory is $1,600, and the factory produces widgets with $0 operating costs. Today's price for a widget is $200, but the price will permanently change to either $300 or $100 with probabilities q and (1-q), respectively, next year. Dixit and Pindyck assume as well for simplification purposes that the firm does not have any firm-specific risk and that it should discount cash flows at the risk-free interest rate, which is assumed to be 10%. Under these circumstances, Dixit and Pindyck ask if this is a good investment.

Calculating net present value is straightforward. The expected price for widgets is $200 (a 50 percent probability that future price will be $300 and a 50 percent probability that future price will be $100). NPV, then, is

$$NPV = -\$1,600 + \sum_{t=0}^{\infty} \frac{200}{(1.1)^t} = -\$1,600 + \$2,200 = \$600 \qquad \text{("Static NPV")}$$

Since this project's NPV is greater than $0, it appears that the project should be pursued.

However, Dixit and Pindyck then go on to analyze the value of this investment under slightly different behavior. Indeed, if this firm waits one more period and invests in the factory only if the price of widgets rises, the NPV calculation looks a little different. First, there is no money spent in year 0. Second, $1,600 is invested only if widget prices rise in year 1. Assuming that the probability of prices rising is once again 50 percent, the investment analysis looks like:

$$NPV = (0.5)\left[\frac{-\$1,600}{1.1} + \sum_{t=1}^{\infty} \frac{\$300}{(1.1)^t}\right] = \frac{\$850}{1.1} = \$773 \qquad \text{("Expanded NPV")}$$

So, net present value today is significantly higher if the factory investment is made next year instead of today. The firm maximizes its net present value, then, by waiting until next year to invest. Dixit and Pindyck's point in introducing the second NPV calculation is to show that the first NPV calculation did not account for the opportunity cost of investing now instead of waiting to invest next period when it will be clear if widget prices rise or fall. In fact, the firm derives value from having the option to wait that is equal to $173, the difference in the two NPVs. This analysis can be expanded beyond the simple binomial example presented here, but the point remains - uncertainty can be valued and is a critical consideration in the correct valuation of any investment.

Proponents of options applications to project valuation under uncertainty often refer to the first NPV calculation as "static NPV" and the second NPV calculation as "expanded NPV." Expanded NPV is a more thorough measure of the value inherent to a project that is irreversible and in which a firm can invest in the future as an alternative to investing today. Looking back at Relationship A, one sees that uncertainty in a project does not necessarily decrease that project's value and that Relationship A, if it were to properly measure a project's present value, would have to include an option premium to reflect the value of having the option to wait:

↑ Uncertainty ➔↑Discount Rate ➔ ↓ NPV +↑option premium ➔↑ or ↓ NPV depending on the nature of the option

(Relationship D)

Investments in telecommunications networks naturally tend towards the expanded NPV evaluation method because they are for the most part irreversible, and firms can invest in the future as an alternative to investing today. If having the option to wait changes today's present value of a project, then clearly option premia need to be included in net present value calculations involving unbundled network elements.

4. REAL OPTIONS VALUATION SHOULD BE INCLUDED IN UNE PRICES

The Dixit and Pindyck example clearly illustrates that a project has an option component when a firm has the ability to postpone the project. Its value derives from uncertainty in either the cash inflows that will be realized in the future or cash outflows necessary to undertake the project. In the Dixit and Pindyck example, cash inflows are uncertain because the firm does not know the future selling price of widgets. Because the firm has the ability to postpone investment and there is uncertainty regarding the value of the investment, however, the project has a valuable option component.

Under the current structure of the local market, CLECs have the ability to postpone investments in real network assets without sacrificing the ability to invest later. Additionally, there is a great deal of uncertainty about the costs to construct network assets and about future cash flows that will be generated by those assets. Just like the firm in Dixit and Pindyck's example, CLECs own a valuable option.

Given that the CLECs own a valuable option, it is easy to show that TELRIC-based prices are too low. If the goal of FCC pricing rules is to exactly reflect the costs a firm would incur when investing in a network, then the option value of waiting to build must be included in the pricing formula. TELRIC prices are designed to capture the costs of construction and operation only, and the value of the option to postpone is not included. By definition, therefore, TELRIC prices are too low. Any telecommunications firm determining whether or not to build a network would have a higher investment threshold than TELRIC would predict because a firm would have to forego the option to wait to build.

