REGULATORY PRICING RULES

TO NEUTRALIZE NETWORK DOMINANCE

by

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Abstract

This paper evaluates the effectiveness of several pricing rules intended to promote entry into a network industry dominated by an incumbent carrier. Drawing on the work of Cournot and Hotelling, we develop a model of competition between two interconnected networks. In a symmetric equilibrium, the price of cross-network calls exceeds the price of internal calls. This "calling circle discount" tends to "tip" the industry to a monopoly equilibrium as would a network externality. By equalizing charges for terminating calls, *reciprocity* eliminates differences between internal and cross-network prices and makes monopoly less likely. *Imputation* counteracts an incentive by the dominant network to "price squeeze" a rival by eliminating differences in the wholesale price of termination and the implicit price for internal use. By increasing profits of rival networks and increasing their subscribers' surplus, imputation supports additional entry. Finally, an *unbundling* rule reduces termination fees charged by a dominant network that was engaging in pure bundling. Again, entry will be facilitated as rival networks offer potential subscribers a more attractive rate schedule.

JEL classification: L1, D4
Key words: two-way networks, interconnection, reciprocity, imputation, unbundling

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1. PRO-COMPETITIVE PRICING POLICIES

In an effort to realize the potential of advances in telecommunications technology, policy makers around the world have set aside policies of heavy handed regulation and chosen instead to encourage entry by new providers. Success of these pro-competitive policies depend on the absence of significant barriers to entry into markets which have long been dominated by incumbent carriers. Many of these barriers are erected by established carriers who have substantial investments in embedded plant and equipment and widely recognized brand names. Importantly, users may prefer to remain with the incumbent providers rather than forgo the benefits of demand-side scale economies, commonly called "network externalities."

Policy makers are suspicious that dominant carriers will use their natural advantages to harm competition. To begin with, it is likely that an incumbent network will set monopoly prices for its bottleneck services. These services include network components that are only available from the incumbent, are needed by other carriers to provide services, but are prohibitively expensive to replicate. Control of such facilities offers the incumbent an opportunity to engage in a "price squeeze" of a rival carrier by pricing the essential inputs higher than it implicitly charges itself for internal use. Market power can also be expressed by discriminatory prices for final services that vary with the threat of competition, thereby tapping protected markets to subsidize production for competitive markets. Finally, an incumbent carrier could simply refuse to interconnect with fledgling networks, denying them access to its large customer base.

Historically, regulators have been hostile to carriers' refusals to interconnect with competitors. But while mandatory interconnection is quite universal, it does not completely eliminate incumbents' advantages. They could still use their control over the terms, conditions and rates for interconnection so as to exclude rival carriers. Fearful of this possibility, regulators have adopted various pricing rules intended to neutralize the advantages and anticompetitive practices of incumbent carriers. These include reciprocal pricing (and its close cousin, the "bill and keep" arrangement), imputation, and unbundling.

State commissions have been experimenting with policies of this sort for some time. The Congress has recently embodied several pricing rules in the terms of the Telecommunications Act of 1996. The Act requires local exchange carriers to provide transmission and termination on a reciprocal basis with competing local exchange carriers (LECs) at rates that approximate costs,[1] and allows carriers to adopt bill and keep arrangements.[2] When selling network services that it uses itself, the law also requires a local exchange carrier to impute charges to its services no less than the amount it charges an unaffiliated carrier.[3] The Act demands that a LEC's network elements be unbundled from more aggregated offerings, and sold at just, reasonable, and nondiscriminatory rates, terms and conditions.[4] Throughout the Act there are calls for nondiscriminatory access and pricing of network services. In particular, LECs are required to extend interconnection to competing carriers and to offer unbundled network elements at nondiscriminatory rates.[5]

These policies were adopted in the rush to deregulate telecommunications markets. Understandably, little is known about how such rules perform in practice. They have been imposed in the U.S. and elsewhere, however, without a full theoretical analysis of their effects. In this paper, we attempt to gain a better understanding of the theoretical implications of these rules, focusing first on reciprocity and then examining imputation and unbundling.

