Downstream integration by a bottleneck input supplier whose regulated wholesale prices are above costs

Gary Biglaiser∗
and
Patrick DeGraba∗∗

We examine the consequences of allowing a bottleneck input supplier to vertically integrate downstream and compete with users of the input when the input has a regulated price above cost. If the supplier maximizes the sum of short-run profits from the downstream market and input market, then allowing the vertical integration will increase social surplus, even if it causes sellers of competing differentiated products to exit the market. If the bottleneck supplier wishes to engage in predatory pricing, increasing the regulated price of the input above cost reduces the incentive to engage in predation. These questions are motivated primarily by assertions made in the public record that allowing Bell Operating Companies into long distance can be harmful if access rates are above cost.

1. Introduction

A recent wave of deregulation in industries that were previously believed to be natural monopolies has occurred in the United States and in other countries. One of the results is that firms that provide a bottleneck input now, or may in the near future, compete against their customers in a final goods market. Leading examples include both long distance and local telecommunications and electricity generation.1 Many commenters representing nonbottleneck input providers have argued that competition with bottleneck input providers can be problematic if the bottleneck

∗ University of North Carolina; gbiglais@email.unc.edu.
∗∗ Charles Rivers Associates; PDeGraba@crai.com.

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1 Section 271 of the 1996 Telecommunications Act outlines conditions under which Regional Bell Operating Companies (BOCs) may enter interLATA interexchange (long distance) voice markets. The act also encourages entry by non-BOCs into the local telephony markets. States such as California and Massachusetts have deregulated their electric generation markets.

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facility can be sold at a price that exceeds the long-run cost of production. The argument is that because the bottleneck provider can provide himself the bottleneck input at a price lower than the price at which he provides it to his competitors, the input provider can undertake strategies that will distort the market and decrease overall welfare. We label such strategies as artificial cost advantage strategies.

In this article we formalize and examine the validity of two artificial cost advantage arguments. The first argument assumes that upon entering, the bottleneck facility provider behaves nonpredatorily. The fear is that it will serve customers that would be better served by a competitor because the cost advantage will allow it to offer a lower price and win customers from a firm that was more efficient at serving these customers. The second argument assumes that the bottleneck provider may behave predatorily when it sells the input at a price above cost. The fear here is that the supplier of the bottleneck facility can set the retail price equal to the price of the bottleneck facility (plus any other marginal cost of production the competitor would incur) and drive competitors from the market. Once the competitors exit, the bottleneck facility provider can then raise the retail price to the detriment of welfare.

These arguments are interesting because each has been raised with respect to allowing Bell Operating Companies (BOCs) into long distance as long as they were the dominant provider of access to Inter-Exchange Carriers (IXC). Access refers to the fact that an IXC must pay a BOC to transport a long distance call from the calling party to the IXC’s network and to transport the call from the IXC’s network to the called party. Because these arguments were raised in the context of BOC entry into long distance, we cast the remainder of our analysis in this setting. However, we note that our analysis may also apply to other situations. For example, it may be important for non-BOC entry into the local telephone market. Furthermore, the Department of Justice has argued that the cost advantage Microsoft gains by bundling Internet Explorer with Windows gives it an advantage over Netscape that may result in the demise of Netscape as the dominant browser.

We examine the nonpredatory argument using a complete-information Hotelling model. In the first model, two IXCs are located at opposite ends of the line, purchase access from the BOC, and compete by setting two-part tariffs. The competition results in a symmetric equilibrium. In this equilibrium, each customer consumes his most preferred good. We then model BOC entry by replacing one of the IXCs with the BOC. This eliminates the symmetry of the equilibrium and introduces an inefficiency because some customers do not purchase their most-preferred good. But having the BOC in the market introduces an efficiency, since it sets a lower usage fee than the non-BOC sets. We show that this efficiency effect outweighs the inefficiency effect, even when the BOC drives the competing firm from the market and fails to serve the entire market.

The second model deals with the case in which the BOC may behave predatorily. To determine the overall effect of increasing access rates on the BOC’s incentive to prey, we examine a two-period model with demand uncertainty where the firms must meet profit hurdles to remain

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2 See paragraph 126 of the Second Report and Order Regulatory Treatment of Local Exchange Carriers. Commenters include AT&T, MCI, and MFS. Prices are regulated above costs in telecommunication to both cover fixed costs of the network and subsidize monthly rates. The latter is to help guarantee “universal service” for consumers.

3 Another set of strategies that BOCs could use to harm a competitor is to withhold or degrade the quality of access services available to competing firms. Economides (1998) shows that a firm will have an incentive to degrade its rivals’ input. Sibley and Weisman (1998) have suggested that the higher access rates are above the cost of access, the less incentive a BOC has to engage in non-price-raising rivals’ cost activities. See also Riordan and Salop (1995).

4 When referring to predation, we do not necessarily mean that the firm prices below cost as dictated by the Areeda Turner Standard. In our model, the firm not only chooses its retail price, but also is a seller of a necessary input whose price is above cost. This is often referred to as a price squeeze. We thank a referee for pointing this out.

5 Sidak and Spulber (1997) and Doane, Sibley, and Williams (1999) argue that Efficient Component Pricing Rule (ECPR) leads to exit by a non-BOC and higher welfare. They focus on the welfare effects of eliminating duplicative investment given a fixed retail price. Our analysis focuses on the welfare effects of competition on retail competition.

6 Two-part tariffs are quite common in the long distance telecommunications market.

7 This predatory scenario is quite controversial. There is a large literature suggesting that such predation can never be profitable because once the BOC raises its price, either the firm will reenter the market or another firm will use the assets of the non-BOC and do so. See Bolton, Broadley, and Riordan (2000).

in the market in the future. This approach follows Bolton and Scharfstein (1990). The profit hurdle may be set by outside investors, or it may be imposed internally by a firm’s finance department. The key is that the financier cannot know the true state of demand with certainty just by looking at profits. This leads to the possibility of “signal jamming” by the BOC to induce exit by the non-BOC.

