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CARTELS MAY BE GOOD FOR YOU

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Discussion Paper

No. 9106

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Christchurch, New Zealand

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April 1991

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Abstract

In this paper we analyse a generalization of vertical monopolies in which monopoly suppliers trade essential inputs with one another. The most obvious applications of the model, which we call symbiotic production, are to postal and telecommunications services. We show how producers can use per-unit tariffs to achieve cooperative outcomes without colluding directly over consumer prices. We then show the firms have an incentive to collude in the setting of tariffs but that such *collusion will lower consumer prices.* In a world of monopoly suppliers, cartelization of the monopolies improves consumer welfare. This benign view of cartels assumes that the monopoly suppliers are otherwise unfettered. In contrast, if the constituent monopolies are regulated, we show that collusion enables the firms to completely undo the restraints of regulation. The model has important policy implications for the international telecommunications market.

Recently, the British newspaper, the *Financial Times* claimed to have uncovered arrangements among the world's telephone companies to keep international telephone call charges artificially high. These arrangements, based on obscure accounting practices, were said to be costing consumers $US10 billion per annum worldwide. [1]

The "obscure accounting practices" arise from the way in which international telephone callers are charged. An international call utilizes the services of a telephone company at each end. Normally, the revenue for the call is collected by the originating telephone company from the party who initiates the call. The company then compensates the other company for the costs it incurs in handling the call. A call may also utilize transmission facilities in third countries. These providers also look to the originating company for a share of the revenue generated by the call.

There is indeed an international cartel, the CCITT (International Telegraph and Telephone Consultative Committee), whose extensive rules govern the sharing of revenue between telephone companies. "The Recommendations of the CCITT are in effect the real international telecommunications rules of today for, although they are not legally binding, they are nevertheless adhered to by most member nations." (Cullen, 1987). Following their last meeting in November 1988, the CCITT published more than 50 volumes of recommendations relating to telecommunications services, including one volume devoted entirely to comprehensive recommendations regarding the sharing of international call revenues (CCITT, 1988). There, the CCITT recommends three alternative methods of international reimbursement: (1) a flat-rate charge, (2) a per-unit charge or (3) equal division of the revenue. In practice, most countries adopt the per-unit charge "accounting rate" and these are normally set bilaterally at meetings between each pair of countries. In a companion piece (Carter & Wright 1991), we discuss the CCITT recommendations and devise the optimal tariff structure which involves a combination of the three alternatives.

Telephone services and other forms of telecommunications services, such as telex, telegrams, and data exchange, involve a form of production which has the following characteristics

- Each producer has a monopoly in its own market.
- Each produces both an intermediate and a final good.
- Each producer must purchase the intermediate good from the other producers.

[1]The stakes are immense. Aronson and Cowley (1988, p7) cite a U.S. Department of Commerce report which estimates total world market for telecommunications in 1990 as $US444 billion which is approximately equal to the GNP of Canada. International telephone calls are the fastest growing component of telecommunications market. We estimate that the international sector may now account for 25 percent of total revenue ($US115 billion per year) which is comparable to the GNP of Austria ($US126).

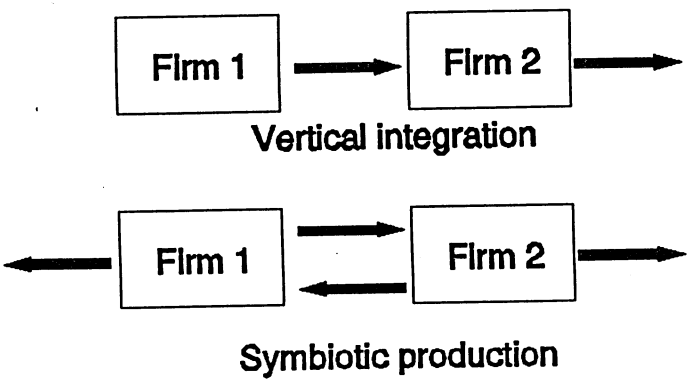

Figure 1: Comparing vertical integration and symbiotic production

This market form has some parallels with the standard vertical integration model and can be seen as an extension in which the production links extend in both directions. This is illustrated schematically in Figure 1. We call this form *symbiotic production.* Other examples are postal services and the international floral delivery service, Interflora.

