

The Optimal Network Interconnection Contract under Partial Bypass in Oligopolistic Network Industries

Stephen Burnell, Lewis Evans and Shuntian Yao

New Zealand Institute for the Study of Competition and Regulation

and

School of Economics and Finance
Victoria University of Wellington

Acknowledgments: William Baumol, John McMillan, Ingo Vogelsang, Richard Arnott and participants of the International Telecommunications Society (Wellington, 1995 and Seville, 1996), and the Rutger Center for the Study of Regulated Industries (San Diego, 1996) conferences have made helpful comments on an early version of this paper.

Summary

The rapid widespread technological change and concomitant deregulation of network industries has engendered a burgeoning demand for connection between technologically similar as well as technologically dissimilar, networks. The processes by which interconnection contracts are reached and the nature of these contracts is important for the performance of these industries. The basis for public policy concern about these contracts stems from the perception that there remain natural monopoly elements in networks. Where these elements are absent or equivalently, if networks are open to economic bypass, interconnection contracts will generally not pose special competition concerns. The purpose of this paper is to examine the effect of credible potential bypass of a network on the economic efficiency of a privately chosen network contract. There is no regulation excepting the requirement that there must be no non-price discrimination against a firm that wishes to utilise the network.

The set up is one in which there are two downstream retail firms that require a network to do business. They supply different, but possibly very similar, services and they compete as a duopoly for retail customers. They each face the same contract for the use of the network.

There is a vertically integrated firm (the incumbent) that owns the network and one retail firm. Two organisational structures are considered. In one, the vertically integrated firm is a conglomerate that chooses the network contract and its retail firm's output, subject only to the reaction of the other retail firm. The second is a divisional organisational structure where the incumbent's retail firm takes the network contract as given and acts independently to maximise profits subject to interaction with the other retail firm. In the divisional structure the network contract is designed to maximise the profits of the total firm, but subject to divisional autonomy. The divisional structure yields relatively more efficient contracts than does the conglomerate but total incumbent profits are lower. As a practical matter, this represents a factor to be considered in choosing an organisational structure because there can be organisational performance gains in decentralised structures.

The second retail firm may build its own network to bypass the incumbent's network. There is no regulatory intervention and because of the threat of bypass the vertically integrated firm does not price the other firm off the network. The vertically integrated firm has the inherent natural monopoly characteristic of taking leadership in the design of its two-part tariff contract for the use of its network. It therefore designs the network contract taking cognisance of the ability of the second retail firm to construct a bypass network and its strategic output reaction to actions of the incumbent.

The results indicate that when the full network has to be bypassed, if at all, the vertically integrated firm has very considerable latitude to raise the variable component of the network charge to restrict the other retail firm's output. This inefficient situation is tantamount to bypass not being possible.

The position is different when the second retail firm can partially bypass the incumbent's network and use a combination of its own and the incumbent's network to service customers. Assuming that if the second retail firm did partially bypass it would do so by bypassing targeted network segments that are relatively densely populated by potential subscribers (e.g. the central business district) partial bypass is such a threat to the incumbent that it designs a much more efficient contract. The vertically integrated firm designs a contract that raises the variable component of the network contract as much as possible to reduce the outside firm's output while ensuring that the outside retail firm does not bypass much of the network. This threat of bypass forces, in the range of examples described in the paper, a relatively efficient outcome and a contract that approximates the incumbent's network cost function.

Because the network contracts are relatively economically efficient the profit performance of the divisional and conglomerate structures are so similar that a choice between them could be made on grounds of organisational performance. This is not considered in the paper.

Although the paper's assumption that there is one contract for all segments of the network is restrictive, the paper does illustrate the strong competitive influence of potential bypass on an unregulated firm's choice of a network contract.

I. Introduction

The theory and practice of regulation have undergone significant change in the last two decades. The possibilities and limitations of regulating near-monopoly oligopolistic industries have evolved to reflect asymmetric information, principal-agent issues, rent seeking and the political economy of regulatory institutions. In the 1970s Baumol, Bailey and Willig (1977) developed the concept of contestability and showed that under very special circumstances the threat of competition was sufficient to induce a monopolist to achieve a second-best welfare maximising outcome. Starting from the presumptions that regulators have their own objectives and that regulatory institutions reflect the political pressures of various constituencies, the public choice literature emphasises the effects of rent seeking, regulatory capture and balancing of special interest groups, for the efficiency of regulatory institutions.¹ The models of regulatory process have revealed the, usually very considerable, amount of information which the regulator should possess to be effective [see the discussions of Berg and Tschirhart (1988, Chs. 3 and 8) and Mitchell and Vogelsang (1991, 149-156), and the access pricing formulae of Laffont and Tirole (1994, 1679-1690)]. These strands of literature have been influential in that they have predicated significant changes in the regulatory policies of various countries. Most often these changes have led to reductions in regulation; but certain markets have been slow to change, and it remains common to have industry-specific regulation in network industries.²

In our definition of light-handed regulation there is no industry-specific or price regulation at all, but owners of a network must offer access to any (potential) user on the same terms and conditions as any other (potential) user. This means that a vertically integrated (conglomerate) firm, that owns both a network and a retail firm that uses the network, must charge its retail firm as well as those of competitors under the same network contract.³ But this standard contract is the only regulatory restriction.

¹ Examples are Peltzman (1976) and Weingast and Moran (1983).

² New Zealand is an exception. Excepting financial markets, it has no industry-specific regulatory bodies. In the example of telecommunications, players act with knowledge of the rules facing any firm under the Commerce Act 1986. The Act contains very significant penalties for actions restricting competition, and the ability for the Government to invoke price control. The incumbent is required to reveal essentially all customer prices, and to provide network access to entrants under transparent, reasonable terms and conditions. When the state-owned company was privatised the Government retained one share which had attached to it the requirement to provide a free residential local calling option, and to satisfy a price cap on the prices of residential local calls. The state-owned company had been formed from a government department in 1986. The department had been a statutory monopoly.

³ The approach that any regulation should first be judged against the outcomes of private markets before any regulatory steps are taken is the philosophy on which New Zealand's industry regulation has been based since 1986.

The key features of this paper are its determination of the efficiency of a network contract which is privately chosen within an environment which simultaneously contains light-handed regulation, an oligopolistic market, product differentiation, and the possibilities of partial and total network bypass. It admits vertical integration wherein a conglomerate owns the network and a downstream firm. Strategic behaviour affects the contract and the efficiency characteristics of it. Because of a key attribute of many bypass networks, it is shown that, given the possibility of partial bypass, unfettered oligopolistic competition under light-handed regulation can very often be second-best efficient.

The issue of an optimal interconnect contract has long been the subject of work by Baumol and Willig whose (1991) "efficient component pricing" (ECP) rule determines a price for entry to the network.⁴ Entry, is presumed to be at the expense of network services used by the incumbent. The ECP price will generally exceed average incremental cost by an amount to cover fixed costs, any cross-subsidisation imposed on the firm by regulation and loss of profit due to the entrant's use of the network. Indeed, setting aside the cross-subsidy issue, if Ramsey pricing by a natural monopoly firm is sustainable and the market is perfectly contestable the efficient and ECP price charged to any entering retail firm will simply be the prevailing price.⁵ This paper characterises the optimal privately chosen pricing contract, and examines the welfare outcomes in a positive theory of regulation.

II. The Basic Industry Set Up

Consider a retail industry with 2 retail firms. Let $p = [p_1, p_2] \in R_{++}^I$, be the vector of industry prices, and $q = [q_1, q_2] \in R_{++}^I$, the vector of industry outputs. Suppose the service demand functions for the retail firms are given by:

$$q_i = D_i[p], \text{ for } i \in 1,2.$$

Assumption 1: $D[p] = \{D_1[p], D_2[p]\}$ is one-to-one.

