PRICING NETWORK INTERCONNECTION: IS THE BAUMOL-WILLIG RULE THE ANSWER?

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ABSTRACT

The Baumol-Willig Rule, also called the Efficient Components Pricing Rule, sets the price of a monopolized input used in a downstream market equal to the vertically integrated monopolist's downstream price less any cost savings to the monopolist due to its competitor's activities. The rule is shown to be complex, and under a wide range of circumstances including when product differentiation is possible, generates outcomes welfare-inferior to those brought about by simpler devices.

JEL Categories—L51, L12, D42

KEY WORDS—interconnection; regulation; access prices.

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In a widely quoted judgment, the Privy Council, on appeal from the New Zealand Court of Appeal, gave its approval to the "efficient components pricing rule" (also called the Baumol-Willig rule by common attribution, and parity pricing[1]) as a basis for the pricing of access by competitors to an essential facility controlled by a vertically integrated utility (Privy Council, 1994). This reversal of the Court of Appeal decision has given considerable further notoriety and legitimacy to the Baumol-Willig rule, and is likely to be cited by vertically integrated utilities in a range of industries as a basis for the setting of interconnection charges.

This paper therefore assesses the claims made on behalf of the Baumol-Willig rule. In addressing this task, it is logical to start with the goals which an interconnect pricing regime should seek to achieve. There are, here, three central elements.

1 Willig 1979, and Baumol 1983. The Baumol-Willig rule is actively espoused by these and others—see for example Baumol 1991, 1993; Baumol and Sidak 1994a, 1994b, Kahn and Taylor 1994. Baumol 1993 is very similar to Baumol and Sidak 1994a, and 1994b. Tye 1994, 205, argues that the Baumol-Willig rule is the avoided cost doctrine, and as such not new at all.

First, the regime should contribute to efficient resource allocation, both in the static sense of promoting the best use of existing resources but also, and perhaps most importantly, in providing appropriate incentives for improving productivity over time. In practice, encouraging dynamic efficiency is likely to be closely bound up with encouraging the development of workable and effective competition.

Second, the regime should allow for the fulfillment at least cost and with the greatest degree of transparency and accountability of any special requirements bearing on the providers. Universal service obligations (USOs) and obligations to serve should, in other words, be clearly identified, weighed against any special advantages which may have been granted to the firms responsible for their discharge, and then financed through procedures which are minimally distorting of competitive outcomes and of the competitive process.

Third, the regime should be realistic in the burdens it imposes on the regulatory process. It should, in other words, be mindful of the costs, difficulties and inherent limitations of regulatory decision making, and notably of its vulnerability to imperfect information. There is no point to designing rules for promoting efficiency and competition which could only be implemented if regulators were perfectly informed — for if they knew so much, competition itself would hardly have been needed.

Drawing on these criteria, this paper argues that the Baumol-Willig rule is severely flawed, so that the Court of Appeal's decision, at least as a matter of economics, was correct. In setting out this argument, the paper proceeds as follows. A first section explains the Baumol-Willig rule. The second section assesses the claim that the rule encourages efficient resource allocation, that is, helps secure a situation in which the prices set for goods and services best reflect the costs to society of their provision. It does this by examining the simplest case, in which the services provided by the competing firms (the owner of the "bottleneck" facility and the entrant) are homogenous — that is, competition occurs solely on the basis of price. A third section then looks at the more complex case in which competition may also occur on the basis of quality. Finally, the fourth section examines the administrative and information burden involved in implementing the rule, focusing on the claim that it is less burdensome than alternative approaches.

1 THE BAUMOL-WILLIG (EFFICIENT COMPONENTS PRICING) RULE

The Baumol-Willig (BW) rule sets the charge for the use by competitors of a component part of the facilities controlled by a vertically integrated firm. In practice, the facility of interest is that which competitors are not able to economically duplicate: local distribution (that is, transmission from the local exchange to the customer's premises) in telecommunications; the high voltage transmission network in an electrical utility; or the pipelines used to transport natural gas. If they are denied access to these facilities, which are often referred to in competition policy as "essential" or "bottleneck" facilities, competitors will not be able to compete in the downstream market — that is, in sales to final customers; the interconnection price is consequently crucial in determining the viability of competitive provision.

From the point of view of the firm controlling this facility (referred to henceforth as the incumbent), allowing competitors to use its network can involve two sets of consequences: it may impose some direct costs (for example, if the facilities being shared need to be expanded to handle the competitors' demands); and it may alter the prices that firm can charge in the final product market, reflecting the increased competitive pressure which the entry of new suppliers creates. From society's point of view, on the other hand, only the additional resources needed to handle interconnection are genuine costs — that is, withdraw resources from other uses; the reduction in charges to consumers, however painful it may be for the incumbent, is not a cost but a benefit, since it encourages those consumers who value the service at more than the cost of the resources required to produce it (but at less than the previously imposed monopoly price) to increase their consumption of the service in question.