In this paper we analyse a general model of symbiotic production, the most obvious applications of which are to postal and telecommunications services. We show how producers can use per-unit tariffs to achieve cooperative outcomes without colluding directly over consumer prices. We then show the firms have an incentive to collude in the setting of tariffs but that such collusion will lower consumer prices. *In a world of monopoly suppliers, cartelization of the monopolies improves consumer welfare. Cartels may be good for you.* This is analogous to a standard result in industrial organisation that vertical integration of a sequence of monopolies improves welfare (Tirole, 1988, p175). This benign view of cartels assumes that the monopoly suppliers are otherwise unfettered. In contrast, if the constituent monopolies are regulated, collusion enables the firms to completely undo the restraints of regulation.

Our results have important implications for international telecommunications markets. Contrary to allegations of the *Financial Times*, collusion over tariff setting may lower (rather than raise) consumer prices and enhance welfare. The telecommunications cartel, the CCITT, may be good for consumers. Overcharging of international telephone calls arises from the local or national monopolization of supply and the CCITT helps to ameliorate the effects of these multiple monopolies. Efficiency in telecommunications will be enhanced by promotion of competition amongst providers nationally, while attempts to undermine the collusive activities of the CCITT, in the absence of competition amongst local suppliers, will only serve to produce greater inefficiency. On the other hand, given the continued existence of the CCITT and its revenue sharing system, attempts to improve national outcomes through regulation should be viewed with caution, since regulation may be offset through international transactions.

The paper is organised as follows. In Section 1 we set up the model and specify the assumptions. In Section 2, we characterise the profit opportunities available to the firms and derive our two fundamental propositions. Section 3 considers the impact of collusion on consumer prices and welfare while Section 4 deals with regulation. Conclusions are presented in Section 5.

1 The model

For expositional simplicity, we will assume that there are only two firms which sell each other intermediate products. [2]

The firms profit functions are:

$$\Pi_1 = p_1 q_1(p_1, p_2) - C_1(q_1, d_1) + T_1(d_1) - T_2(d_2)$$
$$\Pi_2 = p_2 q_2(p_2, p_1) - C_2(q_2, d_2) - T_1(d_1) + T_2(d_2)$$

where standard notation has been used. We use q_i and d_i to denote the demand for the final good and the intermediate good respectively produced by firm i. T_i denotes the revenue received by firm i for sales of the intermediate product to firm j. Each firms profit comprises revenue from final sales minus costs plus the net intercompany transfer. Complete information is assumed throughout.

It is clear that, by appropriate choice of the transfer functions T_i, firms can achieve any division of the potential joint profit. In practice, for example in the international telecommunications market, firms restrict themselves to linear tariffs, that is a fixed price per unit of intermediate good with no lump-sum

[2] Our results generalize readily to n firms with appropriate modifications of the assumptions *provided* that the demand and cost functions are independent, ie. firm i's demand is independent of the price charged by firm j and the cost functions are separable. Independence seems a reasonable assumption with respect to postal services but perhaps questionable for telecommunications. This restriction is of limited practical significance, since tariffs in telecommunications are typically set bilaterally.

transfer. In our companion paper (Carter and Wright, 1991) we discuss the rationale for this restriction. In this paper, we assume this restriction and explore its ramifications. Hence we assume:

A 1 *Tariffs are restricted to be linear, that is*

$$T_i = t_i d_i$$

where t_i is the transfer price charged from firm i to firm j.

We make the following additional assumptions on the demand and cost functions:

A 2 *The demand functions q_i and cost functions C_i are twice continuously differentiable with bounded derivatives.*

A 3

$$\frac{\partial q_i}{\partial p_i} \cdot \frac{\partial q_j}{\partial p_j} > \frac{\partial q_i}{\partial p_j} \cdot \frac{\partial q_j}{\partial p_i} \qquad \forall p_i, p_j$$

A 4 *Firm j's demand for firm i's intermediate good is an increasing, twice continuously differentiable function of its own output with bounded derivatives, that is*

$$d_i = d_i(q_j) \text{ where } d_i(0) = 0 \text{ and } \partial d_i / \partial q_j > 0, \qquad \forall q_j$$

Given these assumptions, the firms profit functions can be written as

$$\Pi_1(p_1, p_2) = p_1 q_1(p_1, p_2) - C_1(q_1, d_1(q_2)) + t_1 d_1(q_2) - t_2 d_2(q_1)$$
$$\Pi_2(p_1, p_2) = p_2 q_2(p_2, p_1) - C_2(q_2, d_2(q_1)) - t_1 d_1(q_2) + t_2 d_2(q_1)$$