Reciprocity in the interconnection fees requires that all networks charge the same amount to terminate calls coming from other networks. The intent of this policy is to prevent incumbent networks from limiting the growth of smaller rivals by charging exorbitant fees to terminate their traffic. Moreover, as a regulatory tool, reciprocity is easier to implement, since it has only minor informational requirements, in contrast with other schemes. Under a version of reciprocity—the “bill-and-keep” system—termination fees are set to zero: each carrier simply collects all revenue from calls made by its subscribers, paying nothing to the terminating network. The rationale for

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[1] §251(b)(5), §252(d)(2), §271(c)(2)(B)(xiii)
[2] §252(d)(2)(B)
[3] §272(e)(3)
[4] §251(c)(3), §271(c)(2)(B)(iv)-(vi)
[5] §251(c)(2)(D), §251(c)(3)

bill and keep is the reduction of transaction costs, especially when balanced traffic flows would result in negligible net payments for termination.

Imputation rules are designed to eliminate any markup on service components sold to competing firms over and above the implicit charges for internal use. Imputation is designed to make it difficult, although not impossible, to execute a price squeeze on a rival who needs access to a dominant network's facilities.

"Bundling" is a network pricing practice that has received much scrutiny. It is believed that, by selling network components only in combination with each other, a dominant network could erect a barrier to entry by firms needing only a subset of the components. By requiring the dominant network to "unbundle" its services, and to quote "reasonable" prices for the constituent components, entry barriers should be reduced.

In this paper we describe a simple model of competition between two networks where one network may have a strategic advantage over the other. As a benchmark, we first analyze the strategically symmetric case, where the networks set their prices simultaneously. Next, we turn to the case where one network has a strategic advantage in terms of being a first mover in setting prices. At the non-cooperative equilibrium, the dominant network is able to steer the outcome in its favor, possibly excluding its rival altogether. Then we examine how pricing rules such as reciprocity, imputation and unbundling alter the different equilibria.

Generally, reciprocity raises consumer welfare without reducing industry profits by inducing a dominant network to lower its termination charge. Results are more ambiguous when we impose exact imputation on a dominant network. This policy has the effect of shifting profits from a dominant firm to its rival, but there is no guarantee that consumers will benefit in the aggregate. The consequences of an unbundling policy are also indeterminate. While the profits of the dominant network are reduced, it is unclear whether rival network profits will rise. Nevertheless, both imputation and unbundling raise the welfare of the rival's subscribers which, in turn, should attract customers away from the dominant carrier and improve chances for viable competition in these markets.

2. PRICE COMPETITION IN A NETWORK DUOPOLY

2.1 The Model

As a starting point we consider a duopoly model of perfect complementary products first analyzed by Cournot (1838). In his model, each firm sets the price of one of two components that are combined in fixed proportions to form a final good demanded by consumers. In equilibrium, the final price exceeds the monopoly level. The reason is that each firm, having a monopoly over its component, marks up price on its cost, which is just the price of the other component (charged by the other firm). The existence of these two markups is often referred to as “double marginalization.” Because each supplier only realizes profits from its component, it fails to internalize the effect that a price increase will have on its rivals' profits. Both industry profits and consumer surplus are sacrificed compared to their monopoly levels.

The Cournot model can be viewed as representing a simple telephone network where a phone call is composed of an originating component combined with a terminating component. We construct a model of two interconnected networks, each owned by one of the two carriers, called 1 and 2. Some calls never leave the carrier's network, while others originate on one network and terminate on another. Figure 1 indicates how calls are composed of one origination component (indicated by the A_i's) and one termination component (the B_i's) supplied by either of the two networks. Thus, each of the two networks sells three services: internal calls to its subscribers, plus origination and termination services to be used in cross-network calls.

In general, consumers consider each call a substitute for other calls that may be made within its own network, as well as across networks. For simplicity we assume that a user derives utility only from placing calls, and not from receiving them. Furthermore, users show no preference across which users they call; what matters is the charge to reach other parties.