Although charging a price above cost for access makes it less costly for the BOC to engage in predatory behavior (i.e., it reduces the loss the firm incurs during the predatory period and makes it less profitable for a non-BOC to stay in the market), it also reduced the benefits from predation. The benefit of predatory behavior is that once a firm drives out its competitors, it is able to enjoy monopoly profits for some period of time. However, being able to capture monopoly profits may represent a small increase in profits for a firm that is already extracting a great deal of the rents from a market through pricing an essential input above cost. We demonstrate that increasing the access rate always decreases the BOC’s overall incentive to engage in predation. In the game that we analyze, the firms receive financing before the access price is determined, so that the hurdle rate is independent of the actual rate of access. We also discuss what effects are present when the profit hurdle is set after access is determined, so that the hurdle is possibly a function of access.

While one may think a BOC would be unable to engage in a price squeeze on a company the size of AT&T, we point out that this behavior need only occur with respect to specific market segments or services. Thus, AT&T need not be driven into bankruptcy as a company for a price squeeze to be successful.

This analysis addresses a very specific policy issue: Given that access rates are regulated above the long-run incremental cost (LRIC), will allowing BOCs into long distance while access rates are above cost incrementally increase or decrease welfare relative to keeping them out? We understand that lowering access rates will probably increase welfare. In practice, however, at least in the United States, access rates are determined by a process that is independent of whether the BOCs are allowed into the long distance market. We therefore treat access rates as exogenously fixed.

In Section 2 we present and analyze a Hotelling model of product differentiation in which a firm behaves myopically when maximizing profits. Section 3 examines a two-period model with uncertainty to examine the incentives of a BOC to engage in predatory behavior. The final section provides concluding remarks.

2. Nonpredatory model

We consider competition between two non-BOCs located on opposite ends of a Hotelling line of length \( l \). To produce one minute of interexchange calling, a non-BOC must purchase one minute of access. The BOC is the only seller of access, and its costs are normalized to zero dollars per minute. The regulatory authorities allow the BOC to sell access to the non-BOCs at a price of \( \alpha \) cents per minute, where \( \alpha > 0 \). Each firm incurs a per-period fixed cost \( F \) of operation and produces a minute of calling at zero marginal cost, except for the per-minute price it must pay for access.

Consumers are uniformly distributed along the line. Each customer has linear travel cost \( t \) per unit travelled and a demand curve of the form \( q = z - bp_i \), where \( p_i \) is the per-unit price charged by firm \( i, i \in \{B, N\} \), where \( B \) denotes the BOC and \( N \) denotes the non-BOC. Thus, consumers view calls as homogenous goods. Firms are differentiated on dimensions such as billing and customer service that are not sensitive to the number of calls consumers make. We allow the firms to offer two-part tariffs, where \( E_i \) represents the fixed portion (entry fee) of the tariff.

We impose two restrictions on the parameters:

8 In practice, the decisions will be made independently of each other. The FCC is required to allow a Regional BOC into long distance if it meets a 14-point checklist, which does not include selling access at cost. An analysis dealing with optimal access rates in a dynamic model is in Biglaiser and Riordan (1999).

9 It should be noted that because the travel cost parameter \( t \) does not affect the quantity demanded by a consumer, restricting attention to two-part tariffs places no restrictions on a firm’s ability to use nonlinear prices.
Restriction 1.  \( t \ell < b(z/b - \alpha)^2/3 \).

Restriction 2.  \( \alpha < z/2b \).

Noting that \( b(z/b - \alpha)^2/2 \) is the surplus generated when a customer purchases minutes while facing a usage charge of \( \alpha \), Restriction 1 implies that the travel cost incurred by the customer located at one end of the line to purchase from a firm located at the other end is less than two-thirds of the surplus he would get by purchasing from that firm. It ensures that all consumers will be served in equilibrium with two firms. Restriction 2 says that the regulated price of access is less than the monopoly price.

We compare an equilibrium in which two carriers purchase access from the BOC at \( \alpha \) to an equilibrium in which the BOC, at location 0, competes against one non-BOC, located at \( \ell \), to which it sells access at \( \alpha \). We analyze entry by the BOC in this way for two reasons. First, to isolate the effect of above-cost access rates, we must keep everything else the same to compare the two equilibria. Each equilibrium must have the same number of firms, the same differentiated products, and, except for the price of access, the same cost structure. To do anything else would introduce additional effects that would mask the effects we are trying to illustrate. Second, the BOC has an incentive to purchase a non-BOC. Interestingly, we are empirically observing this with Bell Atlantic merging with GTE, US West merging with Quest, and SBC’s attempt to buy AT&T. We start with a preliminary lemma.

**Lemma 1.** In any equilibrium, the non-BOC sets \( p_N = \alpha \), while the BOC sets \( p_B = 0 \).

This result stems from the fact that all customers have identical demand functions and the firm must set the same two-part tariff to all customers. Intuitively, a firm would never set a usage fee above the marginal cost of access because it could always do better by lowering the fee to its marginal cost and raising the fixed charge by just enough to cover the loss in revenue from the usage rate reduction. Since all customers are identical except for transportation costs, lowering the usage rate results in the same loss of revenue from each customer, so the same increase in the fixed portion of the tariff will recover this loss from each customer. This repricing will make the marginal customer strictly better off, which will increase the number of customers the firm sells to without reducing the revenue it receives from its original customers.\(^{10}\)

**Proposition 1.** Entry by the BOC makes all customers better off and increases overall social welfare in the short run.