In the absence of collaboration, we assume that the firms choose tariffs and consumer prices sequentially. In other words, the firms play a two stage noncooperative game. In the second stage, the firms set consumer prices to maximise individual firm profits taking the tariffs as given. That is, they play a standard differentiated product duopoly game with Bertrand competition. The outcome is the standard Nash equilibrium. The equilibrium prices are functions of the tariff level. As tariffs vary, this function traces out a set of possible Nash equilibrium prices. We call this function the *Nash equilibrium price mapping* and denote it $p^*(t)$. In the first stage, the firms set tariff levels independently assuming that consumer prices will be determined as above, that is according to the Nash equilibrium price mapping. The noncooperative equilibrium tariffs and the corresponding consumer prices constitute the Nash equilibrium of the two stage game.

To avoid the complications of multiple equilibria we assume:

A 5 *The Nash equilibrium price mapping is a function (rather than a correspondence), that is*

$$p_i^*(t) \in \arg\max_{p_i} \Pi_i(p_1, p_2, t) \text{ is uniquely defined for all } (t_1, t_2)$$

and there is a unique Nash equilibrium, that is

$$t_i^* \in \arg\max_{t_i} \Pi_i(p_1^*(t), p_2^*(t)) \text{ is uniquely defined.}$$

The Nash equilibrium of the two stage game is defined by $(p_1^*(t_1^*, t_2^*), p_2^*(t_1^*, t_2^*))$.

A 6 *At the Nash equilibrium*

1. $\partial q_i / \partial p_i < 0$
2. $\partial q_i / \partial p_j \geq 0$
3. $q_i > 0$

for $i, j = 1, 2, \quad i \neq j$

A 7 *At the Nash equilibrium*

1. $f_{ii} \equiv \frac{\partial^2 \Pi_i}{\partial p_i^2} < 0$
2. $f_{ij} \equiv \frac{\partial^2 \Pi_i}{\partial p_i \partial p_j} \geq 0$
3. $\frac{\partial^2 \Pi_i}{\partial p_i^2} \cdot \frac{\partial^2 \Pi_j}{\partial p_j^2} > \frac{\partial^2 \Pi_i}{\partial p_i \partial p_j} \cdot \frac{\partial^2 \Pi_j}{\partial p_i \partial p_j}$

for $i, j = 1, 2, \quad i \neq j$

Assumptions (A2), (A3) and (A5)-(A7) are standard in models of duopoly (see for example Cheng (1985)). Assumption (A4) is analogous. In the case of international telecommunications or postal services, $d_i(q_j) = q_j$. (A7b) says that prices are weak strategic complements at the Nash equilibrium. That is, each firm responds to more aggressive pricing by following suit.

2 Characterisation of the profit possibilities

The central results of the paper flow from the following two propositions.

Proposition 1 *Given assumptions (A1) to (A5), any prices* p_1^* *and* p_2^* *can be obtained by noncooperative pricing behaviour by appropriate choices of* t_1 *and* t_2.

Proof. Under (A2) and (A4), non-cooperative prices are determined, for given t_1 and t_2 by the first-order conditions:

$$\partial\Pi_1/\partial p_1 = 0 \tag{1}$$

$$\partial\Pi_2/\partial p_2 = 0 \tag{2}$$

Evaluating (1) and (2) at p_1^* and p_2^* yields a simultaneous equation system which is linear in t_1 and t_2. Assumptions (A3) and (A4) guarantee a unique solution exists. Assumption (A5) ensures that these (t_1, t_2) will lead to the desired (p_1^*, p_2^*) in the second stage pricing game. □

Proposition 1 shows that the firms lose nothing by choosing tariffs and prices sequentially. [3] It establishes that *the firms can indirectly collude over consumer prices by colluding over transfer prices.* We now show that firms have an incentive to collude over transfer prices.

Proposition 2 *Assuming (A1), (A2) and (A4)-(A7), the Nash equilibrium is Pareto inefficient. That is, both firms can be made better off by appropriate choice of tariffs, given that consumer prices are set non-cooperatively.*

Proof. Let $\Pi_i^* = \Pi_i(p_i^*, p_j^*)$.