Let s_{ij} be the retail price for a call from network i to network j, where i and j take values of either 1 or 2. Using this notation, s_{ii}, is the retail price for an internal call. Calls from network i to network j, referred to as "cross-network" calls, consist of origination by network i and termination by network j. The price for origination is given by p_i while the price for termination is q_j. The retail price of cross-network calls is the simple sum of the wholesale prices of its components: $s_{ij} = p_i + q_j$.

We model the interaction among the networks and the users as a two-stage game. In the first stage, all users simultaneously make their subscription decisions. In the second stage, the networks set their prices and the users decide on how many calls to make. Thus, the users cannot change their subscription decision after observing the networks' prices. This game structure aims at capturing situations where users are slower in changing network affiliation than in varying the amount of phone calls they make as firms change prices: one can think of the second stage of the game as the "short run" and of the first stage as the "long run." There is some empirical support that subscription decisions respond to price changes with a considerable lag.[6]

We assume that, while there may be a cost to building a network to serve customers, the cost is not sensitive to either the number of subscribers or their levels of usage. Realistically, the marginal cost of operating a modern telecommunications networks is virtually nil. We also make the assumption that the networks have the same cost structures.

We begin by considering the strategically symmetric case in which networks set their prices simultaneously. In that case, the price of internal calls will be set at the monopoly level.[7] This follows from the fact that, after choosing a carrier, each subscriber is "captive" to a network. Cross-network calls, by comparison, are priced jointly by the two networks. Subscribers may still be captive because they have only one alternative for making internal and external calls, but

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[6] Ward (1995) finds subscription behavior to be responsive to price differentials between AT&T and the other long distance carriers only over the long run.

[7] See Economides, Lopomo and Woroch (1996).

unlike internal calls, a single network does not have complete control over the retail price of cross-network calls. Double marginalization causes prices for incoming and outgoing calls to exceed their monopoly levels, $s_{ij}^{c} = p_{i}^{c} + q_{j}^{c} > s_{ij}^{m}$, where the "c" denotes the Cournot equilibrium, and "m" denotes monopoly. Putting results for the two kinds of calls together gives us an important conclusion: assuming costs of calls are identical, the price of cross-network calls exceeds that for internal calls: $s_{ii}^{c} = s_{ii}^{m} < s_{ij}^{c} = p_{i}^{c} + q_{j}^{c}$.

The fact that, at equilibrium, networks charge less for internal calls than for outgoing calls, resembles the so-called "calling circle" plans offered by long distance carriers. Under these schemes, it is cheaper to call a fellow subscriber than someone on a rival network. For this reason a subscriber's overall bill will be lower the more users who choose the same network since then more calls are considered "internal." In effect, the price structure creates a pecuniary externality that acts like a direct "network externality." In this last case a network having more subscribers is seen as more valuable to a prospective subscriber because it offers more people to connect with. Here, both networks are fully interconnected so a user can reach subscribers of both networks.

Assuming that there is a degree of substitutability among calls, it can be shown that originating charges exceed termination charges: $p_{i}^{c} > q_{j}^{c}$.[8] The reason is that the receiving network is less inclined to raise the price of incoming calls. While they may be the source of revenue, incoming calls are independent of other calls because, by assumption, subscribers only value outgoing calls. However, by raising origination fees, a network is able to steer business to internal calls for which it collects on both origination and termination charges. The competition posed by outgoing calls contributes an increment to the existing price premium that results from double marginalization.[9]

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[8] Ibid.

[9] The larger of the two networks will also charge its customers more for outgoing calls than the smaller one since, given the greater attraction of its larger size, it can do so without significantly curtailing revenues. See Economides, Lopomo and Woroch (1996). More specifically, origination fees are increasing in the relative size of the originating network: a larger network can command a higher percentage of the revenue from outgoing calls. Likewise, termination fees are decreasing in the relative size of the terminating network.