Hence, there exists $H[\cdot] = D^{-1}[\cdot]$, such that $p = H[q]$, and so $p_i = H_i[q]$. Given that Firm i decides to enter the market, then for it to produce q_i units of service the non-network cost is

⁴ See also Laffont and Tirole (1993, ch.5).

⁵ Waterson (1987, 69-70) summarises the links between Ramsey pricing, sustainability, contestability and efficiency. Laffont and Tirole (1994, 1693-1696) discuss the efficiency pros and cons of the ECP rule.

given by:

$$c_i = c_i[q_i] \text{ for all } i = 1, 2$$

Further, the amount of network service required by retail Firm i to produce q_i units of retail service is given by:

$$g_i = g_i[q_i]$$

Assumption 2: The functions $c_i: R_+ \rightarrow R_+$ and $g_i: R_+ \rightarrow R_+$ are strictly increasing; in particular the inverse of $g_i[\cdot]$ exists.

Assumption 3: It is assumed that $H[\cdot]$, $c_i[q_i]$, and $g_i[q_i]$ are common knowledge (to all firms).

Throughout this discussion we assume that there is a network provided by Firm N (the incumbent).⁶ The contract, $f[g_i(q_i)]$, specifies the payment which firm i makes to Firm N for the use of the network when i produces q_i , and it is described in

Definition 1: A network contract, $f: R_+ \rightarrow R_+$, is a continuous increasing function mapping any firm's usage of the network into a payment to Firm N .

Under light-handed regulation we require Firm N to offer network access to any firm under terms and conditions of the contract $f[\cdot]$. The constraint to offer the same contract to all firms is suggested by a regulatory framework in which an incumbent firm should not exploit a dominant position to lessen competition.⁷ It will be apparent from the analysis which follows that, if the network was owned by a company that also owned a retail firm, this vertically integrated firm could use network contracts that differed between firms to preserve a monopoly position in the retail market. Such actions would be transparently clear violations of the requirement not to exploit a dominant position, even under a light-handed regulatory regime, and they would be actionable under competition statutes. Thus, we define light-handed regulation to be the case where the network the contract $f[\cdot]$ is the same for both retail firms, although this assumption implies no regulatory restriction because for a vertically integrated firm the payment for network services provided to retail is an internal transfer that

⁶ We shall allow retail firms to build their own, either complete or part, networks.

⁷ This is the content of Section 36 of the New Zealand Commerce Act 1986.

nets out of the conglomerate's profit equation.

We assume that the firm that owns the network firm (firm N) acts as a Stackleberg leader; this is consonant with the network owning firm being the incumbent. When $f[\cdot]$ is announced the 2 retail firms decide whether to enter the market or not. In this paper we assume that both enter and choose an output strategy, q_i , yielding a profit of:

$$\pi_i = H_i[q] \cdot q_i - c_i[q_i] - f[g_i(q_i)]. \quad i=1,2 \quad (1.1)$$

given the network contract, $f[\cdot]$. Then the profits for the network Firm N will be:

$$\pi_N = \sum_{i=1,2} f[g_i(q_i)] - c_N\{\sum_{i=1,2} g_i[q_i]\}, \quad (1.2)$$

where $c_N[\cdot]$ is the cost function for the network.

We further suppose that a single institution may own both Firms 1 and N , which we refer to as the *conglomerate*. The profits for the conglomerate - Firms 1 and N combined - are given by:

$$\pi_1 + \pi_N = H_1[q] \cdot q_1 - c_1[q_1] + f[g_2(q_2)] - c_N\{\sum_{i=1,2} g_i[q_i]\}. \quad (1.3)$$

Now, there are three basic ways that Firms 1 and N can be related to each other. These alternative institutional arrangements are listed in Cases 1-3 as:

Case 1: Firms 1 and N are independent; there is no conglomerate but Firm 1 must use Firm N's network.

Case 2: The conglomerate exists although Firm 1 acts as an independent entity when choosing q_1 . That is, given $f[\cdot]$, Firm 1 maximises its profits, as defined in Equation (1.1). This will be referred to as a two-division conglomerate.

Case 3: The conglomerate exists and Firm 1 recognises its place in the conglomerate when choosing q_1 . That is, given $f[\cdot]$, the profits of Firms 1 and N, as defined in Equation (1.3), are maximised; This will be referred to as a one-division conglomerate.

Case 1 should be viewed as a benchmark because in our subsequent analysis we impose the implicit contract that Firm 1 is committed to use Firm N's network: there is no threat of Firm 1 building an alternative network or using any network built by any other retail firm. In Case 2 the retail division of the conglomerate takes the network contract as given in choosing q_1 to maximise its profits. Of course the design of the network contract will anticipate this behaviour. Finally, Case 3 differs from Case 2 because q_1 is chosen to maximise the joint profits of Firms 1 and N: again this behaviour will be anticipated and influence the design of a contract that is optimal from the point of view of the vertically integrated conglomerate.

For each of the three cases, a Nash equilibrium - given $f[\cdot]$ - can now be defined. If there is no conglomerate, or a two-division conglomerate, a Nash equilibrium is given by an output vector, $q^*[f] = \{q_i^*[f]\}$, such that i 's output maximises π_i , given the output levels of the other retail firm. Further, let $p^*[f] = \{p_i^*[f]\}$, be the equilibrium price vector. If there is a one-division conglomerate - Case 3 -, a Nash equilibrium is given by an output vector, $q^*[f] = \{q_i^*[f]\}$, such that i 's output maximises π_i , for $i \neq 1$, while Firm 1's output maximises $\pi_1 + \pi_N$.

As i 's profit function is common knowledge, each retail firm (as well as Firm N) can calculate the equilibrium $q^*[f]$ and so decide whether or not to enter (remember, $q_i^*[f] = 0$ is equivalent to Firm i not entering the market, at least from the viewpoint of other retail firms). We will assume that $c_i[0]$ incorporates any rental cost of fixed capital, and so given $q_j[f]$ ($j \neq i$), i will enter only if there exists $q_i > 0$, yielding $\pi_i > 0$.

Notice, the Nash equilibrium can be interpreted as a function from the network contract, $f[\cdot]$, to the equilibrium quantities (and hence prices). As the only restriction (thus far) on $f: R_+ \rightarrow R_+$ is that it be continuous and increasing, the range of the equilibrium mapping, $q^*[f]$ has the potential to be quite a large subset of R_+^I .

Notice also that despite

Lemma 1. Consider the world with no conglomerate (Case 1). Given the network contract, $f[\cdot]$, the set of Nash equilibria is the same as the world with a two-division conglomerate (Case 2).

the network contract may not be chosen to be the same in cases 1 and 2, because in Case 2 the design of the network contract will take into account the fact that Firm 1 is part of the

conglomerate.

Assumption 4: $H_i[q] \cdot q_i$ is concave in q_i . Further, it achieves a maximum value at some finite value of q_i . Alternatively, consider the (vector) function, $H: R_+^I \rightarrow R_+^I$. There exists a compact subset of R_+^I , call it \hat{Q} , such that for all $q \notin \hat{Q}$, $D_{q_i}\{H_i[q] \cdot q_i\} < 0$.

That is, marginal revenue - for each retail firm - is negative if q lies outside the compact set, \hat{Q} .