**Proof.** See the Appendix.

Routine calculations, which are relegated to the Appendix, show that \( E_N^{**} \), the fixed fee set by the BOC, is \( t \ell + b\alpha^2/6 + \alpha(z - b\alpha) \); \( E_N^* \), the non-BOC’s fixed fee when the BOC is in the game, is \( t \ell - b\alpha^2/6 \); and \( E_N^* \), the fee when two non-BOCs are in the game, is \( t \ell \). Clearly, \( E_N^{**} > E_N^* \). Thus, when the BOC enters, the customers who continue to purchase from the non-BOC see no change in their usage fee but a decrease in their fixed fee, so they are better off. Customers who purchase from the BOC who were originally purchasing from the firm it replaced see a reduction in their usage fee but a decrease in their fixed fee, so they are better off. Customers who purchase from the BOC who were originally purchasing from the firm it replaced see a reduction in their usage fee from \( \alpha \) to 0, but an increase in their fixed fee from \( E_N^* \) to \( E_N^{**} \). We show that the increase in the fixed fee when the BOC is in the market extracts only a fraction of the additional surplus generated by the increase in the quantity purchased by customers in response to the decrease in the usage fee. Customers who switch from the non-BOC to the BOC must be better off because they had the option of continuing to purchase from the non-BOC at the same usage fee but at a lower fixed fee. Thus, all consumers are better off.

There is a positive and a negative welfare effect for customers who buy from the BOC when it enters. As argued above, all customers are better off as a result of the usage fee falling (the price effect). On the other hand, there is an increase in travel cost because more than half the customers

\(^{10}\) Note that raising \( w_B \) allows us to lower the \( F \) that induces exit, but the critical \( F \) falls at a slower rate than the increase in \( w_B \).
purchase from the BOC. As the proof demonstrates, the price effect outweighs the increase in travel cost.

The intuition for why welfare is higher with a BOC in the market is robust across a large class of models. In fact, it holds for all models in which the goods are strategic complements and the slopes of the best-response functions are less than one. First, note that when the BOC enters it lowers the usage fee faced by its customers from $\alpha$ to 0. Since all customers are identical, this increases social surplus (because it increases usage) by some value, $v$. Now assume that when the BOC enters it reduces its usage charge from $\alpha$ to 0 but sets the fixed part of its two-part tariff equal to $v + E^*_N$. In this case, the allocation of customers is identical to what it was in the non-BOC equilibrium. Welfare is improved by the amount $v$ per customer served by the BOC. If the BOC did this, the non-BOC would have no incentive to change its fixed price because it would face the same effective price combination as when competing against a non-BOC. The BOC has an incentive to set a lower fixed price, however, because it is serving the same number of customers as the non-BOC it replaced, but the profit per customer is higher. Thus, at this point the BOC is faced with an elastic demand curve and can increase its profit by lowering its fixed fee. This fact, along with the assumption that the fixed parts of the two-part tariffs are strategic complements and the slopes of the best-response functions are less than one, implies that in equilibrium the difference between the fixed rates charged by the BOC and the non-BOC is less than $v$. Since this difference in fixed charges represents an upper bound on the increase in travel costs, a customer who switches from the non-BOC to the BOC generates a smaller increase in travel costs than $v$.

We now determine how long-run welfare is affected by having the BOC in the market. Since entry by the BOC reduces the non-BOC’s revenue, it is possible that in the long run the non-BOC could be driven from the market, whereas it could have survived had it been competing with another non-BOC. This would occur if $F$, the fixed cost of operation, is in the interval $[(3t\ell - \alpha^2 b^2/2)^2/18t, \ell^2\ell/2]$. If $F$ is smaller than $(3t\ell - \alpha^2 b^2/2)^2/18t$, then the non-BOC will not be driven from the market and by Proposition 1 welfare would be higher with the BOC in the market. If $F$ is greater than $\ell^2\ell/2$, then it is not possible for two non-BOC firms to be in the market; so having the BOC in the market instead of a single non-BOC improves welfare.

With respect to the long-run result, when the other non-BOC exits, four new (competing) effects are introduced. First, eliminating the non-BOC means that the double-marginalization effect is eliminated for the customers who used to be served by the non-BOC. Second, exit by the non-BOC eliminates its fixed cost. Third, exit exacerbates the redistribution effect, i.e., it causes all customers to purchase from the BOC. Finally, the elimination of a competitor could result in a higher fixed portion of the two-part tariff and thus cause some consumers not to be served. In the next proposition and ensuing discussion we demonstrate that BOC entry always improves welfare.

**Proposition 2.** Entry by the BOC increases welfare in the long run.

*Proof.* See the Appendix.

For this discussion it will be useful to let $w_B$ represent the surplus a consumer gets when he faces a usage rate of zero from the BOC and $w_N$ represent the surplus of a customer who faces a usage rate of $\alpha$ from the non-BOC; $v \equiv w_B - w_N$. We first provide the intuition when all consumers are served. In this case, the non-BOC’s exit increases welfare in two ways. First, it increases the number of customers the BOC serves and therefore the number of customers who enjoy a surplus of $w_B$ rather than $w_N$. Second, it eliminates the fixed cost that would have incurred had it continued to operate. On the other hand, welfare is reduced because of the increase in travel costs due to the additional consumers served by the BOC.

To compare these magnitudes we use Figure 1, which shows the equilibrium prices when the two non-BOCs compete and the short-run equilibrium price when the BOC enters. There are two key observations that allow us to compare the size of the three welfare changes. First, when differentiation is modelled as a fixed welfare differential regardless of the number of units purchased (as is the case with a travel cost that is independent of the number of units purchased),
then the difference in the fixed part of the two-part tariff charged by the BOC and the non-BOC is less than \( v \). This can be seen by noting that when the BOC competes against a non-BOC, the indifferent customer \( i^* \) is the one for whom \( v = E_B^* - E_N^* + [i^* - (1 - i^*)]t \). Second, \( E_B^* \) is greater than \( tl \), which is the fixed portion of a non-BOC’s tariff when it competes with another non-BOC.

The shaded triangle ABC represents the additional travel cost incurred by the market if the non-BOC exits and all customers are served by the BOC. The rectangle \( i^*DE_N^*l \) is a lower bound on the size of the non-BOC’s fixed cost. This is because the non-BOC exits if and only if the revenue represented by this rectangle is less than \( F \). The benefits from facing lower user fees, \( vl \), are the sum of the two hatched rectangles. The shaded triangle has an area \( tl^2/4 \). The rectangle \( i^*DE_N^*l \) can be as large as \( tl^2/2 \). Thus, if \( F > tl^2/4 \), exit is welfare improving because the fixed costs exceed the travel cost savings.