2.2 Network Dominance

Up to this point, we have treated the two networks symmetrically: not only have their products and production costs been identical, but they also set prices simultaneously. In the situation we seek to model, however, one network commands a dominant position. This position could derive from its greater size (measured either by network investment or the number of subscribers) and/or from having been around longer than its rivals. We capture this asymmetry by simply having one network, say network 1, choose its termination charge before the opponent. This could be a benefit of having a network in place before its rival, and the fact that a new carrier needs to have an interconnection agreement in place before it starts business. Commitment to service prices should give a strategic advantage to the first mover.[10]

As might be expected, a rebalancing of prices occurs when one carrier gains a first-mover advantage over the other. Internal prices remain at monopoly levels for both networks: $s_{ii}^d + s_{ii}^m = s_{ii}^s$ where we use "d" to indicate that network 1 is dominant (*i.e.*, a first mover). In addition, calls that originate on the dominant carrier's network are unchanged from the simultaneous-mover equilibrium: $s_{12}^d = s_{12}^s$.

The impact of a first-mover advantage is registered in the price of incoming calls. First of all, the price of these calls increase:[11] $p_2^d + q_1^d > p_2^c + q_1^c$. Here is where pricing restrictions could improve upon the non-cooperative equilibrium. Second, the prices for origination and termination are rebalanced in network 1's favor: $q_1^d > q_1^s$ and $p_2^d < p_2^s$. Effectively, the dominant carrier commits to higher termination charges, squeezing the follower network by increasing the price that the follower's subscribers must pay for outgoing calls, and taking a larger proportion of the revenues from those calls.

3. DUOPOLY COMPETITION FOR SUBSCRIBERS

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[10] In some strategic settings there may be a second mover advantage. See Gal-Or (1985). These conditions do not hold here.

[11] Economides, Lopomo and Woroch (1996), op. cit.

Whereas Cournot's early work supplied a model to analyze price competition between two networks, we turn now to models of spatial competition in the Hotelling tradition to describe competition for subscribers. Users have three subscription options: subscribe to one of the two networks, or subscribe to neither. Subscribing to both networks is not an option. In making that decision, users take into account three factors: prices charged by the two networks for internal and outgoing calls, the value of money relative to phone calls, and finally, perceptions of the relative "attractiveness" of the two networks.

This last factor is what Hotelling models of horizontal differentiation are designed to capture. We think of users that "live" at each address along the continuum of characteristics that lie between the positions of the two networks. A user's location indicates his ideal network configuration. A departure from this ideal causes the user disutility when it compromises by choosing one of the two networks. Of course, if the networks charged the same prices for the same services, then each user would simply choose the "closest" of the two to minimize the disutility. Disutility associated with a network position could simply arise from user perceptions of service quality created over time and through advertising.[12] Brand loyalty has been shown to be an important determinant of users' choice of a carrier.[13]

Formally, the final utility from subscription and usage is:

$$V_{ti} = U_i - \lambda\,|t - t_i|$$

where U_i represents the derived utility from using network i at its prices for internal calls (s_{ii}) and outgoing calls (s_{ij}). The second term measures the disutility of subscribing to network i located at t_i for a subscriber who is located at t. The proportionality factor λ scales disutility according to the "distance" between the two locations.

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[12] This is most likely true for residential users. It may also be due to differences in compatibility between the user's hardware and software and the technology adopted by the network. Especially in the case of sophisticated business services, there are several competing technical standards which are not fully compatible with all customer premise equipment.

[13] Tardiff (1995) finds brand loyalty to be an important determinant of the choice of a long distance carrier by Japanese consumers.

In the first stage of the game, users choose to subscribe to one of the two networks, or to not subscribe at all. When making their decisions, users correctly anticipate the prices that will be realized in the subsequent stage of the game. This structure departs from the Hotelling's approach where firms announce prices before users decide from whom to purchase.[14] We believe that, in the case of network services, it is more costly and more time consuming for users to switch networks than it is for carriers to change prices.[15]

Carriers are unable to commit to prices before users make their subscription decisions. An exception might be, for example, a firm may be able to commit to bundling that equalizes prices for all components in the package while leaving open the price of the bundle itself. Alternatively, regulatory policy could restrict prices before users make their subscription and usage decisions. This paper is concerned with several of these rules. The issue is whether such pricing rules restrain the exercise of market power by carriers, or whether they enhance it.