This assumption is sufficient to ensure the problem of profit maximisation always has a (finite) solution, even if the cost function (and/or the network contract) is also concave in q_i .⁸

Proposition 1: Given assumptions 1-4, the network contract $f[\cdot]$ and that each firm has a convex cost function at least one Nash equilibrium exists for each case.⁹

In general, the set of Nash equilibria depend upon the contract, and the contract itself need not be convex for an equilibrium to exist.

The uniqueness of the equilibrium is of considerable interest, for without uniqueness the optimal contract cannot be defined. Uniqueness usually requires some kind of linearity in the reaction functions. For the duopoly case, which we consider in detail below $I=2$ and we have

Proposition 2: In the class of inverse demand functions, H_i , that are linear in (q_1, q_2) , and the quadratic (and linear) firm total cost functions there exists a large set of these functions that yield unique Nash equilibria in each case, given the contract.¹⁰

III. Duopoly: Linear Contracts and Complete, if any, Bypass

⁸ Notice, without additional assumptions (possibly on the signs of the third-order derivatives of revenue and costs), there is no guarantee that Firm i 's optimal strategy is a continuous function of the strategies of the other retail firms (given the network contract).

⁹ By the convexity of costs and Assumption 4 each retail firms' profit function will be concave. Also, there will exist an upperbound Q for the q_i such that when the profit of firm i is negative. Thus there is a compact, convex, nonempty strategy set $[0, Q]$ for each firm.

¹⁰ Proposition 2 for Cases 2 and 3 is demonstrated in Appendix 1.

In this section we examine the optimal contract and its welfare implications in detail in the particular case of our general model where network contracts, cost and demand functions are linear and where there is duopoly in the retail market. We also allow for the possibility of retail Firm 2 building its own complete network at the same cost of that of Firm N.

Under the linearity assumptions we also add:

Case 0: The contract shares network fixed costs between Firms 1 and 2 and its rate of usage cost is the marginal cost of the network, so $\pi_N = 0$.

to our analysis. It is a benchmark case wherein network profits are constrained to be zero and fixed costs are allocated equally between the retail firms and each retail firm is charged the network marginal cost. Case 0 is the situation where the contract is the network cost function with the exception that the fixed costs are equally shared by the 2 retail firms, that is, if the network cost function is $c_N[g] = a + b \cdot g$ then the linear network-use contract is $f[g] = a/2 + b \cdot g$ for $a > 0$ and $b > 0$. In this case, for each of the three ownership/control structures (no conglomerate, one-division conglomerate, two-division conglomerate) this network contract yields the same Nash equilibrium and consequently the same welfare. As we shall demonstrate, Case 0 will in general not arise unless it is imposed by regulation.

Suppose that Firm N is free to choose the network contract, $f[\cdot]$, without any government regulation excepting that the contract should be the same for both retail firms. Irrespective of the variable network contract costs, the fixed cost component will be chosen so as to reduce Firm 2's profit to its lowest possible value, subject to the continued participation of firm 2 in the market. However,

Assumption 5: Firm 2 can build its own network with the same cost function as that of Firm N.

provides an additional option for Firm 2 that will place an upper bound on the network's - Firm N's - ability to extract profit from Firm 2.

The game proceeds as follows. First, Firm N announces a contract, $f[\cdot]$. Firm 2 must then decide whether to enter the retail market or not (we will focus on the case where it does). Given that Firm 2 chooses to enter the retail market, it conjectures that Firm 1 will purchase its network services from Firm N and this yields Firm 1's best-response function. Firm 2 then

calculates two Nash equilibria, one in which it builds its own network, and the other in which it purchases its network services from Firm N. The equilibrium with the higher profit level for Firm 2 then indicates whether Firm 2 should build its own network or not. Put another way, if Firm N wishes to ensure that Firm 2 does not build its own network, it must set $f[0]$ sufficiently small.

Hence, Firm N will choose $f[\cdot]$ so as to maximise its objective function - either π_N or $\{\pi_1 + \pi_N\}$, depending upon the conglomerate's organisational structure - subject to the constraint that Firm 2 will build its own network if $f[0]$ is too large. In the examples that follow, Firm N will choose $f[\cdot]$ so as to make Firm 2 indifferent between building its own network and purchasing from N. It is necessary to assume that, if Firm 2 is indifferent between buying from Firm N and building a network, it chooses to purchase network services from Firm N.

We start by considering departures from the benchmark situation of Case 0 because it provides a basis for an evaluation of whether it is desirable for the marginal cost of the network contract to differ from the marginal cost of the network. For each of the three institutional arrangements we consider whether the network's owners will prefer the contract $f^*[g] = A + B \cdot g$ to the contract $f[g] = a/2 + b \cdot g$, where A and B (both assumed to be non-negative) are chosen so as to make Firm 2 indifferent between accepting the network contract and building their own network. The equations determining the Nash equilibria for this game are set out in Appendix 2. They establish

Proposition 3: Let $c_N[g] = a + b \cdot g$, \hat{q}_1 be the level of Firm 1's output when Firm 2 has built a network and q_1 be the level of Firm 1's output without the network, and consider a network contract of the form, $f^*[g] = A + B \cdot g$ with initial values $[A, B] = [a/2, b]$. Then

$$\frac{d\pi_N}{dB} = g_1[q_1] - g_2[q_2] - 2 \cdot \{D_1 H_2[q] \cdot q_2\} \cdot \left\{ \frac{d\hat{q}_1}{dB} - \frac{dq_1}{dB} \right\}$$

and if $g_1[q_1] \leq g_2[q_2]$, $D_1 H_2[q] \leq 0$, and $\frac{d\hat{q}_1}{dB} \leq \frac{dq_1}{dB}$, the network will (weakly) prefer $B \leq b$ to $B > b$, for B belonging to a small enough neighbourhood of b .

Proposition 3 gives sufficient conditions for the network not to make the usage charge exceed the marginal cost of network provision. If Firms 1 and 2 have the same demand functions then $g_1[q_1] \equiv g_2[q_2]$ and $D_1 H_2[q] \leq 0$ because the services yielded will be substitutes.

Moreover, if the demand function is linear it is straightforward to show that $\frac{d\hat{q}_1}{dB} < \frac{dq_1}{dB}$ which, from Proposition 3, establishes that the usage charge will be less than the marginal cost of the network in these circumstances. This result is an extension of Oi's (1971) proposition to upstream input supply, that in particular circumstances it is in the interest of a monopolist to price below marginal cost when setting two-part tariffs. Reducing the contract marginal cost of two imperfectly competitive retail firms can induce their production of extra output and permit higher fixed charges paid to the network.

In order to assess the nature and welfare implications of the optimal contract for the various cases it is necessary to consider numerical examples. Examples of duopoly under linear contracts and linear cost and demand functions are given in Table 1 and in Appendix 2. Consumer surplus is taken to be the area under the two demand curves - above the price. In these examples it is given by $CS = [0.5] \cdot \{[q_1]^2 + [q_2]^2\}$, and welfare is $W = CS + \pi_1 + \pi_2 + \pi_N$.

In Table 1, first note that welfare and consumers' surplus both increase from Case 0 to Case 1. The linear demand functions which are the same for each retail firm fit the preconditions of Proposition 3: thus when the network firm is free to choose the contract it moves away from the zero-profit-constrained Case 0 to a situation in which it chooses a usage charge rate which is less than the marginal cost of the network. In both Examples 1 and 2 of Table 1, the extra output this generates produces higher aggregate welfare and consumers' surplus in Case 1 than Case 0. The profits the network is making in Case 1 are at the expense of reductions in profits of the retail firms in going from Case 0 to Case 1. In Example A2.1 of Appendix 2, we have

Table 1
Duopoly and Linear Contracts

Example 1.