We must still check the case of \( F < tl^2/4 \). First, suppose that \( F \) is arbitrarily close to \( tl^2/4 \). Since \( vl \) is strictly positive, it must outweigh the difference between total travel cost and \( F \). Second, for \( F \) arbitrarily close to zero, the non-BOC will be forced to exit if and only if in the short-run equilibrium its fixed part of the two-part tariff is arbitrarily close to zero. But since \( v > E_B^* - E_N^* \) and \( E_B^* > tl \), then \( v > tl \). Thus, the total benefit generated by all consumers buying from the BOC is greater than \( tl^2 \). This is four times greater than the travel cost saving from having the non-BOC in the market.

The intuition can be summarized as follows. When the fixed cost of the non-BOC is very small, a very large increase in benefit due to lowering the usage rate from \( \alpha \) to zero is required to make short-run prices low enough to drive the non-BOC from the market. This benefit far outweighs the loss of product differentiation. When the fixed costs of the non-BOC are about the same as the benefits from differentiation, these two effects are a “wash” when the BOC exits. Society therefore benefits by approximately \( v \) per consumer. Finally, when the fixed cost of the non-BOC exceeds the benefits from differentiation, then non-BOC exit is always beneficial.

Extending these results to the case where the BOC does not serve the entire market is a bit more complicated. Now there are four welfare effects, as opposed to three from before. The previous three effects were the saving in fixed costs, the reduction in usage charge by the BOC, and an increase in travel costs due to consumers beyond \( \ell/2 \) going to the BOC. The fourth effect is an additional loss, since some consumers are not being served. We first place constraints on the magnitudes of \( w_B \) and \( w_N \). For this analysis, we need only examine cases where \( w_B < 2t\ell \) and \( w_N > 3t\ell/2 \). The former restriction arises because if \( w_B > 2t\ell \), then the BOC serves the entire
market when it is a monopolist. The latter restriction is necessary for two competing non-BOCs to serve the entire market. Of course, \( w_B > w_N \).

First, we find the biggest reduction in welfare that can result from the BOC not serving the entire market. The largest welfare loss occurs when \( w_N = 3t\ell/2 \) and \( w_B = 3t\ell/2 + \epsilon \) for \( \epsilon \) arbitrarily close to zero. \( w_B \) being arbitrarily close to \( 3t\ell/2 \) means that the number of unserved consumers is close to \( \ell/4 \), which, given the constraints of the model, is the maximum number of consumers that the BOC will not serve. \( w_N = 3t\ell/2 \) maximizes the welfare loss from a customer not being served. Thus, the lost benefit from unserved customers can be at most \( 3t\ell^2/8 \). The travel cost of the additional customers served by the BOC is \( t\ell^2/16 \), and the travel cost eliminated by unserved customers is \( t\ell^2/32 \). Thus, the overall loss in surplus is \( 13t\ell^2/32 \).

For the non-BOC to be driven from the market when \( \alpha \) is close to zero, it must have a fixed cost arbitrarily close to \( t\ell^2/2 \). Hence, there is a gain in welfare from BOC entry when \( \alpha \) is close to zero because the saving of fixed cost exceeds the welfare loss. As \( \alpha \) increases \( \nu \) rises, which will increase the number of customers the BOC can serve and increase the benefit from having the BOC serve customers instead of a non-BOC. This will increase social surplus.

These results suggest that if a seller of a bottleneck facility has a cost advantage over competitors, then allowing it into the market, even if this drives out a competitor, will not result in welfare losses. Intuitively, this is because for the seller of the bottleneck to drive out the competitor, the cost advantage must be more valuable to society than the benefits from the differentiation net of fixed costs needed to generate them. Thus, the value of allowing BOC entry is greater than the potential loss of a carrier offering a somewhat differentiated product. Similarly, in the case of Microsoft, allowing it to bundle Internet Explorer with its operating system may give it a cost advantage that allows it to drive Netscape from the market, but only if the marginal additional benefit Netscape offers over Internet Explorer is in some sense smaller than the cost advantage enjoyed by Internet Explorer.

Our analysis allows us to comment on another current policy. In nonregulated downstream markets in which BOCs have entered where they are the provider of a bottleneck input, there has been a longstanding tradition of ensuring that the BOC does not discriminate against its downstream competitors. One way this has manifested itself is through the “affiliate transaction rules.” Often a BOC will be required to provide a nonregulated service through a separate affiliate, which, among other things, must purchase services from the BOC in arm’s-length transactions. The BOC is then required to sell these services to downstream competitors at the same price that governed the arm’s-length transaction with its affiliate. Our analysis demonstrates that this restriction reduces welfare if the BOC charges a price for the input above LRIC.

While in our model each firm sets its usage rate equal to marginal cost, we recognize that in many instances in telecommunications markets, usage rates often exceed marginal cost. We point out that our results are not “knife edge” and do not depend on usage rates equalling marginal cost. For example, if there are two sets of customers distributed along the Hotelling line with different but sufficiently similar demand functions (for example, the slopes differ by \( \epsilon \)), then in equilibrium usage rates would exceed marginal cost. The equilibrium values of such a model could be made arbitrarily close to the results of our model. Thus, all of our qualitative results would still hold. Furthermore, it is a straightforward exercise to show that our results hold if we assume carriers compete as Cournot duopolists facing linear demand and constant marginal cost, instead of the differentiated market structure posited in our model.