The Nash equilibrium is characterised by the first order conditions

$$\frac{d\Pi_i^*}{dt_i} = \frac{\partial\Pi_i^*}{\partial p_i}\frac{\partial p_i}{\partial t_i} + \frac{\partial\Pi_i^*}{\partial t_i} + \frac{\partial\Pi_i^*}{\partial p_j}\frac{\partial p_j}{\partial t_i} = 0, \qquad i,j = 1,2, \quad i \neq j \tag{3}$$

Noting that the Nash equilibrium price locus is characterised by the condition $\partial\Pi_i^*/\partial p_i = 0$, solving (3) for $\partial\Pi_i^*/\partial p_j$ we get

$$\frac{\partial\Pi_i^*}{\partial p_j} = -\frac{\partial\Pi_i^*/\partial t_i}{\partial p_j/\partial t_i} \tag{4}$$

Differentiating the profit functions with respect to the other tariff at the Nash equilibrium, we have

$$\frac{d\Pi_i^*}{dt_j} = \frac{\partial\Pi_i^*}{\partial p_i}\frac{\partial p_i}{\partial t_j} + \frac{\partial\Pi_i^*}{\partial t_j} + \frac{\partial\Pi_i^*}{\partial p_j}\frac{\partial p_j}{\partial t_j} \tag{5}$$

Substituting (4) into (5) we have

$$\frac{d\Pi_i^*}{dt_j} = \frac{\partial\Pi_i^*}{\partial t_j} - \frac{\partial\Pi_i^*}{\partial t_i}\frac{\partial p_j/\partial t_j}{\partial p_j/\partial t_i} \tag{6}$$

which evaluates to

$$\frac{d\Pi_i^*}{dt_j} = -d_j(q_i) - d_i(q_j)\frac{\partial p_j/\partial t_j}{\partial p_j/\partial t_i} \tag{7}$$

[3] This proposition is somewhat analogous to the relationship between the numbers of targets and instruments in control theory.

To show that prices are increasing in tariffs, we totally differentiate the first-order conditions which determine the non-cooperative prices, namely

$$f_1(p_1,p_2) \equiv \frac{\partial \Pi_1}{\partial p_1} = 0 \tag{8}$$

$$f_2(p_1,p_2) \equiv \frac{\partial \Pi_2}{\partial p_2} = 0 \tag{9}$$

yielding

$$\begin{pmatrix} \frac{\partial p_i}{\partial t_i} \\ \frac{\partial p_j}{\partial t_i} \end{pmatrix} = -F^{-1} \begin{pmatrix} \frac{\partial f_i}{\partial t_i} \\ \frac{\partial f_j}{\partial t_i} \end{pmatrix}$$

where

$$F = \begin{pmatrix} f_{ii} & f_{ij} \\ f_{ji} & f_{jj} \end{pmatrix}$$

It follows from (A4), (A6) and (A7) that

$$\frac{\partial p_1}{\partial t_1} \geq 0 \tag{10}$$

$$\frac{\partial p_2}{\partial t_1} > 0 \tag{11}$$

Similarly

$$\frac{\partial p_2}{\partial t_2} \geq 0 \tag{12}$$

$$\frac{\partial p_1}{\partial t_2} > 0 \tag{13}$$

Thus from (A4), (A6c), and equations (5), (9) and (11) we have at the Nash equlibrium

$$\frac{d\Pi_1^*}{dt_1} = 0 \tag{14}$$

$$\frac{d\Pi_1^*}{dt_2} < 0 \tag{15}$$

and similarly

$$\frac{d\Pi_2^*}{dt_2} = 0 \tag{16}$$

$$\frac{d\Pi_2^*}{dt_1} < 0 \tag{17}$$

Both firms can be made better off by a simultaneous reduction in tariffs. □

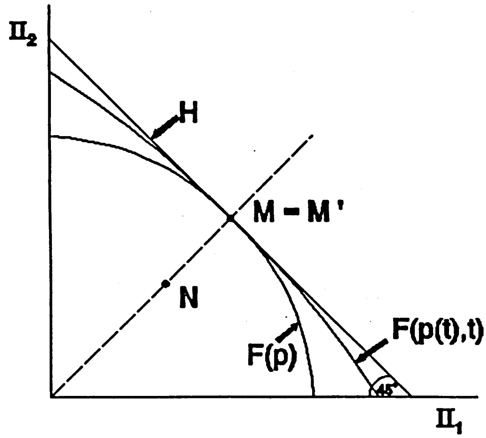

Figure 2: Profit possibilities for symmetric firms

The profit possibilities are illustrated in Figures 2 and 3. Let $F(p)$ denote the profit possibility frontier where the firms can choose any prices while tariffs are set to zero. Let $F(p^*(t), t)$ denote the profit possibility frontier where the firms choose any tariffs while prices are chosen noncooperatively given the tariffs. In other words, $F(p^*(t), t)$ is the image of the Nash equilibrium price mapping in profit space. Let M and M' denote the points along $F(p)$ and $F(p^*(t), t)$ respectively at which joint profits are maximised. Finally, let N denote the Nash equilibrium outcome defined in Section 2.