$I = 2$, $H_1[q] = 100 - q_1 - [0.7] \cdot q_2$, $H_2[q] = 100 - q_2 - [0.7] \cdot q_1$, $c_i[q_i] = 100 + [0.5] \cdot q_i$
 $g_i[q_i] = q_i$, and $c_N[g] = 500 + 2 \cdot g$.

	Case 0	Case 1	Case 2	Case 3
f[g]	$250 + [2] \cdot g$	583	$328 + [6] \cdot g$	$[16] \cdot g$
q1	36	37	35	39
q2	36	37	35	28
p1	39	37	41	41
p2	39	37	41	44
π_1	954	675	766	879
π_2	954	675	766	704
π_N	0	518	448	414
Cong.Prof.	954	1193	1214	1293
Cons.Surp.	1304	1358	1194	1156
Welfare	3212	3227	3172	3153

Example 2. Same as Example 1, except $c_N[g] = 500 + g$

	Case 0	Case 1	Case 2	Case 3
f[g]	$250 + g$	542	$323 + [5] \cdot g$	$[14] \cdot g$
q1	36	37	35	39
q2	36	37	35	29
p1	38	37	41	41
p2	38	37	41	44
π_1	981	716	794	907
π_2	981	716	794	731
π_N	0	510	446	414
Cong.Prof.	981	1226	1240	1321
Cons.Surp.	1331	1358	1217	1182
Welfare	3293	3300	3252	3234

asymmetric demand functions in that Firm 2's demand function has a lower constant term than that of Firm 1. Here we get a usage charge rate in Case 1 that exceeds the marginal cost of the network. Also, in that example we get declining welfare in the move from Case 0 to Case 1, but unusually the highest welfare is attained in Case 3, the situation of the fully integrated conglomerate.¹¹

In the examples of Table 1 the chosen contract entails increasing the usage component, $\partial f[g]/\partial g$, and reducing the access component as institutional arrangements move from independent firms (Case 1) to a fully integrated conglomerate (Case 3). To explain this consider the decision problems of the two forms of conglomerate. Ignoring the constraint that Firm 2 should be indifferent between building its own network and using that of Firm N, decision making for the two division (Case 2) conglomerate can be described as

$$\max_f \{ \pi_1(q_1(f), q_2(f), f) + \pi_N(q_1(f), q_2(f), f) \}$$

where $q_1(f) = \arg \max \{ \pi_1(q_1, q_2, f) : q_2 = q_2(q_1, f) \}$. Whereas for the vertically integrated one-division conglomerate (Case 3) the decision problem is

$$\max_{q_1, f} \{ \pi_1(q_1, q_2, f) + \pi_N(q_1, q_2, f) : q_2 = q_2(q_1, f) \}$$

Thus, conglomerate profits will be higher in Case 3 than Case 2. Furthermore, in Case 2 the conglomerate has to be concerned not to set a very high marginal cost component of the network contract because this will inhibit the level of production of both retail firms through its effect on the marginal cost of retail firm production. In both conglomerate structures (Case 2 and 3) the network payments by Firm 1 do not appear in conglomerate profits because they are a payment by Firm 1 and a receipt by Firm N the sum of which vanishes (see 1.3): they are internal transfers. Nevertheless, the choice of q_1 is affected by the marginal cost of the network contract in Case 2 because Firm 1 acts as a distinct division that takes $f[\cdot]$ as given, whereas in Case 3 the conglomerate chooses q_1 directly to maximise total conglomerate profit and this choice is not directly affected by the marginal cost of the network contract.

These differences between the different conglomerates' choices of q_1 are reflected in the data of Table 1. In choosing the network contract the conglomerate seeks low output for the

¹¹ Maximum consumer surplus is attained in Case 1, although the difference from Case 4 is quantitatively minimal.

competing Firm 2. It can achieve this by raising the marginal (or usage) cost element of the contract because this is a component of marginal cost to Firm 2. The two-divisional conglomerate (Case 2) is constrained in raising marginal network cost by the fact that Firm 1 acting as a separate division chooses q_1 in the same manner as Firm 2 chooses q_2 because network-contract marginal cost is part of its aggregate marginal cost. However, the fully integrated conglomerate (Case 3) is free to inhibit Firm 2's output by a high marginal contract payment, because its choice of q_1 is not affected by the marginal cost of the network contract. In Examples 1 and 2, Case 3 generates the largest conglomerate profit, and output of Firm 1 that is higher than that of Firm 2. The marginal network cost to retail firms is higher in Case 3 than in Case 2 (which in turn is higher than in Case 1): all of which is in accord with our previous arguments.¹² Consumer welfare is lowest under Case 3.

The key result illustrated in Table 1 is that light-handed regulation in which the same network contract must be provided to all retail firms still leave the single-division vertically-integrated monopolist much scope for strategic choice of a network contract that favours the conglomerate at the expense of consumer welfare and rival companies' profits. It holds even if rival retail firms can duplicate, and hence bypass, the entire network.

IV. Partial Bypass

Thus far, the story could have been about any industry and any essential input (involving a high fixed cost). Examples (A2.3) and (A2.4) of Appendix 2 attempt to capture the idea that the network involves a high fixed cost but a very small marginal cost. However, they do not encapsulate the possibility that in many situations Firm 2 may construct a sub-network, thereby reducing its contractual payments to Firm N.¹³ We term this possibility partial bypass.

Suppose that the network cost function is again $c_N[g] = a + b \cdot g$, and that Firm 2 constructs a bypass network that carries with it variable cost b and fixed cost $K^* \leq a$.¹⁴ The proportion of the total network covered - by Firm 2 - is given by K^* / a . Let $\delta[\cdot]$ be the function that

¹² Notice that profits are present in all cases. This simply reflects the fact that the market is imperfect. But our comparison of welfare outcomes will follow the comparative institutional approach of comparing welfare outcomes, recognising that no state is first-best efficient. In a dynamic world without institutional restrictions on entry the profits of the retail firms can be expected to attract entry until they are much reduced, if not eliminated.

¹³ We assume that the firms have access to the same network technology at the same installed cost.

¹⁴ This assumes that, whereas the extent of network coverage (duplication) is determined by the ratio of fixed costs K^* / a , the marginal cost of use of each network is the same. Arguments can be adduced for scaling down the marginal cost of the bypass network, in which case the threat of bypass will gain more force from that represented here. It could also be represented that by not reducing the marginal cost of the bypass network we have provided some recognition of interconnection costs not represented elsewhere in the model.

maps the physical proportion of the network built by Firm 2, namely K^*/a , into the proportion of the market actually used by the bypass network. Then we invoke

Assumption 6: Usage of Firm 2 and Firm N's network, respectively, are given by

$$\delta[K^*]g(q_2) \text{ and } (1 - \delta[K^*])g(q_2).$$

Thus the choice of K^* by Firm 2 will determine the distribution of Firm 2's network traffic between the bypass network and Firm N's network. In the case of partial bypass, Firm 1 is restricted to the use of Firm N's network, as formerly. As will become apparent, the nature of the bypass-use function, $\delta[\cdot]$, is critical to the equilibria of the network market. The approach is directly applicable to telecommunications markets, but it will apply to other network industries where bypass is feasible.

We need to distinguish between the bypass network's coverage of customers and the actual usage of the network.¹⁵ Let the function $\gamma[K^*]$ for bypass capital $K^* \in [0, a]$ map the physical proportion of the bypass network into the coverage obtained. It will reflect the fact that Firm 2 will optimise in constructing its network. Customers' volumes of use are far from identical and they are not randomly distributed over the network; in consequence Firm 2 will construct the bypass network to maximise network traffic volumes for any given K^* .¹⁶ Thus $\gamma[K^*]$ will satisfy $\gamma[0]=0$, $\gamma[a]=1$, and be strictly increasing and concave in K^* . We use the specific form $\gamma[K^*] = (K^*/a)^\alpha$ for $\alpha \in (0, 1)$.