### 3. Predatory price squeeze

In this section we look at the incentive of a bottleneck input supplier who also competes in the downstream market to engage in predatory price squeeze, given that the price of the bottleneck input is set by a regulator. We focus on a very specific question: As the difference increases between the regulated rate and the cost of supplying the bottleneck facility, does the bottleneck provider have an increased incentive to engage in a price squeeze in the downstream market to eliminate its competitor? As we stated in the Introduction, the issue has been raised in many regulatory settings, including BOC entry into the long distance market.
To address the question, we present a two-period model of competition based on the model of Section 2. To model the price squeeze formally, we add some uncertainty to the model. We assume that \textit{ex ante} there is uncertainty about the BOC’s relative advantage over its non-BOC rival. It is quite natural for there to be uncertainty about the relative abilities of the two firms, especially in a market where a competitor is a new entrant, such as the BOC in the long distance market or a non-BOC in the local market.\textsuperscript{11} Let \( k \) be the term that captures this advantage. \( k \) is the same in both periods. In our Hotelling framework, a consumer receives \( k \) more units of surplus if she goes to the BOC instead of the non-BOC. It is common knowledge that \( k \) is equally likely to be zero or \( \bar{k} > 0 \). We assume that this advantage is nonnegative, to capture the idea that a customer will be able to obtain all her telecommunications services, both local and long distance, from one carrier if she purchases from the BOC: the one-stop shopping effect.\textsuperscript{12} Once the non-BOC enters the market, \( k \) is observed by both firms.

A firm must incur \( F \) in each period. \( F \) could represent three different forms of costs. First, it could represent the expenditures necessary for new equipment to stay competitive in a market that undergoes frequent technological advances. Second, it could be the costs of maintaining billing systems, customer service, marketing departments, etc. Finally, it could represent the opportunity costs of being in the market, for example, the forgone profits of being in this market instead of some other market, since the firm is capital constrained.

Given the nature and size of \( F \), we assume, following Bolton and Scharfstein (1990), that a firm must receive financing to cover it and participate in the market. We have two different ways to interpret the financing of \( F \). First, the firm must make payments to outside investors such as stockholders and creditors. This is quite a reasonable assumption for relatively small firms. It even makes sense for a firm like AT&T, since it issues corporate bonds and is a publicly traded company. Second, our modelling approach can be justified even if the firm is internally financing its participation in the market. This is because when a firm, the principal, is allocating money across activities it may restrict funds to activities, agents, because it has less information than the manager of the activity. That is, the AT&T finance division plays the role of the financier and the AT&T division manager for each market is treated as a firm that needs financing.

Neither a firm’s creditors, its finance department, nor the courts can observe \( k \).\textsuperscript{13} We restrict contracts or internal financing rules to state that the non-BOC can obtain financing in period 2 only if it pays back \( \pi^N \) to the financier—or to the finance division if the project is internally financed—in period 1. If the non-BOC cannot meet its profit target, then it must exit the market and pay its creditors the profits it earned in period 1.\textsuperscript{14} We are ruling out contracts in which a firm receives financing in the second period with some probability that is strictly increasing in its first-period profits. For simplicity, we assume that the investor or finance department can commit to a contract, and we do not allow renegotiation. We also assume no discounting of future profits.

If \( k \) is known, then in the static stage game equilibrium a non-BOC can make profits larger than \( F \) if \( k = 0 \), but cannot cover \( F \) if \( k = \bar{k} \). Thus, there is some positive probability that the investors will not be paid back \( F \). This implies that a non-BOC’s cost of capital will be above the risk-free rate. The capital markets are competitive. If a firm finances \( F \) internally, then in expectation the profit hurdle is set so that the profits in that market are in expectation nonnegative profits. We make the following assumption concerning \( \bar{k} \):

\textit{Restriction 3.} \( 3t\ell - a^2b/2 - (18tF)^{1/2} < \bar{k} < 3t\ell - a^2b/2 \).

\footnote{Demand uncertainty in newly deregulated markets has also been examined in Biglaiser and Ma (1995).}

\footnote{We discuss later how the results would change if \( k \) could be negative.}

\footnote{Thus, following the incomplete-contract literature (see Grossman and Hart (1986)), we are assuming that having a transaction occur within the firm—the financing of the project—gives the financiers no more information than if the project is externally financed.}

\footnote{The non-BOC faces a positive profit hurdle because there is some positive probability it will lose money in period 2. However, the BOC does not face a profit hurdle because it always makes profits in period 2.}
The first inequality is a sufficient condition for a non-BOC firm to be unable to cover $F$ in the stage game equilibrium if $k = \bar{k}$. The second inequality is a sufficient condition for the non-BOC to get positive sales in the stage game equilibrium.

We focus our attention on whether the BOC will have an incentive to prey. Unlike Bolton and Scharfstein (1990), we do not focus on the issue of strategic manipulation of $\pi^N$ by investors or the finance division.

The timing of the model is the following: In stage 1, the firms either receive financing or they do not. In stage 2, the price of access is determined. In stage 3, a firm enters if it receives financing. In stage 4, both firms learn $k$. The firms then compete by simultaneously choosing two-part tariffs. If a firm’s profit exceeds its hurdle in period 1, then it gets financing in period 2 and the firms again compete by simultaneously choosing two-part tariffs. If a non-BOC’s profit is less than its hurdle, then it exits the market and the BOC is a monopolist in period 2.

In this setting, we define the incentive for the BOC to engage in predatory pricing as the difference between the sum of the profits the BOC makes when engaging in predatory behavior and the sum of its profits from engaging in non-predatory pricing. If this difference is increasing in the price of access, $\alpha$, then we say that increasing $\alpha$ increases the incentive for the BOC to engage in predatory pricing. We solve the game by working backward from the final stage in period 1.

The static duopoly Nash equilibrium payoffs for the BOC and non-BOC in a period are

$$
\pi_D^B = \left[3t\ell + \alpha^2b^2/2 + k\right]^2 + \alpha \ell (z - \alpha b).
$$

$$
\pi_D^N = \left[3t\ell - \alpha^2b^2/2 - k\right]^2 - \pi^N.
$$

The monopoly profit of the BOC is

$$
\pi_M^B = \frac{z^2\ell}{2b} - t\ell^2
$$

if the BOC wants to serve the entire market and

$$
\pi_M^B = \frac{z^4}{16tb^2}
$$

if it does not. That is, $\pi_M^B$ is (1) if $z^2/4bt > \ell$ and (2) otherwise.