Because of the price premium on outgoing calls, and the associated benefits of a large subscriber base, multiple equilibria are as likely here as they are with direct network externalities. When deciding which network to join, a user must form expectations as to how many other users will make the same choice since the worth of a network's discount depends on how many calls will be internal. Several combinations of subscription decisions and network size expectations form an equilibrium. In the extreme, the decision not to subscribe to either network is an equilibrium for all users when every consumer believes no one else will subscribe to either network.

When making their choice of a network, users will pay close attention to relative prices for internal and external calls because the difference determines the size of the "calling circle discount," and hence, how attractive it is to join a network. However, joining the larger network is not the only consideration of a subscriber. Users must also take account of the disutility they

[14] Laffont, Rey and Tirole (1996) adopt the traditional sequence of decisions.
[15] See footnote 6 supra.

experience from subscribing to a less-than-ideal network. The disutility of making a compromise can be so large that not subscribing to either network is the preferred alternative. When users attach little weight to differences between the networks, and when their price structures are similar, then the larger network will be preferred so long as internal calls are priced at a discount. In that event, we will see a "tipping" of the market, resulting in only one active network. Formally, a "corner equilibrium" occurs when $n_i = 1$ for some i and $n_j = 0$ for $j \neq i$ where n_i is the fraction of all users who subscribe to network i.

With higher degrees of network differentiation, a symmetric equilibrium outcome results: *i.e.*, $n_1 = n_2 = ½$. When users have very sharp preferences over networks, there is a large disutility to compromising on the one that is "further away." In this case, subscribers who favor a network with characteristics that lie in between the two alternatives may opt not to subscribe to either; in that case, $n_1 + n_2 < 1$. Of course, a loyal few customers will choose their favorite network, so that $n_1 > 0$, $n_2 > 0$.

Summarizing, taking a spatial approach to the subscription decision, we find that, under strategic symmetry, competition between networks for subscribers may "tip" the industry toward monopoly because of price-induced demand-side scale economies. The consequences of monopoly are not as bad here as in the usual case, however. Prices of cross-network calls actually fall as the monopolist eliminates the double marginalization: $s_{ii}^m = s_{ij}^m < p_i^d + p_j^d$. Consequently, consumer surplus increases as well as industry profits. The sector could perform much better, nevertheless, since it is still far from achieving the welfare maximum. The question remains as to whether there are regulatory policies that could further improve upon this equilibrium without creating additional distortions.

4. <u>RECIPROCITY</u>

Reciprocity holds when each network charges the same fee for terminating traffic that originates on its rival's network.[16] In our notation, reciprocity requires $q_1 = q_2$. Reciprocity

[16] Reciprocity, in principle, could require networks to charge the same amount for origination, *i.e.*, $p_1 = p_2$.

could be implemented in a number of ways. A third party such as a regulatory agency could set the mutual termination charge.[17] Alternatively, the interconnecting networks could negotiate a common fee. Finally, one of the networks could unilaterally set the termination fee. The last two arrangements may not differ by much if one of the networks has a disproportionate amount of bargaining power in negotiations. It is this situation we model here.

Recall that one part of the double marginalization on cross-network calls is the markup on termination. If that markup were eliminated from calls traveling in either direction, then both networks would earn higher profits. This is the reason why the dominant network would set the common termination charge at cost: $q_1 = q_2 = c$. The dominant network, and its rival as well, would then each earn half of the maximum profit, which is more than half of the smaller Cournot profits. It does not matter whether the dominant network can choose prices before the rival or not; either way, it prefers to set both termination fees at cost.[18] Note that under reciprocity, the equilibrium price of an internal call is the same as the price of an outgoing call.[19] This implies that, under the rule of reciprocity, at equilibrium, $s_{ii} = p_i + q_i$, in which case exact imputation holds.

Under reciprocity, relative network size also affects the structure of other component prices. A relatively larger network charges more than a smaller one for outgoing calls. This is due, in part, to the fact that origination fees increase as the originating network gets larger. This occurs because a larger network, given its size advantage, commands a higher percentage of the revenue from outgoing calls.[20]

Consumers benefit from reciprocity as the drastic reduction in termination charges reduces prices for cross-network calls, and prices for internal calls remain at stand alone monopoly levels. Significantly, both networks share in the increased industry profits as double marginalization is

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[17] Presumably this is how access prices are set in Laffont, Rey and Tirole (1996).