Returning to the proportion of Firm 2's network use that uses the bypass, $\delta[K^*]$, consider the case where, given $\gamma[K^*]$, customers randomly contact other customers. In this event, the distribution of network use will be

$$\begin{array}{ll} \gamma[K^*]^2 & \text{within Firm 2's network, and} \\ [1 - \gamma[K^*]]^2 & \text{within Firm N's network, and} \\ 2\gamma[K^*][1 - \gamma[K^*]] & \text{between the networks,} \end{array}$$

implying that the proportion of Firm 2's network usage that employs bypass is

¹⁵ Here the term customer includes coverage of network traffic or volume.

¹⁶ This optimisation problem poses an interesting direction for further work. Note that in telecommunications bypass is predominantly directed towards large volume customers such as those within and between central business districts.

$$\begin{aligned}\delta[K^*, \alpha] &= \gamma[K^*]^2 + (K^*/a)2\gamma[K^*][1 - \gamma[K^*]] \\ &= (K^*/a)^{2\alpha} + 2(K^*/a)^{\alpha+1} - 2(K^*/a)^{2\alpha+1}\end{aligned}$$

which is increasing in K^* . It defines the two sets

$$\begin{aligned}U &\equiv \{K^*/a; \delta[K^*, \alpha] < K^*/a\}, \text{ and} \\ V &\equiv \{K^*/a; \delta[K^*, \alpha] > K^*/a\}\end{aligned}$$

that are partitioned at the fixed point $(K^*/a)_{fp} \equiv \{K^*/a; \delta[K^*, \alpha] = K^*/a\}$. The function $\delta[K^*, \alpha]$ is convex on the set U and concave on V . In the example where $\alpha = 0.8$, the fixed point occurs at $(K^*/a)_{fp} = 0.34$, and hence for bypass below 34 percent of the full network, coverage will be less than the proportion of the physical network built. Also at $\alpha = 0.8$, when 40 percent of the network is bypassed 48 percent coverage is obtained and 43 percent of Firm 2's network usage can be handled by bypass. If $\alpha > 0.5$ then the set U is nonempty and this will predispose Firm 2 to build a bypass network of a size that at least reaches the fixed point if it builds at all. For $\alpha < 0.5$ the concavity of $\gamma[K^*]$ ensures that $\delta[K^*, \alpha]$ is concave for all $K^* \in [0, a]$ and that the set U is empty. If, for example, $\alpha = 0.25$ and 40 percent of Firm N's network is bypassed then 80 percent customer coverage is provided by bypass and 76 percent of Firm 2's usage will be via the bypass network. In what follows it will be assumed that $\delta[K^*, \alpha]$ is increasing and concave in K^* .

Assumption 7: Given the contract, $f[g]$, if Firm 2 chooses a fixed cost of K^* and network use of $g(q_2)$ then its network payment is given by:

$$f[(1 - \delta(K^*))g(q_2)]$$

Firm N remains free to choose the contract $f[\cdot]$.

The sequence of events can now be imagined as follows. First, Firm N announces the contract, $f[\cdot]$. Second, Firm 2 simultaneously chooses its fixed cost (or equivalently: size of network), K^* , and its retail output, q_2 . Also, Firm 1 chooses her output level, q_1 . It will be assumed that $[K^*, q_1, q_2]$ is chosen so as to yield a Nash equilibrium. As usual, the network contract, $f[\cdot]$, is chosen so as to maximise profits - of either the network (Case 1) or the conglomerate (Cases 2 and 3) - taking the equilibrium process into account.¹⁷ Finally, in a

¹⁷ The assumption that Firm 2 chooses K^* and q_2 simultaneously is made for technical convenience. For if K^* is chosen before retail output levels, Firm 2 must construct a function from K^* - and $f[\cdot]$ - to the Nash

world with no conglomerate (Case 1) both retail firms will choose a capital stock and an output level in response to the contract, $f[\cdot]$. The proof of

Proposition 4: Given a linear contract and Assumptions 1-7 there exists at least one Nash equilibrium (for each Case ?) in the presence of the possibility of bypass.

is given in Appendix 3. The Nash equilibrium for this game and for Firm N's choice of a

equilibrium in outputs (thereby making the first-order conditions for an optimal value of K^* rather difficult to solve analytically).

Table 2
Linear Contracts in the Presence of Bypass

Example 3:

$I = 2$, $H_1[q] = 100 - q_1 - [0.7] \cdot q_2$, $H_2[q] = 100 - q_2 - [0.7] \cdot q_1$, $c_i[q_i] = 100 + [0.5] \cdot q_i$,
 $g_i[q_i] = q_i$, $c_N[g] = 500 + 2 \cdot g$, and $\delta(K^*/a) = (K^*/a)^{0.5}$

	Case 0	Cases 1-3
$f[g]$	$250 + 2 \cdot g$	$500 + 2 \cdot g$
q_1	36	36
q_2	36	36
p_1	39	39
p_2	39	39
π_1	954	704
π_2	954	704
π_N	0	500
Cong.Prof.	954	1204
Cons.Surp.	1304	1304
Welfare	3212	3212
K^*	0	0
δ	0	0

Example 4:

$I = 2$, $H_1[q] = 100 - q_1 - [0.7] \cdot q_2$, $H_2[q] = 100 - q_2 - [0.7] \cdot q_1$, $c_i[q_i] = 100 + [0.5] \cdot q_i$,
 $g_i[q_i] = q_i$, $c_N[g] = 500 + 2 \cdot g$, and $\delta(K^*/a) = (K^*/a)^{0.9}$

	Case 0	Cases 1-2	Case 3
$f[g]$	$250 + 2 \cdot g$	$500 + 2 \cdot g$	$17 \cdot g$
q_1	36	36	39
q_2	36	36	28
p_1	39	39	41
p_2	39	39	44
π_1	954	704	826
π_2	954	704	668
π_N	0	500	469
Cong.Prof.	954	1204	1265
Cons. Surp.	1304	1304	1155
Welfare	3212	3212	3119
K^*	0	0	34

δ | 0 | 0 | 0.09 |

contract, is set out in Appendix 4. Two examples are provided in Table 2.

In Example 3 the proportion of Firm 2's traffic which uses Firm 2's network is approximated by $\delta[K^*, \alpha] = (K^*/a)^\beta$ where $\beta = 0.5$.¹⁸ The contract, $f[g] = a + bg$, is certainly optimal when $A \leq a$ (and $B \geq b$). To see that the integrated conglomerate will never set $\{A > a, B < b\}$ notice that for $B < b$, A will be chosen by the conglomerate to just ensure that Firm 2 does not build a bypass network, because if it pays firm 2 to build any network it will pay to build a complete network. Furthermore, B below b will result in larger output from Firm 2 at a cost of Firm 1 sales and profits. Hence, the integrated conglomerate will not choose $\{A > a, B < b\}$.

In Example 3 we see that the introduction of the possibility of partial bypass has markedly reduced the market power of the conglomerate. In fact, its optimal contract entails setting the usage charge rate at network-marginal cost to all retail firms, and there is no bypass. In this event, all of Cases 1-3 collapse to yield the same outcome: namely the relatively efficient outcome of Case 0 in Example 1.¹⁹ This occurs because retail output decisions are based on the same marginal cost in each case.