We want to compare the profits of the BOC from predatory pricing with the profits from maximizing short-run profits in each period. Clearly, we only need to examine the case when $k = 0$, since if $k = \bar{k}$, the non-BOC will always exit at the end of the first period, and thus the BOC will always maximize short-run profits in this case. If the BOC maximizes short-run profits, then its total profits are $2\pi_D^B$.

To obtain the BOC’s profits from predatory pricing, we need to determine what tariffs it must use to force the non-BOC to exit the market. From Lemma 1, the non-BOC’s optimal variable part of the tariff is equal to $\alpha$. The first-order condition for the non-BOC’s optimal $E_N$, given the BOC’s fixed tariff $E_B$, is

$$
E_N = \frac{t\ell - \alpha z + \alpha^2b^2/2 + E_B - k}{2}.
$$

---

15 As was true in the previous section, our results do not depend on the use of two-part tariffs. Again it is a straightforward exercise to show the results hold when carriers compete as Cournot duopolists facing linear demand and constant marginal costs.

This generates an indifferent consumer $i^*$ of 

$$i^* = \left[ \alpha z - \alpha^2 b/2 - E_B + 3t \ell + k \right] / 4t.$$

Thus, the non-BOC’s profits as a function of $E_B$ are

$$\frac{(t \ell + E_B - k - \alpha z + \alpha^2 b/2)^2}{8t}.$$

If $\pi^N$ is the profit target that the non-BOC must meet to get funding for the next period, then if the BOC wants to prey it must set the fixed portion of the two-part tariff, $E_B$, so that the non-BOC cannot meet the target. The highest $E_B$ that causes the non-BOC not to meet its target and induces exit is

$$E_B^* = 2(2t\pi^N)^{1/2} - t \ell + \alpha z + k - \alpha^2 b/2.$$

This generates an $E_N = (2t\pi^N)^{1/2}$.

If $k = 0$, then the BOC’s profit if it preys in period 1, and is a monopolist in period 2 is

$$\pi_B^P = [2(2t\pi^N)^{1/2} - t \ell - \alpha z - \alpha^2 b/2] \left[ \ell - \left( \pi^N / 2t \right)^{1/2} \right] + \alpha (z - b\alpha) \left( \pi^N / 2t \right)^{1/2} + \max \left[ \frac{z^4}{16b^2t} - \frac{1}{2} \ell \ell^2- \ell^2 \right].$$

The first bracketed term in (3) is the tariff that the BOC charges. The second term is its market share. The second term represents the BOC’s profits from access in period 1. Line (4) is the BOC’s monopoly profits in period 2.

The difference between the BOC’s profits when it preys and does not prey is $H = \pi_B^P - 2\pi_B^D$.

To determine the incentive of the BOC to prey as a function of the price of access, we need to investigate the derivative of $H$ with respect to $\alpha$.

$$\frac{\partial H}{\partial \alpha} = \frac{7\alpha b l}{3} - z l - \frac{\alpha^3 b^2}{9t} - \alpha b \left( \pi^N / 2t \right)^{1/2}.$$

**Proposition 3.** The BOC’s incentive to prey is decreasing in the price of access.

**Proof.** We need to demonstrate that (5) is negative. Clearly, for $\alpha < 3z/7b$, the result holds. By Restriction 2, $\alpha < z/2b$; the price of access is below the monopoly price. For $3z/7b < \alpha < z/2b$, let $\alpha = \lambda z / b$, where $\lambda$ is between 3/7 and 1/2. Substituting for $\alpha$ in the first three terms of (5), we get $(7\lambda/3 - 1)z l - \lambda^3 z^3 / 9tb$. This can be rewritten as

$$\left(7\lambda/3 - 1\right) \frac{z^2}{t} \left[ t \ell - \frac{z}{9b(7\lambda/3 - 1)} \right].$$

We can rewrite Restriction 1 as $t \ell < \frac{z(1-\lambda)^2}{3b}$. Substituting $t \ell = \frac{z(1-\lambda)^2}{3b}$ into the bracketed term of (6), we obtain

$$\left(7\lambda/3 - 1\right) \frac{z^2}{t} \left[ \frac{(1-\lambda)^2}{3b} - \frac{1}{9b(7\lambda/3 - 1)} \right],$$

which is less than zero for all $\lambda \in [3/7, 1/2]$. \textit{Q.E.D.}

The intuition behind this result is that the ability to charge an above-cost price for access both reduces the cost of engaging in predatory pricing and decreases the benefits. The decrease
in the cost of preying comes from the fact that the BOC need not set as low a predatory price as it would if it sold access at cost. The reduction in the benefit arises because the difference in profit from being a monopolist in period 2—or a duopolist in period 2 that also collects access charges—decreases as the level of access charges increases. In our model, the reduction in benefits exceeds the reduction in costs. Thus, increasing the access rate decreases the incentives for the BOC to engage in predatory pricing, which is contrary to what many commenters believed.

There are two things to note about this result. First, it holds for any positive $\pi^N$. Thus, no matter what beliefs the investors or the non-BOC’s finance division have about the determination of the price of access, the BOC’s incentive to prey is always lower the higher the price of access. Second, the incentive to prey does not depend on the demand uncertainty parameter, $k$. Thus, whether the BOC has an advantage, or even a disadvantage relative to the non-BOC, its incentive to prey is decreasing in the price of access.

At the start of the game, the financier will decide whether to finance the non-BOC depending on whether the BOC will or will not prey. If $H$ is positive, then the non-BOC will never receive financing, since the BOC will always prey. If $H$ is negative, then the BOC will not prey, the non-BOC will receive financing, and there is a positive probability that there will be competition in period 2. Thus, we would never see preying in equilibrium.16,17 It is easy to construct examples where $H$ is either positive or negative. Our analysis demonstrates that raising the price of access will increase the likelihood that there will be two firms in the second period, since raising $\alpha$ reduces $H$. This contradicts many statements in the record.