Another way to illustrate that TELRIC prices are too low is to show what a CLEC both pays and receives from building a network and from buying UNEs. If a

CLEC chooses to build a network, then it pays the construction and operation costs of the network, and it receives cash inflows from selling services "produced" by the network. On the other hand, if a CLEC chooses to buy UNEs, it pays a price that is designed to be equivalent to the costs of the network's construction and operation, and it receives cash inflows from selling services "produced" by the network plus the option to build its own network at a later date. Given that the option to build at a later date is always valuable, a CLEC is always better off buying UNEs at current TELRIC prices because it simply gets more for its money.

In terms of the earlier pricing relationships, the value of the CLEC's option to wait needs to be added to the right-hand side of Relationship B. Reflecting the value of the option, Relationship B becomes:

TELRIC Price + RBOC Transaction Costs =
Cost to Build + Value of Option to Wait (Relationship E)

A firm facing this investment decision would be indifferent to the build-versus-buy decision, which would go a long way towards achieving the FCC's goals of stimulating competition in local markets.

It is clear that options theory is relevant to the CLEC's build-versus-buy decision. Under the FCC's pricing rules, CLECs have been given the option to delay investing in networks today in favor of waiting to invest in networks in the future. Indeed, both the build and buy decisions have the characteristics of options. Both have a strike price and a finite time horizon. The value of financial options increases as their time horizon increases, and the same holds for the real options available to CLECs. There is no compelling reason for CLECs to exercise their option to build before the option expires. Furthermore, the option is costless to the CLEC because it did not have to purchase the option. The most rational decision for CLECs to make under this pricing structure is to test local markets using UNEs, gather more information, and invest in networks later when sure payoffs are available.

5. OPTION VALUATION

It is clear that CLECs own a valuable option. What remains is to assess the value of that option. Although it can be complicated to derive the exact value of a real option, and it is not calculated here, it is still useful to discuss some general rules and relationships that can be employed.

Option valuation rules have been derived through extensive research on financial options.[11] The simplest financial option is a call option on a stock. A call option gives the owner of the option the right, but not the obligation, to purchase a stock at a prespecified price over some prespecified time period. The prespecified price at which the stock can be purchased is called the strike price or exercise price, and the prespecified time period is defined by the option's expiration date. Valuation research has shown that the value of a call option is a positive function of the profitability of exercise (which is the difference between the current value of the stock (S) and the exercise price(X)), the time to maturity, and the volatility of the stock price. This research has also shown that an option always has a positive value, because an option is a right, but not an obligation, to purchase a stock.

When studying the effects of the three variables that determine the value of an option (profitability of exercise, time to maturity, and volatility), the effects of profitability of exercise and time to maturity are the easiest to understand. The effect of profitability of exercise, for example, simply predicts that the option to purchase the stock for $X becomes more valuable as the positive difference between the current price of the stock, $S, and the exercise price, $X (i.e., S-X) becomes larger. The effect of time to maturity of the option simply predicts that, all else being equal, an option is more valuable if it has a longer life.

The valuation effect of volatility, on the other hand, is less intuitive. Options research shows that the value of an option increases as the volatility of the underlying asset increases. In other words, all else being equal, an option on a more volatile stock such as Yahoo! is more valuable than an option on a less volatile stock like AT&T. The reason for this is that an increase in volatility increases the chance that the stock price will experience a large upward move which, in turn, increases the profitability of exercising the option in the future. Of course, an increase in volatility also increases the chance that the stock will experience a large downward move in price, but this is of little consequence to the owner of a call option because the downside of a call option position is simply the cost of the option. Remember, a call option gives the owner the right, but not the obligation, to purchase the stock. In the event of a large downward movement to the point where the value of the stock ($S) is less than the exercise price ($X), the owner of the call option does not exercise the option and loses only the amount paid for the option. It is important to note that the positive effect of volatility on the value of an option comes from the fact that the owner of the option is not obligated to purchase the stock, and the option will only be exercised (i.e., the call option's owner will use the option to buy the stock for the exercise price $X) if it is profitable to do so.