The network profit stems from a higher access fee than that required to cover its fixed costs, but it is not high enough to induce bypass. To examine whether this outcome of our game is specific to demand and cost parameters assumed in Example 3 we explore alternatives. Under the scenarios of Table 3 we get exactly the same qualitative conclusions as Example 3: the integrated conglomerate privately chooses the relatively efficient contract.

There will exist specific parameter values which yield contracts, chosen by the conglomerate, which differ from pricing usage at the marginal cost of the network. In particular, as the exponent of $(K^*/a)^\beta$ approaches 1 we would expect the contract to revert to Case 3 of Example 1, and, indeed, Example 4 demonstrates this outcome. As β approaches 1 coverage of network traffic approaches the proportion of the physical network covered, thus increasing

¹⁸ Setting $\beta = 0.5$ is a conservative approximation to that which obtains in many telecommunication networks where an historical rule of thumb has been that 20 percent of network covers 80 percent of the traffic. It represents the envelope of $\delta[k^*, \alpha]$ and it captures the increasing and concave nature of this function discussed earlier in the text.

¹⁹ Note that although Case 1 of Example 1 is relatively efficient in terms of Cases 2 and 3, it actually produces higher welfare and consumers' surplus than does Case 1. However, because the result does not carry over to other specifications (eg see the asymmetric demand examples of Appendix 2) we use Case 0 as the efficiency benchmark.

the cost to Firm 2 of bypass.²⁰ It is likely, however, that, particularly for low values of

²⁰ In our standard example (as specified in Example 3) the integrated conglomerate switches to a contract with a usage charge rate which exceeds network marginal cost when $\beta > 0.8$.

Table 3
Specified Departures From Example 3

i) Cost:

A lower network marginal cost as in $c_N[g] = 500 + g$.

ii) Demand:

Asymmetric Demand: $H_1[q] = 100 - 0.7q_2 - q_1$
 $H_2[q] = 85 - q_2 - 0.7q_1$

Reduced Substitutability: $H_1[q] = 100 - 0.4q_2 - q_1$
 $H_2[q] = 100 - q_2 - 0.4q_1$

Increased Substitutability: $H_1[q] = 100 - 0.9q_2 - q_1$
 $H_2[q] = 100 - q_2 - 0.9q_1$

iii) Coverage:

$$\delta[K^*] = (K^* / a)^{0.8}$$

K^*/a , small proportions of the physical network will cover large proportions - in our examples represented by $\beta < 1/2$ - of the traffic, making the threat of bypass to the conglomerate credible.

[we could drop this para ?] A comparison of Case 2 in Examples 3 and 4 reveals the importance of strategic reactions between the firms. Although Firm 2's profit is greater in Case 2 of Example 3, where Firm 2 essentially faces the network cost function, than in Example 4, the situation of the latter example is indeed a Nash equilibrium given the contract. If Firm 2 did behave as if in Example 3 then Firm 1 would react by producing 36 (as in Example 3), but it would then not be rational for Firm 2 to build a complete network given the network contract 17g: instead it would pay to use the conglomerate's network rather than build a second network. It can be shown that 17 is the marginal cost to Firm 2 of an additional unit of network so that $K^*=34$ is the optimal amount of bypass network. The network contract is chosen as if the conglomerate is a Stackleberg leader, and if this assumption is relaxed then other contracts might emerge.

In sum where traffic density varies around a network the threat of partial bypass can constrain the vertically integrated conglomerate to design network contracts that are second-best efficient.

V. Nonlinear Contracts

The contracts we have considered so far have been linear, and under bypass these have optimally included an access fee. It is natural to explore a wider class of contracts to assess the consequent outcomes and the importance of an access fee. We restrict attention to contracts of the form:

$$f[g] = A + B \cdot g + C \cdot g^\phi; \quad A \geq 0, B \geq 0, C \geq 0, \phi \in (0,1).$$

This contract space confers more instruments on Firm N, and hence the conglomerate, than do linear contracts, and in consequence the conglomerate can be expected to produce higher profits. The choice of the optimal contract is complicated by the fact that the functional form of the cost function may also be generalised. Indeed, to provide a long-run declining marginal cost - used in many analyses of monopoly pricing - requires an increasing, concave cost function. The addition of nonlinear cost functions and contracts to our model introduces nonlinear reaction functions and increased possibility of non-unique Nash equilibria.

We restrict analysis to the case where partial bypass is feasible and the linear network cost function has high fixed and low marginal cost. Here, it will be possible to mimic the relatively efficient linear contract of, say, Example 3, with a nonlinear contract which has no constant term, of the form $f[g] = B \cdot g + C \cdot g^\phi$; $B \geq 0, C > 0$, and where $\phi \in (0,1)$ is sufficiently small for the second term to act as an approximate access fee.

We now turn to the determination of the optimal contract under bypass and duopoly using the basic symmetric demand function of Example 3, and searching over $\{A, B, C, \phi\}$ in the contract. Because the network coverage function is concave and bypass will be carried out until the cost saving from another unit of bypass equals the cost of this investment, a concave contract will inhibit larger amounts of bypass and duplication of the network. In addition, because of the interaction between the demand functions a profit-maximising conglomerate will want to restrict Firm 2's output. Its tool for this purpose is the marginal payment of the contract, that is, $\partial f[g] / \partial g$: the higher is this quantity the lower will be output of Firm 2.²¹ These two factors lead to there being no absolutely fixed access fee, thus we maintain $A = 0$.

Further bounds on the contract should be established to prevent the entrant committing to building a parallel network. The situation differs as between the one and two division conglomerates. The conglomerate's two division and one division, respectively, choices of output are determined by the first-order conditions, as

$$q_1^{3*} = \{q_1; H_1(q_1) - q_1 - D_{q_1}c(q_1) - D_{q_1}f[g(q_1)] = 0\} \text{ and}$$

$$q_1^{4*} = \{q_1; H_1(q_1) - q_1 - D_{q_1}c(q_1) - bD_{q_1}g(q_1) = 0\}.$$

The sequence of moves is that the conglomerate announces a contract and Firm 2 determines whether, given that contract, it will commit to build a complete network. If it has the incentive to commit to build the full network the conglomerate will adjust the contract to (just) eliminate the incentive. Thus, for this incentive compatibility of the contract we require that

$$\text{for Case 3: } \pi_2(q_1^{3*}, f[\cdot], K^* \in [0, a)) \geq \pi_2(q_1^{3*}, f[\cdot], K^* = a), \text{ and}$$

$$\text{for Case 4: } \pi_2(q_1^{4*}, f[\cdot], K^* \in [0, a)) \geq \pi_2(q_1^{4*}, f[\cdot], K^* = a).$$

²¹ Subject to the requirement that total contract payments are not large enough to induce Firm 2 to build its own network.

The conglomerate imposes these constraints in choosing $\{B, C, \phi\}$.

Table 4
Nonlinear Contracts in the Presence of Bypass

Example 5:

$$I = 2, H_1[q] = 100 - q_1 - [0.7] \cdot q_2, H_2[q] = 100 - q_2 - [0.7] \cdot q_1,$$

$$c_i[q_i] = 100 + [0.5] \cdot q_i, g_i[q_i] = q_i, c_N[g] = 500 + 2 \cdot g, \text{ and } \delta(K^* / a) = (K^* / a)^{0.5}$$

	Case 2	Case 3
$f[g]$	$190g^{.31}$	$128g^{.43}$
q_1	35	37
q_2	35	33
p_1	41	40
p_2	41	41
π_1	728	748
π_2	734	680
π_N	492	499
Cong.Prof.	1220	1247
Cons.Surp.	1221	1240
Welfare	3175	3167
K^*	8.2	24
δ	0.13	0.22

The optimal contracts are described in Table 4 where, for the two-division conglomerate $\{B=0, C=190, \phi=0.31\}$ and for the integrated conglomerate $\{B=0, C=128, \phi=0.43\}$. Both contracts carry heavy discounting: in the example of the integrated conglomerate a 10 per cent increase in total network usage yields a 5.7 percent reduction in the average cost of a unit of network services. The average cost charged Firm 2 reduces by 2.7 per cent if, at equilibrium, there is a 10 per cent increase in that firm's output. Under both conglomerate structures there is some bypass.