Consider first the special case in which the firms have identical profit functions (Figure 2). By Proposition 1, the firms can choose (linear) tariffs which yield the joint profit-maximising outcome. Since the firms are identical, these tariffs imply no re-distribution of profits compared with point M. Thus points M and M' coincide for identical firms. Proposition 2 implies that N lies in the interior of $F(p^*(t), t)$.

One way of understanding Figures 2 and 3 is as depicting the different constraints imposed by restricting the tariff regimes. The least restrictive regime involving general tariff functions $T_i(d_i)$ generates the linear profit frontier H, since the best the firms can do is to redistribute the joint maximum profit M through lump sum transfers. Restricting the firms to linear tariffs does not constrain the profit opportunities *provided* the firms can price accordingly. The firms can still achieve the joint maximum profit and then mimic lump sum transfers by suitable choice of tariff levels. Linear tariffs do constrain profit opportunities if firms also act independently in setting prices given tariffs $F(p^*(t), t)$. Alternatively, profit opportunities are constrained if tariffs are precluded altogether.

The profit possibility frontiers for non-identical firms are illustrated in Figure 3. By Proposition 1, there exist linear tariffs which imply the joint profit maximising prices (with independent pricing) and achieve the same total profit, although with a different distribution between the firms. Hence points M and M' must lie on the same hyperplane, though in general they will not coincide. It follows that the profit possibility frontiers under the two regimes $F(p)$ and $F(p^*(t), t)$ will only partially overlap as shown in Figure 3. While both firms would benefit from a general tariff regime (including lump-sum transfers), their interests in the two alternative restricted regimes are conflicting. [4] Again we note that N lies in the interior of $F(p^*(t), t)$ by Proposition 2.

It is not necessarily the case that M' is Pareto-superior to N. For example, if one firm was very much smaller than the other, it might do better by exploiting the bigger firm's demand at the Nash equilibrium N than cooperating over tariffs at M'. This observation may have relevance for the trading between telephone systems of vastly different sizes. [5]

We make a final observation. Figure 2 suggests that, with symmetric conditions, firms will lose nothing by relying on linear tariffs (rather than more general tariff structures) and pricing non-cooperatively provided they cooperate on the tariff levels. [6] Figure 3 suggests that this regime may also be reasonable with asymmetric firms, provided the asymmetries are not excessive.

3 The effect of collusion on prices

In 1990, the Financial Times alleged that, in colluding over tariffs, the world's telephone companies were able to artificially raise consumer prices and extract an additional $US10 billion in revenue worldwide. Our analysis so far suggests that the telephone companies have a powerful incentive to collude since the Nash equilibrium is inefficient. However, contrary to these allegations, our results suggest that collusion over tariffs will in fact lower prices and benefit consumers. Starting from the Nash equilibrium N, firms increase their profits by jointly

[4] We remind the reader that this paper is devoted to exploring the ramifications of particular tariff regimes (especially linear tariffs) rather than explaining the choice of regime.

[5] We understand that Australia has tried unsucessfully to persuade small Pacific nations to lower bilateral tariffs. The *Financial Times* notes that some newly industrialized countries, which export many workers to richer economies who then call home, have proved very resistant to negotiating lower tariffs.

[6] Of course if the firms are symmetric, net tariffs will be zero under all regimes.