These valuation effects can be applied to the real option component of CLECs' build-versus-buy decisions, although not all of these effects are directly relevant. One of the effects that is not directly relevant is profitability of exercise. Because a CLEC can realize profits from local markets by either buying UNEs or building networks, the profitability of exercise does not affect the value of the option component in the CLECs' build-versus-buy decision. Time to maturity, on the other hand, is more relevant. Because CLECs appear to face no imminent expiration date on their option to build, their option has a long life and is therefore more valuable than if it had a defined expiration date.

Probably the most important insight into the value of the CLECs' option to build comes from the idea that volatility, or uncertainty, increases the value of this option. Various sources of uncertainty in the local market are discussed in the next section, but suffice it to say that given the high degree of uncertainty in the local market, the CLECs' option to postpone investment in building network assets is very valuable. And because a CLEC's option ceases to exist the moment it commits to building, the most rational decision for a CLEC is to test local markets using UNEs purchased at low TELRIC-based prices and keep its valuable option alive. As was pointed out in Relationship E in the previous section, the only way for the FCC to alter this decision is to capture the value of the option in UNE prices.

6. UNCERTAINTIES

As discussed above, one of the most powerful insights that real options analysis has on business decision-making is that uncertainty does not necessarily decrease the value of a project. Indeed, if firms have the option to wait, increased uncertainty, as in Dixit and Pindyck's simple example, can generate greater value as measured in net present value terms. If real options are to be applied to TELRIC-based pricing (and other) decisions in telecommunications, it is worth spending a little time discussing the uncertainties that currently characterize the industry and that would lend themselves to increasing the value of the option to wait.

Uncertainties in the telecommunications industry are vast, which explains to a large extent why there has been little change in the distribution of market share in local markets. The decisions that make the largest net impact on local market participants are regulatory. The Act has been thrown into question, and it is unclear if and how it will be modified after sustained and repeated legal challenges to its constitutionality. Certain FCC mandates could be suspended indefinitely, for instance, completely reversing the course of local market entry and rendering CLEC

investments in local markets useless until subsequent legislation is written and passed by Congress and ultimately upheld in the courts. RBOCs continue to press for within-region InterLATA market entry. So far, success has eluded them, but recently Joel I. Klein, assistant attorney general-antitrust, prognosticated "that within a year to 18 months, Bell companies will begin winning approval to offer in-region interLATA services."[12] RBOC entry into long distance within 18 months would change the business landscape for interexchange carriers, ushering highly capitalized, well-branded competitors into the long distance market and, presumably, forcing interexchange carriers to be more aggressive in local competition to offer full service "one-stop-shop" packages.

Competition in local markets generates a great deal of uncertainty. Through June 1998, CLECs had raised about $20 billion in investment since the Act was passed.[13] Investors and market participants are placing their bets on many different types of firms, all of which are looking for growth opportunities in both traditional and new segments of the local market. With CLECs of all sizes and telecommunications equipment firms angling at different segments of the market, even large CLECs must continually reevaluate local market opportunities. If one type of competitor emerges with a distinct advantage, many other CLECs may follow. Until then, some firms seem willing to wait to see who can offer the most compelling package.

Rapid technological changes are enabling new forms of CLECs and are rendering other CLECs obsolete just as rapidly. One of the most dramatic changes has been in the movement of data (and soon voice) traffic away from circuit-switched networks and towards packet-switched networks. Wireless local loops still appear to be cost-prohibitive for the replacement of all local lines, but each year wireless costs decline, making wireless local loops a more viable alternative. PCS and cellular services are offering inexpensive, flat-rate pricing plans that are leading customers to use wireless phones for many calls that would have previously been made on a wireline phone. Wireless services involving toll calls are now competing with wireline services. Meanwhile, consumers are also demanding that the copper network be able to handle significantly larger volumes of traffic, and equipment companies are developing inexpensive technologies that can do just that. It is difficult to tell which technologies will prove to be winners in this environment.

As in any market, it is difficult to predict what services the market will demand in the future. As consumer preferences, regulation, competitive landscape, and technology change, market demands continue to reshape. No one predicted ten years ago that the mass market would be demanding third and fourth access lines into the home for multiple modem connections to ISPs. Nor could anyone have pre-

dicted that in two years seven RBOCs would consolidate into four, that Worldcom would become the nation's second-largest long distance carrier, or that AT&T would spend tens of billions of dollars to acquire cable TV assets. All of this activity generates uncertainty. And all of that uncertainty enhances the value of the option to wait or the option to take alternative actions. Public policy decisions must consider the impact of these options, and real options analysis must be included in pricing methodologies for the deregulation of the telecommunications industry.