We have assumed that the BOC always had the advantage in the market. This is because we wanted to focus our attention on the incentives of an owner of a bottleneck, the BOC, to engage in predation. There could be situations in which a user of the bottleneck facilities, the non-BOC, has demand advantages: for example, it already participates in the downstream market and has established a reputation, or it offers other services that consumers want to purchase (one-stop shopping). Our results concerning the BOC’s incentives to prey would still hold in this case. There are three additional points that we can make if $k$ can be negative. First, if the BOC makes losses for some realizations of $k$ on long distance, then it must meet a profit hurdle. As the price of access rises, the hurdle that the BOC faces falls. This is because as access increases, the non-BOC will raise its prices, and this will improve the BOC’s profit in all states of the world. Thus, as access rises the BOC’s ability to prey will rise. Second, if there is a possibility that $k$ could be very negative, then the non-BOC may be able to prey on the BOC.18 As the price of access increases, it will be more difficult for the non-BOC to prey on the BOC, since the non-BOC’s profits fall and it will be harder for it to meet a profit hurdle. Finally, the incentive for the non-BOC to prey also falls as the price of access increases, since it must become more aggressive to take customers away from the BOC.

**The effect of access on the profit hurdle.** Now we address the issue of the BOC’s incentive to prey when the hurdle rate can be a function of access. The hurdle rate will typically be a function of the price of access if the non-BOC obtains financing after the price of access is determined. Differentiating $H$, we obtain

$$\frac{\partial H}{\partial \alpha} = \frac{7abl}{3} - zl - \frac{\alpha^3b^2}{9t} - \alpha b \left( \frac{\pi^N}{2t} \right)^{1/2}$$  (7)

16 There are other models in the literature in which preying does not occur in equilibrium, but the possibility of preying does deter entry. (See Milgrom and Roberts (1982) for an example).

17 If $k$ were a continuum, then preying could occur in equilibrium. It will in general still be the case that raising the price of access will reduce the BOC’s incentive to prey. Furthermore, if there is some positive probability that the antitrust authorities could detect a BOC preying, with the BOC having to pay a fine if caught, then this is equivalent to lowering $H$ and hence making it less likely that the BOC will prey.

18 We can show that in some symmetric models, symmetry with respect to $k$, the non-BOC will not prey in equilibrium.
Expression (7) is the BOC’s incentive to prey holding the hurdle rate constant; it is the left-hand side of equation (5). Expression (8) takes into account that the hurdle may change with the access rate. It is always the case that $\frac{\partial H}{\partial \pi^N}$ is positive, since as the profit hurdle rises it is easier for the BOC to prey. It should be noted that the profit hurdle does not decrease the BOC’s incentive to prey.

Thus, whether the incentive to prey is higher or lower when the profit hurdle is a function of access depends on $\frac{\partial \pi^N}{\partial \alpha}$. There are three possibilities: either $\frac{\partial \pi^N}{\partial \alpha}$ is equal to, less than, or greater than zero. If the hurdle rate is independent of $\alpha$, $\frac{\partial \pi^N}{\partial \alpha} = 0$, then, as we showed in the original game, the incentive to prey is decreasing in $\alpha$.

If $\frac{\partial \pi^N}{\partial \alpha}$ were greater than zero, then the change in the incentive to prey with respect to $\alpha$ would be higher than in the original game. In an earlier version of this article, we examined a model in which $\frac{\partial \pi^N}{\partial \alpha} > 0$. In that model, we set the profit hurdle rate so that the financier on average made zero profits in period 1 if the BOC did not prey. In that game, if the BOC does not engage in predation, $\pi^N$ is

$$\pi^N = 2F - \frac{[3t\ell - \alpha^2 b/2 - \bar{k}]^2}{18t}.$$  

Raising the price of access now increases the profit target that the non-BOC must meet, since when the type $\bar{k}$ non-BOC goes into bankruptcy the financier will get a lower profit. We found that although it was theoretically possible to have the incentive to prey increase in access, it was quite unlikely to occur. In particular, the access price must be sufficiently close to the monopoly price of access for this to even be a possibility.

The final case is $\frac{\partial \pi^N}{\partial \alpha} < 0$. Now the change in the incentive to prey as a function of access is even lower than in the original model. This is because as the entrant’s hurdle rate falls it is more expensive for the incumbent to prey, thereby decreasing even more his incentive to prey. The easiest way to obtain a hurdle rate that is decreasing in $\alpha$ is to have a signal-jamming model in which the BOC prices so that the financier can not infer the value of $k$ from the first-period profit. Specifically, if when $k = 0$ the BOC prices so that the non-BOC earns the same duopoly profit that he would earn if $k = \bar{k}$, then the financier cannot infer the value of $k$ from observing the non-BOC’s profit. In this case, the value of the non-BOC’s duopoly profit when $k = \bar{k}$ is the hurdle rate, which is decreasing in $\alpha$.

4. Conclusion

We have shown that allowing a BOC into the long distance market when it receives a price for the bottleneck input above marginal cost will result in higher welfare when the BOC does not attempt to act predatorily. Furthermore, the higher the price of the input, the lower the incentive for the BOC to price predatorily.

We recognize that the effects of entry encompass more welfare considerations than those examined in this article. For example, allowing BOCs into long distance may change other long distance carriers’ incentives to engage in R&D. In particular, it may change the incentives of a non-BOC to build its own facilities. It may also affect the government’s ability to deregulate the industry. Finally, we have implicitly assumed that customer switching costs are zero and thus have ignored some dynamic considerations. We look to future research to consider such effects.

Situations in which the provider of a bottleneck input competes with its downstream customers in the final goods market are becoming much more common, especially in network-related markets. So our analysis, which we have thus far motivated by looking at the telecommunications market, can also be used to address questions of whether monopoly owners of electrical transmission facilities should also be allowed to generate electricity, and whether cable owners should be
able to provide broadband services and their own programming at the same time they sell access to competing providers of broadband services.