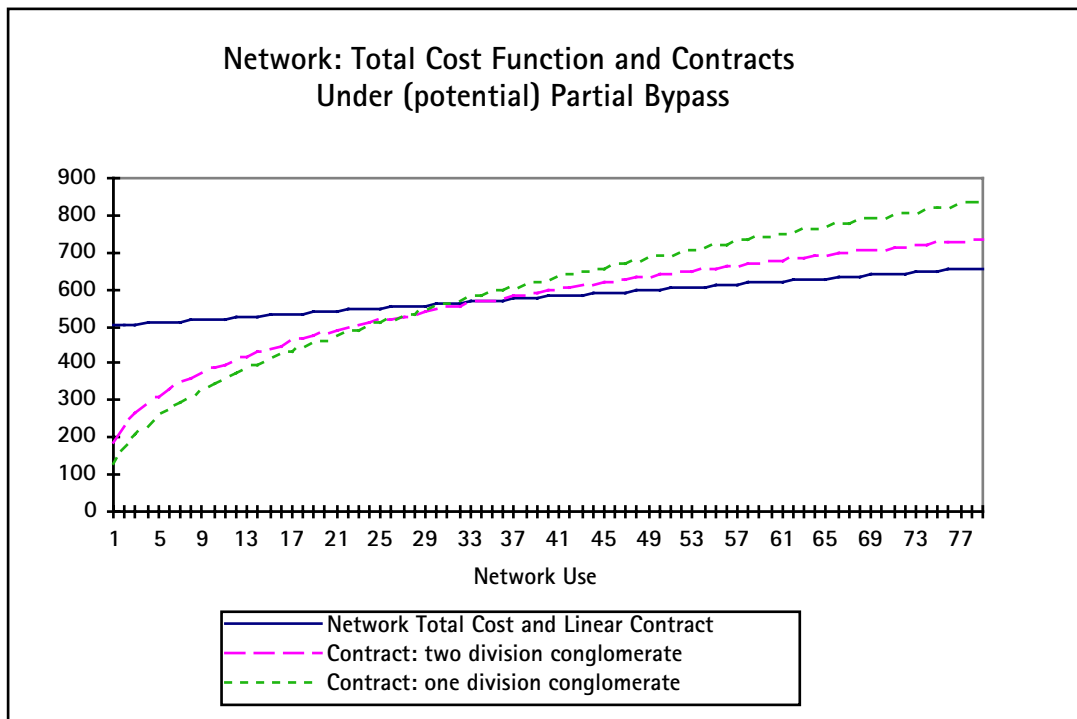
The higher marginal cost of use of the network under the contract for Case 3, as compared to Case 2, has the same rationale as for linear contracts. It is interesting that the fully integrated conglomerate produces the larger consumer surplus but has a lower total welfare, in part resulting from the greater investment in bypass. The larger consumer welfare results from the use of the marginal contract payment to restrict Firm 2's output. In the two-division conglomerate it also reduces Firm 1's output. The wider class of contracts permits the conglomerate to make higher profits under nonlinear contracts. However, notice also that Firm 2 does better under nonlinear than linear contracts in the two-division conglomerate case.

The credible potential for partial bypass also constrains the conglomerate to offer a network contract that approaches that of second-best efficient. Welfare and consumer surplus are less those associated with efficient linear contracts, but are significantly higher than Case 3 of Example 1 where partial bypass is not possible. This latter comparison understates the gain from the threat of partial bypass because under nonlinear - as opposed to linear - contracts welfare and consumers' surplus will be lower than those reported for Case 3 of Table 1.

VI Synopsis and Discussion

The contracts we have derived are summarised in Figure 1. It is evident that each contract has an access fee. Given the retail demand and cost functions, the linear network cost function of our example offers most advantage, over other plausible cost functions, to the conglomerate for the exercise of market power. The cost function of a network industry cannot be expected to be convex - that is, to have increasing marginal cost. Also, the increasing, concave, network-traffic coverage function means that the conglomerate will never choose a convex network contract. Thus the design of the concave contract trades off the degree of concavity of the cost function against that of the network coverage function. The linear cost function of our examples is the least concave cost function that can be expected in network industries. It offers the conglomerate the sharpest difference in marginal cost (payment) between the

network and the contract, and thus the most scope to cause a divergence between the two retail firms' output levels. Even here however there is little welfare or consumers' surplus lost by the private determination of the contract. If the network cost function is strictly concave then the welfare cost of any privately determined strategic pricing of the network services will carry even less welfare cost under bypass.²² The network contract chosen by the integrated conglomerate will more closely approximate the network cost function as the degree of concavity of this function increases, thus leading to even less efficiency loss in the private determination of network contracts under partial bypass.



Our analysis of imperfect competition in network industries presumes only light regulation wherein all firms must be offered the same contract for use of the network. This requirement is absolutely minimal, in that under competition law different contracts could be construed as a signal that the network owner was exploiting market dominance to inhibit competition. Thus, different contracts could predicate anti-trust actions in many countries and action by regulators in others. However, without partial bypass, as the structure moves from firms behaving independently to integrated control by a conglomerate there is a redistribution of

²² When commentators refer to long-run marginal cost in network industries they must have in mind an increasing strictly concave cost function. We reason that if our fixed and variable cost function was approximated by a strictly concave cost function that there would be much reduced scope for the integrated conglomerate to write a contract which induces different output levels for retail firms with symmetric demand and cost functions.

profits among the firms and consumers' surplus declines. The optimal contract chosen by the network shifts from a high access fee and low per-unit usage cost to one in which the usage charge is high for the integrated conglomerate as it chokes off the second firm's supply of output. The high usage charge is irrelevant to the conglomerate's retail firm as it is simply a transfer payment within the conglomerate and this firm will not base decisions upon it.²³ Indeed, we can view the integrated conglomerate case as one where despite complying with light regulation the conglomerate effectively sets a contract for itself that differs from that for other firms. Thus, a standard network contract for all network users does nothing to preclude strategic behaviour in the design of the contract, by a vertically integrated network owner, that inhibits competition and consumers' surplus.

This situation changes completely with the advent of partial bypass. Our analysis of bypass is particularly germane to telecommunications, but will be applicable to other industries where bypass is feasible and it enables other retail firms to gain access to a larger proportion of network traffic than the proportion of the physical coverage of the network provided by bypass. In this case we get a sort of contestability result in an oligopolistic game with only two entities: the conglomerate and Firm 2. Under linear contracts the conglomerate does raise the access fee over and above that which would cover the network's fixed costs, and thus the network makes a profit, but the usage charge is set at the marginal cost of the network, there is no bypass, and welfare and consumers' surplus are maximised given the imperfect nature of competition.

Notice that this outcome does not require even the minimal requirement of a common contract for all firms. We have seen that the contract does not affect the retail output choice of a vertically integrated monopolist and hence in the duopoly the contract is relevant for the competing retail firm only. Writing a second-best efficient contract under (potential) partial bypass results solely from the credibility of bypass. In short, no regulation is required under partial bypass. Indeed, under duopoly the requirement of a standard contract affects the outcome in the two-divisional conglomerate (Case 2) case. In this situation, the ability to write two contracts would enable the conglomerate to mimic the outcome of a one-division conglomerate.