7. PENETRATION OF RESIDENTIAL LOCAL MARKETS

The introduction of this paper notes that there has been little competition in residential local markets. Although the focus here has been on the effects that UNE prices have had on CLEC build-versus-buy decisions, there are clearly other reasons for limited competition in residential markets. Perhaps the most important of these has to do with the "low hanging fruit" strategy many CLECs have employed. Average business customers make more calls and overall pay higher rates than average residential customers. So, CLECs entering local markets have by and large targeted business customers first. Indeed, even before the Act, competition for large and medium-sized businesses was fierce, and competitive access providers had laid thousands of miles of competitive fiber in all large metropolitan areas in the country. Today, any business owner located in a metropolitan area with average or higher toll calling volumes, even a small business, is frequently approached by CLEC salesforces offering them discounts from ILEC rates. With most of their energy concentrated on high-margin business customers, CLECs may not have had the resources for broad residential market entry.

Another explanation for low residential penetration levels is that the vast majority of residential customers are unprofitable. Estimates are that ILECs make profits on only 30 percent of residential customers, who cover much of the losses associated with the other 70 percent of customers. If a CLEC were to try to win a portion of residential local revenues away from an ILEC, it would have to be able to find a way to target the 30 percent of the residential market that is profitable. However, unlike business customers, which are typically clustered in business parks or in downtown metropolitan business districts, high-usage residential customers are not typically clustered together. CLECs might be able to target residential areas, like California's Silicon Valley, where there might be high usage on local lines, but CLECs run the real risk that these customers are not using their lines for attractively priced toll calls, but instead are paying a low flat monthly charge and dialing into their Internet service providers for hours at a time. Profitable residen-

tial customers are those who make a large volume of intraLATA toll calls and long distance calls. It is not likely that these customers are clustered together, which raises marketing and selling costs, and also renders the use of unbundled loops less attractive. On an aggregate basis, residential margins may not be high enough to justify CLECs deploying switches in residential areas where the CLEC succeeds in winning only a few high toll usage customers.

8. CONCLUSION

Senator Mike DeWine, who is quoted in this paper's preamble, articulates nicely the frustrations that policy makers, industry participants, and the public have voiced over what they see as failure to achieve the goals of the 1996 Telecommunications Act. Many factors account for the current levels of competition in local markets. One of the most compelling is the uncertainty surrounding the direction and extent of ongoing regulatory rule making. Because the value of many local market investments hangs in the balance with each local market regulatory decision, competitors are reluctant to make major investments.

At the most fundamental level, however, it appears that the pricing of unbundled network elements may be a cause of some of the delay in network investment by CLECs. The FCC's TELRIC-based pricing methodology has many shortcomings, not the least of which is that it does not measure all of the costs attributable to a forward looking investment in telecommunications. Real options frameworks supply a new and more exact way to view telecommunications investment and UNE pricing.

The proper valuation of unbundled network elements is critical to the efficient operation of competitive local exchange markets. If UNE prices are too high, competitors are left without a good short-term method for entering the market. If they are too low, competitors have a low-cost method for entering local markets quickly, but are left without an incentive to build competitive networks. And, incumbents are left without the ability to earn on added investments. Neither result is ideal from a public policy standpoint, and every effort should be made to ensure that UNE prices are efficient. Using current methodologies, they certainly are not.

The more uncertainty that exists surrounding the local markets, the more valuable the option to wait to enter or to wait to build local networks becomes. Regulatory decisions, with billions of dollars hanging in the balance, continue to be unpredictable. Competitors are raising money and staking claims to the portions of the local market that are attractive now, but they are forced to delay entry into some

larger segments of the market until the regulatory and competitive landscapes are more clear. Technological advances have served both as a shield and a threat to ILECs as the types of technologies that make it possible for ILECs to offer new services over old networks allow competitors to exploit their advantages in organizational speed and time to market. But they have also made it much less clear which technology is most appealing to customers, providing yet another reason to delay until the local market is more well defined.