[18] Economides, Lopomo and Woroch (1996), op. cit.

[19] Ibid.

[20] It is also the case that termination fees are decreasing in the relative size of the terminating network. This tendency, however, is dominated by the effect on origination fees.

eliminated. Since a first mover otherwise gets a disproportionate share of industry profits, by reducing the disparity in profits, reciprocity rewards the second mover.

If flows of traffic between two networks are approximately equal, then reciprocity will equalize their payments for termination. It is this idea that underlies “bill and keep” arrangements in which networks collect the retail price for outgoing calls and make no payment to each other for termination. A bill-and-keep system effectively forces termination fees to zero: $q_1 = q_2 = 0$. In fact, if marginal costs of termination are zero ($c = 0$), reciprocity will also result in zero termination charges. This property of reciprocity is true only in equilibrium, whereas it always holds for bill and keep.[21]

By equalizing termination charges, reciprocity tends to wipe out the price difference between internal and outgoing calls. As a result, network size vanishes as a factor in user subscription decisions, and the market no longer “tips” to monopoly. Under the reciprocity rule, corner equilibria do not exist in the long run game; the symmetric equilibrium is the only full coverage equilibrium.[22] This is because reciprocity eliminates the power of the leading network to set different prices for termination, and the leader finds it to its benefit to set zero termination charges, resulting in equal prices for internal and outgoing calls. This rate restructuring sustains network duopoly which eliminates high prices for outgoing calls. Thus, reciprocity—a conduct rule—has a structural effect, the encouragement of viable competition.

5. IMPUTATION

A network can reduce a rival's sales of outgoing calls by simply charging a large sum to terminate these calls. This strategy becomes a “price squeeze” when the network implicitly charges its own subscribers a smaller amount for the same service, namely, termination of

[21] Note that the two policies may have different outcomes if commitment to zero termination fees alters other prices through a strategic effect.

[22] Economides, Lopomo and Woroch (1996), op. cit.

internal calls. An imputation rule restricts termination fees to be no larger than the implicit price for termination sold as part of internal calls: $s_{ii} - p_i \geq q_i$. Invariably, this inequality is violated in the industry structures we analyzed above because double marginalization causes the price of cross-network calls to exceed the price of internal calls: $s_{ii} < p_i + q_j$. And since termination charges will be approximately equal under strategic symmetry, $q_i \simeq q_j$, imputation will not hold in equilibrium.

To analyze the effectiveness of imputation, we compare two equilibria, both of which involve a dominant network who sets all of its prices before its rival. Suppose the dominant network, say network 1, is required by regulation to obey *exact* imputation: $s_{11} = p_1 + q_1$. In our discussion of the impact of this rule on price equilibrium, we will take the sizes of the two networks as given. A general treatment would solve for subscription equilibrium in an earlier stage. However, we will show that the rule increases profits of the nondominant network and the surplus of its subscribers, which will have the effect of supporting additional entry.

Imputation restructures the dominant network's prices, lowering both its originating price and its terminating price while raising its price for internal calls. In effect, (exact) imputation prevents the dominant network from maintaining relatively high component prices for cross-network calls while keeping prices for internal calls low—the essence of the calling circle discount. By imposing imputation, the dominant firm reluctantly raises internal price above the monopoly level while origination and termination fees fall to satisfy the constraint.

Predictably, imputation reduces profits of the dominant network. It is important to note that imputation also increases the profits of the second mover. In fact, the incremental profit of the follower exceeds the reduction for the dominant network so that overall industry profits rise.

The effect of imputation on users depends on which network they choose. The welfare of subscribers to the dominant network may rise or fall, depending on the relative size of the two networks and on the demand parameters. That is not the case for subscribers to its rival.

Because the price of internal calls charged by the rival network does not change, and because its origination and termination fees fall as a result of imputation, its subscribers are better off.[23]

Taken together the facts that the rival's profits increase and the welfare of its subscribers also increases suggest that imputation should encourage entry into an industry dominated by an incumbent network. A rise in overall welfare is not guaranteed, however, since imputation could merely function to redistribute wealth from a dominant network's owners and subscribers to its rivals' owners and subscribers.