Baumol and Willig (1991) argue that their ECP principle is a pricing rule that is necessary for efficiency. The rule has been most controversial, mainly on the basis that to equate the

²³ Of course this would appear as a poor profit performance of the retail division.

efficient price with the ECP as measured by existing prices struck for the network is to charge for any surplus profits, or inefficiencies characterising the network.²⁴ Much attention has been focussed on these issues within the context of network bottlenecks.²⁵ Our work suggests that where bypass is feasible bottlenecks become irrelevant: there will be little in the way of surplus profits and the network owner will have every incentive to reduce costs. Furthermore the threat posed by bypass means that if there are surplus profits to be generated they will not be imposed in the usage charge of linear contracts: the usage charge will be set at the efficient level, namely the marginal cost of the network.

[perhaps we should delete this ?] The paper is indicative that there may be efficiency conclusions which can be drawn from the shape of the contracts themselves, without investigating prices or costs. The absence of an access fee when it is known that the network cost function consists of fixed costs and constant marginal costs suggests a contract which is less in the interest of consumers than it is in the interest of both the conglomerate and other retail firms.

A feature of the discipline of partial bypass is that it renders the institutional structures of cases equally efficacious from all perspectives, but particularly that of the conglomerate. Given the possibility of partial bypass, optimal linear contracts make two and one division conglomerates yield the same outcome, and this approximately holds for nonlinear contracts. There being no market advantage in the case of linear contracts, and little advantage with nonlinear contracts, in vertical integration, the conglomerate may then choose that organisational structure which delivers, and integrates the delivery of, products or services at low cost.²⁶ It may be that this has been anticipated in telecommunications. Zielinski (1995) reports that Rochester Telephone's Open Market Plan has the objectives of supplying customers with integrated services at low cost and that it entails no vertical integration, instead, it calls for the breakup of their conglomerate into stand-alone businesses sharply focussed on their customers.

²⁴ This was the basis of the challenge of Clear Communications Ltd. (the entrant) to Telecom Corporation of New Zealand Ltd's network pricing rule (*Clear Communications, Ltd. v Telecom Corporation of New Zealand, N.Z. High Court, Decision Dec. 22 1992, Court of Appeal, Decision Dec 17 1993, United Kingdom Privy Council, Decision Oct. 1994*). The case went as far as the Privy Council where the ECP rule was upheld, the ruling being that the (potential) existence of monopoly profits and network inefficiencies were issues separate from the rule, and that, in particular, monopoly profits had to be demonstrated for the Clear case to be supported.

²⁵ Tye and Lapuerta (1995) make the notion of a bottleneck a key part of their critique of ecp.

²⁶ This remark ignores other factors - such as the informational issues treated by Mathewson and Winter (1984) - relevant to decisions about vertical integration. The range of these factors is reviewed in Perry (1989).

[*delete this para ?*] An active regulator faces additional conundrums. For example, in the absence of bypass our analysis of duopoly provides examples where welfare, even consumers' surplus, need not be a maximum under Case 1 where the network is forced to earn zero profits. This arises because, where the retail firms have very similar demand functions, the network makes more profit out of charging a usage fee which is less than network marginal cost. The extra output thus generated generates extra profit and improvements in consumers' surplus.

Empirical studies of deregulated industries suggest that actual entry, rather than potential entry, is important in affecting pricing behaviour.²⁷ Also, it is well-known that the preconditions for efficient, sustainable Ramsey pricing are exceedingly stringent (see Dixit (1982) and Brock (1983)). An outcome of our work is to suggest that, where bypass is credible, network industries under light-handed regulation can generate outcomes normally associated with perfect contestability but in oligopolistic markets with differentiated products. It may be that in practice some actual bypass is required to enhance the credibility of the potential of bypass, and hence to engender network contracts that are second-best efficient.

²⁷ See, for example, Whinston and Collins' (1992) analysis of the airline industry.

References

- Baumol, W.J., E.E. Bailey, and R.D. Willig, "Weak Invisible Hand Theorems on Pricing and Entry in a Multiproduct Natural Monopoly", *American Economic Review*, 67, June 1977, 350-65.
- Baumol, William J., and Robert D. Willig, 1992, *Brief of Evidence: Economic Principles for Evaluation of the Issues Raised by Clear Communications Ltd. on Interconnection with Telecom Corporation of New Zealand Ltd.* mimeo.
- Baumol, W. J., and Sedak, J.G. 1994, "The Pricing of Inputs Sold to Competitors", *Yale Journal of Regulation*, 11(1), 171-202.
- Berg, Sanford V., and John Tschirhart, 1988, *Natural Monopoly Regulation: principles and practice*, Cambridge University Press, Cambridge.
- Baye, Michael, R., Crocker, R., and Jiandong Ju, 1996, "Divisionalisation, Franchising, and Divestiture Incentives in Oligopoly", *The American Economic Review*, 86(1), 223-236.
- Brock, W.A., 1983, "Contestable Markets and the Theory of Industry Structure: a Review Article" , *Journal of Political Economy*, 91, 1055-1066.
- Dixit, A. 1982, "Recent Developments in Oligopoly Theory", *American Economic Review*, 72, 12-17.
- Laffont, Jean-Jacques, and Jean Tirole, 1993, *A Theory of Incentives in Procurement and Regulation*, MIT Press, Cambridge Mass.
- Laffont, Jean-Jacques, and Jean Tirole, 1994, "Access pricing and competition", *European Economic Review*, 38(9), 1673-1710.
- Mathewson, G.F., and R.A. Winter, 1984, "An Economic Theory of Vertical Constraints", *The Rand Journal of Economics*, 15(1), 27-38.
- Mitchell, Bridger, and Ingo Vogelsang, 1991, *Telecommunications Pricing: Theory and Practice*, Cambridge University Press, New York.
- Oi, Walter Y., 1971, "A Disneyland Dilemma: Two-Part Tariffs for a Disneyland Monopoly", *The Quarterly Journal of Economics*, Vol. LXXXV(1), 77-96.
- Peltzman, S. 1976, "Towards a More General Theory of Regulation, *Journal of Law and Economics*, 19, 211-40.
- Perry, Martin K., 1989, "Vertical Integration: Determinants and Effects", Ch. 4 of *The Handbook of Industrial Organisation*, Vol. 1, eds. Richard Schmalensee and Robert Willig, North-Holland, Amsterdam.

Tye, William B. and Carlos Lapuerta, 1995, "The Economics of Pricing Interconnection: Theory and Application to the Market for Telecommunications in New Zealand", paper presented at the International Telecommunications Society Interconnection Conference, Wellington, New Zealand.

Waterson, Michael, 1987, "Recent Developments in the Theory of Natural Monopoly", *Journal of Economic Surveys*, 1(1), 59-80.

Weingast, B.R., and Moran M.J., 1983, "Bureaucratic Discretion or Congressional Control? Regulatory Policymaking by the Federal Trade Commission", *Journal of Political Economy*, 91, 765-800.

Whinston M.D., and S.C. Collins, 1992, Entry and Competitive Structure in Deregulated Airline Markets: An Event Study Analysis of People Express, *The RAND Journal of Economics*, 23(4), 445-462.

Wilson, Robert B., 1993, *Nonlinear Pricing*, Oxford University Press, New York.

Zeilinski, Paul, 1995, "Rochester Telephone Competitive Market Plan", paper presented to The Telecommunications Interconnection Workshop, Wellington, New Zealand.