Real options techniques can help to explain the current state of competition in local markets and to understand CLECs' choices of market segments and investment plans. Real options techniques can also be used to identify the conditions necessary to stimulate greater investment in local networks and to promote CLEC penetration of the residential market. Understanding why CLECs have made their current decisions and what changes could stimulate different investment decisions would be valuable in the development of improved public policies and regulations. The pricing of ILEC wholesale services, like unbundled loops, is just one of the important factors. Many other factors are important to achieving public policy goals as well. Under the current circumstances, with a great deal of uncertainty and variety of local strategies to choose from, options valuation is clearly the most appropriate foundation for decision-making in the telecommunications industry, for both business decision makers and public policy makers.

NOTES

[1] FCC, "Responses to the First Common Carrier Bureau Survey on the State of Local Competition," March 27, 1998. See http://www.fcc.gov/ccb/local_competition/survey/responses/.

[2] Hume, Barbara. 1988. *Local Loop Competition.* Masters thesis, University of Colorado.

[3] The FCC estimates that AT&T's share of long distance minutes has dropped from 85% in 1984 to about 55% today. See Zolnierek, James and Katie Rangos. January 1998. *Long Distance Market Shares – Third Quarter 1997*, FCC, p. 29.

[4] Pacific Telesis offered the following summary of the problems associated with FCC Access Charge Reform proposals in its Comments on the Commission's Notice of Proposed Rulemaking, FCC Docket No. 96-262. *See http://www.fcc.gov/Bureaus/Common_Carrier/Comments/access_reform/samples/0155376.htm*

"The current access charge system is designed to recover all costs allocated to interstate access service, including all current costs. These current costs are allocated between the intrastate and interstate jurisdictions by arbitrary formulae that have one over-riding objective: to keep basic exchange rates low. Interstate costs are recovered by access charges. Access charges also recover some costs of the current Universal Service Fund, which is used to subsidize high cost carriers in rural areas. Likewise, interstate access charges also recover current and embedded LEC costs including investment being depreciated more slowly than economically justified to keep current rates low, as well as the cost of plant that may be stranded due to competition. Plainly, LEC shareowners will be subject to a new, fundamentally different and greatly increased risk if access reform creates a 'regulatory squeeze' by moving prices to economic costs without providing for the recovery of all current costs outside of the access charge regime.

The Notice proposes to reform access charges by several possible means: changing the rate structure; reducing or eliminating regulation to allow market forces to work; and/or continuing to regulate prices but with a changed basis. The ideal thrust of each of these proposals would be, in the Commission's view, to 'make [the] system of interstate access charges more economically rational and compatible with competitive local markets.' [As discussed in detail below, the likely reality of certain proposals would be quite the opposite.] To the extent that the Commission's access charge reform reflects a single-minded principle that prices must be lowered to recover no more than forward looking costs, the real current costs now included in access charges will be unrecovered and land solely on the shoulders of LEC shareowners. Under some of the options proposed, LECs would be precluded from recovering any costs other than forward looking costs in their access charges. Under other options, certain access charge elements might theoretically include a portion of these costs, but given competition, cost recovery would be impossible, leaving LEC shareholders 'holding the bag.'"

[5] *Telecommunications Report*, Nov. 2, 1998.

[6] Dixit, Avinash K. and Robert S. Pindyck. 1994. *Investment Under Uncertainty.* Princeton, NJ: Princeton University Press.

[7] *Telecommunications Reports*, Nov. 9, 1998.

[8] See Alleman, James, "The Application of Real Options to Cost Models," this volume. This list is largely based upon Alleman's presentation at CITI's October 2, 1998 real options conference.

[9] For a good example of this, see Ross, S. Autumn 1995. "Uses, Abuses, and Alternatives to the Net-Present-Value Rule." *Financial Management*, Vol. 24, No. 3, pp. 96-102.

[10] Dixit and Pindyck, op. cit., pp. 26- 29.

[11] The seminal work in this area is: Black, F. and M. Scholes. May-June 1983. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy*, and Merton, R. Spring 1973. "Theory of Rational Option Pricing," *The Bell Journal of Economics and Management Science*, Vol. 4, No. 1.

[12] *TR DAILY*, Nov. 20, 1998.

[13] Madden, Andrew P. October 1998. "What Happened to the Telecom Act?" *The Red Herring*. See http://www.redherring.com/mag/issue59/telecom.html.