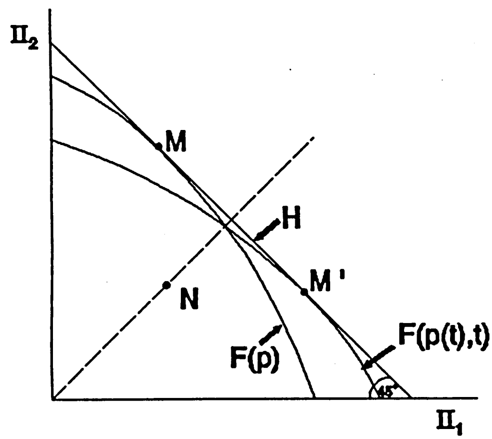

Figure 3: Profit possibilities for asymmetric firms

lowering rather than raising tariffs. Assuming that the firms continue to price independently, lower tariffs lead to lower prices and greater benefit to consumers. We formalize this result in the following proposition.

Proposition 3 *Given assumptions (A1) - (A7) and independent pricing behaviour, collusion over tariffs will lead to lower prices.*

Proof. This proposition is in fact established in the course of proving Proposition 2, in which we showed that both firms could be made better off (compared to the Nash equilibrium) by a simultaneous reduction in tariffs. We also showed (equations (7) and (9)) that prices were increasing functions of tariffs and hence lower tariffs imply lower prices. □

The intuition here is analogous to the elimination of "double marginalization" through vertical integration (see for example Tirole 1988, p174-175). In this case the double marginalization effect works both ways and both firms have an incentive to remove it. In other words, the firms impose an externality on each other through tariffs and this externality is reflected in consumer prices. Collusion enables internalization of the externality and a corresponding reduction in costs and consumer prices.

4 The effects of regulation on prices

Proposition 1 showed that firms can effectively collude over prices by colluding over tariffs while setting prices independently. The essence of this result carries over to regulated firms, provided that the regulated prices depend in some way upon tariffs. [7] Suitable examples include marginal cost pricing, average cost pricing and average variable cost pricing.

The intuition is straightforward. Proposition 1 characterised attainable prices assuming that they were a given function of tariffs, viz. the Nash equilibrium price mapping. The generalization asserts that the proposition holds for any univalent tariff-price relationship.

In order to compare the prices chosen in the regulated and unregulated cases under linear tariffs, we would have to determine the outcome of bargaining in each case. We can abstract from the bargaining problem by assuming identical firms. Thus, in order to illustrate the more general result, we consider the effectiveness of marginal cost pricing in the symmetric case. This yields the following proposition.

Proposition 4 *Assuming (A1)-(A4) and identical firms, marginal cost pricing regulations are completely ineffectual.*

[7] If this were not the case, in for example the case of international telecommunications, a decision to regulate in country i could allow country j to extract all the rents through an appropriate linear tariff.

Proof. We have already seen in Section 3 that, in the absence of regulation, identical firms would choose prices which maximised their joint profit. Under marginal cost pricing, the regulated price loci are

$$p_1^R = \frac{\partial C_1}{\partial q_1} + t_2 \frac{\partial d_2}{\partial q_1} \tag{18}$$

$$p_2^R = \frac{\partial C_2}{\partial q_2} + t_1 \frac{\partial d_1}{\partial q_2} \tag{19}$$

Since both $\partial d_1/\partial q_2 > 0$ and $\partial d_2/\partial q_1 > 0$, the firms can achieve any prices by appropriate choice of t_1 and t_2. Identical firms will indeed choose t_1 and t_2 so as to attain the joint profit maximising outcome. These t_1 and t_2 will then lead under the regulations to the desired prices (provided the tariff-price relationship is univalent).

□

The firms can completely undo the effect of regulations on their output markets by appropriately setting transfer prices on their input markets. Furthermore, the result trivially extends to the case of two-part tariffs even when the firms' profit functions or bargaining powers differ. Finally, it is worth noting that, in the case of two-part tariffs, the result is not restricted to symbiotic production. For example, in the standard vertical relationship, regulations on the downstream firm can be completely negated through the use of an appropriate two-part tariff by the upstream firm. [8]

While collusion amongst telephone companies appears beneficial for consumers in an unregulated environment, this outcome may be reversed when the firms are regulated. This suggests a need for international coordination on competition in and regulation of telecommunications. Individual countries regulatory efforts may be undermined by the international cartel.

5 Conclusion

Symbiotic production occurs when two or more firms sell each other essential intermediate goods. Important examples involve international telecommunications and postal services. In the case of two firms, we showed that collusion between the firms may be good for consumers and that price regulation may be ineffective. A forthcoming paper looks specifically at the international telecommunications market and the recommendations of the international telecommunications union.

[8] Spulber (1989, p.277) notes that regulations can be undermined in a vertically integrated firm.

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