More generally, measuring the loss from firms exiting a market is becoming an increasingly important issue as firms with bottleneck facilities enter new markets and compete with former customers. For an example consider the Microsoft case, in which the harm found by the courts was that Microsoft raised Netscape’s cost of accessing customers’ computers because customers had to affirmatively download Netscape, whereas they got Internet Explorer by default bundled with Windows. But this raises the question of what is the loss to society from raising these costs. It seems that Netscape’s marginal value to society may be rather small if people are not willing to download it for free given that Internet Explorer is already installed on their computers.

Appendix

Proofs of Propositions 1 and 2 follow.

Proof of Proposition 1. First, we derive the equilibrium when two non-BOCs are in the market. Using Lemma 1, the firms only get revenues from the fixed portion of the two-part tariff, $E_r$, since each charge the same variable price $a$. The profit function for the firms located at 0 and $\ell$, are

$$\pi_n^0 = \frac{E_0[t\ell - E_0 + E_1]}{2t}, \quad \pi_n^\ell = \frac{E_\ell[t\ell - E_\ell + E_0]}{2t},$$

(A1)

where the bracketed terms are the firms’ market shares. Using symmetry, it is easy to see that $E_0^N = t\ell$.

Now, if the BOC is at location 0, the objective functions for the BOC and the non-BOC at location $\ell$ are

$$\pi_B^0 = \frac{E_0[t\ell + E_\ell - E_0 + az - a^2b/2]}{2t} + \frac{a(z - ab)(t\ell - E_\ell + E_0 - az + a^2b/2)}{2t},$$

(A2)

$$\pi_N^\ell = \frac{E_\ell[t\ell - E_\ell + E_0 - az + a^2b/2]}{2t}.$$  

(A3)

Equation (A1) differs from (A3) because the BOC charges a variable fee of 0. Taking the first-order conditions and solving for the equilibrium, we obtain prices $E_0^B = t\ell + ba^2/6 + a(z - ba)$ and $E_N^N = t\ell - ba^2/6$.

Ignoring transportation costs, the surplus that a buyer receives from buying from the BOC is $z^2/2b$. This gives the buyer a net surplus of $z^2/2b - t\ell - ba^2/6 - a(z - ba)$. The surplus that this buyer receives if she buys from a non-BOC is $b(z/b - a^2)/2$; this gives a net surplus to the buyer when there is no BOC in the game of $b(z/b - a^2)/2 - t\ell$. If the buyer at location $\ell/2$ is better off with the BOC in the market, then all other buyers must be better off, since buyers below $\ell/2$ will also do better from buying from the BOC, and buyers greater than $\ell/2$ could always remain purchasing from the non-BOC at a lower price. It is straightforward to show that buyer $\ell/2$ is better off with the BOC in the market.

The increase in social welfare from the BOC is the gain in the additional surplus generated by the variable charge dropping from $a$ to zero for all customers who buy from the BOC. This is equal to the BOC’s share of the market, $[\ell/2 + ba^2/12t]^2$, times the gain due to the drop in price, $ba^2/2$. The loss in welfare is the additional travel cost incurred by consumer between $\ell/2$ and $ba^2/12t$ now going to the more distant firm, the BOC. This is equal to $1ba^2/24t + b^2a^4/288t$, which is clearly less than the gain in surplus. Thus, surplus is higher with the BOC in the market. Q.E.D.

Proof of Proposition 2. There are two cases to consider: either the BOC serves the entire market or it does not. The BOC serves the entire market if $t\ell < z^2/4bt$, and it serves only a subset of the market, equal to $z^2/4bt$, otherwise. We examine each case in turn. If the market is served by two non-BOCs, then the social surplus is $b(z/b - a^2/2 - t\ell^2/2 - F)$.

Case 1. $t\ell < z^2/4bt$. In this case, the monopoly social surplus is $z^2\ell/2b - t\ell^2/2 - F$. The difference in welfare between when there is a BOC monopoly and a non-BOC duopoly is thus

$$z\alpha\ell - \frac{ba^2\ell}{2} - \frac{t\ell^2}{4} + F.$$  

(A4)

We know that $F$ is at least $[3t\ell - a^2b/2]^2/18t$. Using the smallest permissible value for $F$ in (A4), we obtain

$$z\alpha\ell - \frac{2ba^2\ell}{3} + \frac{t\ell^2}{4} + \frac{a^4b^2}{72t}.$$  

(A5)

Expression (A5) is positive since the first term is bigger than the second term by Restriction 2.
Case 2. \( z^2/4bt < t \ell < b(z/b - \alpha)^2/3 \). Social surplus when the BOC is a monopolist is \( 3z^4/32b^2t - F \). Welfare is higher under monopoly if

\[
\frac{3z^4}{32b^2t} - \frac{z^2 \ell}{2b} + t\ell^2 - b\frac{\ell^2}{2} + \frac{t^2}{4} + F
\]

is positive. Expression (A6) is minimized when \( \alpha = 0 \), since this maximizes welfare when the non-BOCs are in the market. When \( \alpha = 0 \), expression (A6) becomes

\[
\frac{3z^4}{32b^2t} - \frac{z^2 \ell}{2b} + t\ell^2 - b\frac{\ell^2}{2} + \frac{t^2}{4} + F
\]

Multiplying (A7) by \( t \), we obtain

\[
\frac{3z^4}{32b^2} - \frac{z^2 \ell t}{2b} + t\ell^2 - b\frac{\ell^2}{2} + \frac{t^2}{4} + F
\]

We check both endpoints of the allowable values of \( t \ell \), \( t \ell = z^2/4bt \), and \( t \ell = z^2/3b \) to see if (A8) is positive. Using \( t \ell = z^2/4bt \), (A8) becomes

\[
\frac{z^4}{b^2} \left[ \frac{3}{32} - \frac{1}{8t} + \frac{3}{64t^2} \right].
\]

It is easy to check that (A9) is positive for all positive \( t \). If \( t \ell = z^2/3b \), then (A8) becomes

\[
\frac{z^4}{b^2} \left[ \frac{3}{32} - \frac{1}{6} + \frac{1}{12} \right]
\]

which is positive. Finally, it is straightforward to verify that (A8) is minimized at one of the endpoints for \( t \ell \). Q.E.D.

References