Note that in our analysis of reciprocity we had found that the imposition of the rule resulted in equilibrium prices that also satisfied the criterion of exact imputation. In this section, we find that the converse is not true, *i.e.*, the imposition of exact imputation does not result in equilibrium prices that satisfy the criterion of reciprocity.

6. UNBUNDLING

As mentioned in the introduction, it is commonly believed that bundling of network components can be used for anticompetitive purposes. By bundling services, a network is able to exclude entrants and forestall rivals by raising the price they pay for inputs needed for their final services. Bundling is more likely to be adopted by a firm having a dominant position since market power is needed to sustain such a policy. Indeed, a competitive firm would quickly lose market share as rivals offered customers more flexible options for purchase of network components.

A policy of unbundling is seen as preventing this strategy and its welfare harms. By forcing incumbent carriers to sell individual components separately, and insisting that prices reflect relative costs (and possibly absolute costs), entrants are able to purchase only the network services they need. Furthermore, no longer able to commit to selling packages of services,

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[23] It remains unclear whether aggregate consumers' surplus rises as a result of imputation. The same is true for total welfare defined as the unweighted sum of consumer surplus and profits.

dominant carriers must battle rival carriers who could achieve lower costs by specializing in selected components.

To evaluate the effectiveness of an unbundling policy, we again consider our simple network model. Now we use as a benchmark the equilibrium in which the dominant network moves first, setting a *single* price for internal calls and for origination and termination of cross-network calls: $s_1 = p_1 = q_1$. This strategy is called "pure bundling." A policy of unbundling would force the dominant firm to set separate prices for each of these three services.

We find that pure bundling increases the profits of the dominant firm. The reason for this result is not obvious, however, since the dominant firm has a first-mover advantage whether or not it bundles. Apparently, the benefits of commitment to not competing on individual components outweigh the costs of reduced pricing freedom.[24] In comparison, the effect of pure bundling on the rival network is indeterminate. It can be shown that bundling raises profits of the rival when the dominant network is small, but lowers its profits when the dominant firm serves a large fraction of the market. Nevertheless, combined industry profits will fall with bundling. Therefore, in many relevant cases, a policy of unbundling will raise the profits of a rival network at the expense of the dominant firm.

By de-averaging the prices for the dominant firm's services, unbundling allows prices of components to reflect their specific demand and cost characteristics. Recall that without bundling, the origination charge exceeds the termination charge, $p_i > q_i$, and together their sum exceeded the internal price, $p_i + q_i > s_{ii}$. Bundling forces these rates to be equal, thus lowering the internal price (below the monopoly level), and rebalancing origination and termination charges. Specifically, unbundling reduces the dominant network's termination charge. This effect assists a fledgling network by reducing the cost of calls terminated on the dominant network. On

[24] This would not be the case for horizontal competition where a first mover could always commit to a uniform price to all three services, ensuring at least as much profit as under pure bundling.

net, its subscribers are better off because the price of their outgoing calls falls while the price of internal calls is unchanged.[25]

Unbundling restructures prices not only by de-averaging component prices, but also by altering the dominant network's pricing incentives. When it is able to bundle services, the dominant network hesitates to cut price to gain market share because it cannot do so selectively. It cannot resist when it is forced to unbundle. This incentive effect could actually *lower* the nondominant network's profits. Nevertheless, since the lot of the rival's subscribers unambiguously improves, we should expect unbundling to encourage migration away from the dominant network to new entrants.

7. CONCLUSION

Using a simple model of network competition, we examined the effects of three pricing rules on equilibrium prices and industry structure. Our preliminary results confirm that the rules promote deregulation's goal of encouraging entry. This is especially true for reciprocity which counteracts the tendency toward monopoly by lowering the dominant firm's termination charges. Imputation and unbundling also encourage duopoly competition but with some reservations. All three pricing rules redistribute profits from the dominant network to its rival and raises welfare of the rival's subscribers, encouraging entry by new carriers to the benefit of all subscribers.

In a rush to deregulate telecommunications markets, regulators and legislators had to adopt policies without a complete understanding of their economic effects. In most cases, expediency won out over theoretical certainty that the rules would promote entry by new carriers. Nor did policy makers have the time to explore the rules' possible detrimental effects. For instance, under reciprocity, rival networks could agree to jointly raise the price of terminating each other's calls. Potentially, the rule could harm welfare relative to the unregulated outcome. Further, it is known that imputation will tend to equalize prices charged by direct competitors; in the process, it could

[25] Prices for other dominant network services will rise when it must unbundle, and this causes the surplus of its subscribers to fall. The difference in the effects of unbundling on the two groups of subscribers makes the combined effect on all subscribers indeterminate; similarly for the effect of total welfare.

possibly dampen price competition among competing networks. More generally, price restrictions could work to carriers' advantage by allowing them to commit to prices that otherwise were not be possible in equilibrium.

As the analysis of our simple model makes clear, the implications of pricing rules are quite complex in a network industry. A detailed investigation of their performance in more general settings is called for. This applies as well to the many other rules and regulations that have been ordered or proposed. The Telecom Act puts into place a plethora of restrictions governing resale, nondiscrimination, arbitration and separate subsidiaries, among others. Closer examination of the effects of these provisions is needed, as well as how the various policies operate in combination to ensure they do not work at cross purposes to one another. After all, it is the net effect on industry performance of all of the Act's provisions that will be used to judge its success in the end.

REFERENCES

Cournot, Augustin, (1927), *Researches into the Mathematical Principles of the Theory of Wealth* (N.T. Bacon Trans.), New York: Macmillan. (Original work published 1838).

Economides, Nicholas, Giuseppe Lopomo, Glenn Woroch (1996), “Strategic Commitments and the Principle of Reciprocity in Interconnection Pricing,” Working Paper no. 96-13, Stern School of Business, New York University.

Gal-Or, Esther (1985), “First Mover and Second Mover Advantages,” *International Economic Review*, vol. 26, pp. 649-653.

Laffont, Jean-Jacques, Patrick Rey and Jean Tirole (1996), “Network Competition: I. Overview and Nondiscriminatory Pricing,” draft, February.

Tardiff, Timothy (1995), “Effects of presubscription and other attributes on long distance carrier choice,” *Information Economics & Policy*, 7, pp. 353-366.

Ward, Michael (1995), “Product differentiation and demand in the long distance telecommunications industry,” draft, November.

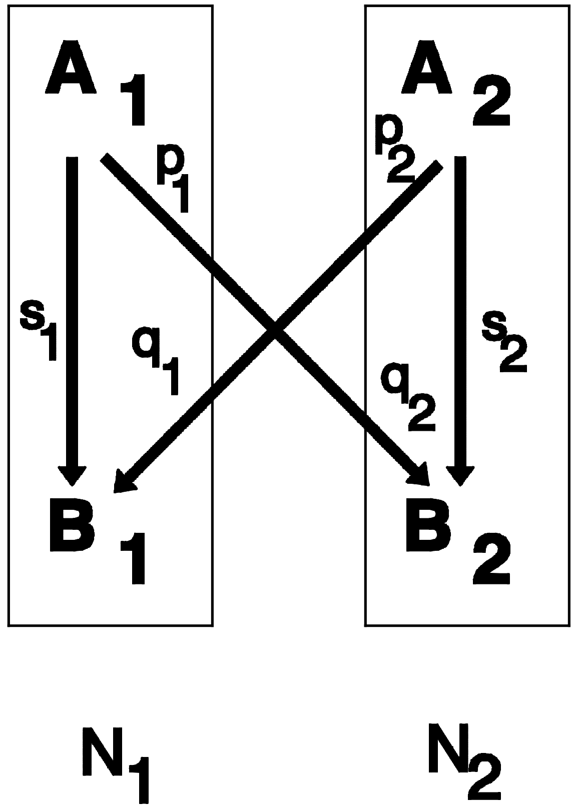

Figure 1: Network Structure