As a result, most approaches to pricing interconnection base the interconnect charge on the direct costs which interconnection causes: that is, on the costs which the incumbent must incur so as to handle the demand arising from shared use of its facilities. The BW rule, in contrast, starts from the revenue consequences for the incumbent of allowing competitors to use its facilities; and sets the charge for interconnection on the basis of the resulting revenue loss.

In the case determined by the New Zealand High Court, for example, Clear proposed to use Telecom Corporation of New Zealand's (TCNZ's) local distribution facilities mainly for the purpose of originating and terminating long distance calls; through access to these facilities, it could provide long distance service on a ubiquitous basis, attracting traffic from all TCNZ subscribers and terminating traffic with any subscriber. At issue was how TCNZ should charge for these local transport services.

The BW rule derives this charge from the price TCNZ sets for long distance calls. It treats this amount as the basis for determining the "opportunity cost" of allowing competitive access — that is, it assumes that each time Clear carries an long distance call, TCNZ forgoes the revenue which carrying that call on the TCNZ network would otherwise have yielded. The rule notes, however, that TCNZ makes a saving from the fact that Clear itself provides some part of the facilities handling that call entails: in the specific case in question, the long distance facilities which connect the originating and terminating local exchange (or, more properly, point of interconnection). It therefore reduces the long distance price by the average incremental cost (AIC) of these facilities, so that the interconnection charge the competitor pays is the incumbent’s final product price minus the AIC of the facilities the competitor provides.

Thus, if TCNZ ’s average per minute charge for an long distance call was $NZ0.20, and the per minute AIC of the long distance component (which Clear would provide on its own behalf) was $NZ0.05, the interconnect charge for using TCNZ local network to carry long distance traffic would be set at NZ$0.15.

2 THE IMPACT ON EFFICIENCY: HOMOGENOUS PRODUCTS

In the New Zealand judgement, this amount — the incumbent’s final product price minus the AIC of the facilities the competitor provides for itself — is frequently referred to as the “opportunity cost” of interconnection. This creates a strong presumption that the charge is economically justified, since a price equal to opportunity cost will generally encourage efficient resource allocation. Yet, though it did not allow this fact to sway its decision, the Court itself notes that any identification of this amount with social opportunity cost is inappropriate.

To begin with, it is hardly sensible to assume that each call being handled by the entrant would otherwise have been handled by the incumbent. On the contrary, the entrant, to the extent to which it lowers charges or provides better service, will expand the market and increase the total number of calls. Indeed, if there are network and call externalities (so that each call made generates other calls), the increase in traffic will exceed that directly carried by the entrant.

Additionally, even putting aside these demand effects, it is only under very special circumstances that the revenue loss identified in the BW rule can be associated with social (as against purely private) opportunity cost, and hence serve as a guide to efficient resource allocation. In essence, the incumbent's initial prices must be optimal — that is, they must include no element of excess return to any input used in production, be set in such a way as to at most just cover costs, and thereby maximize the value to consumers of the consumption bundle they choose. These conditions merely say that the incumbent must already be pricing in such a way as to ensure that consumer welfare is as great as it can be, subject to the incumbent firm meeting its budget constraint.

If these conditions are met, an interconnection charge set by the BW approach will be consistent with efficient resource allocation. This is because the interconnect charge will ensure that any competitive outcome is an improvement on the previous status quo: after all, the prices being charged are already optimizing the use of society's resources; so that if the entrant can—despite the interconnect charge— set lower prices for the service it provides, while having a neutral impact on the net revenues of the incumbent, society as a whole must be better off.

This case, however, is purely of textbook interest. In practice, incumbents, notably former monopolists, operate far from the frontiers of technical efficiency, and the prices they set bear little relation to optimal pricing algorithms such as the Ramsey rule. The costs and prices which would be used as a benchmark, were a BW approach implemented, would consequently be highly distorted ones. The relevant question is the impact of the BW rule ***given*** these distortions.

The presumption must be that the final (consumer) price is too high: that it carries too high a mark-up over cost, especially when cost is defined in terms of world best practice.[2] The price being set is, in other words, a monopoly price; and though it may not be that at which the incumbents' profits are maximized, it will usually be high enough to allow excess payments to inputs, be it in the form of a supra-normal return on capital or (more usually) inefficiency in production. It is the prospect of capturing a share of these rents which attracts competitors, who naturally seek to compete in the areas where margins are greatest.

Under these circumstances, the BW rule will generally act to protect the incumbent's rents. This is most readily seen in the context of a simple model developed below. As in the TCNZ case, this model involves two firms operating in the provision of telecommunications service: an incumbent, which provides both local and long distance service; and an entrant, which seeks to use the incumbent's local service to provide competing service in the long distance market. (The restriction to a single entrant does not affect the results, since even if there were multiple entrants only the most efficient of these would determine the market outcome).

2 This is shown in the case of Telecom Australia in Ergas, Ralph and Sivakumar, 1990.

Consider first the situation in which the entrants' costs ***exceed*** those of the incumbent — for example, because it knows less about the customer base and/or has had less chance to improve its performance through "learning by doing", or simply because its start-up costs exceed what are essentially incremental costs to the incumbent. Entry may still be socially desirable if it reduces the welfare losses which monopoly would otherwise create: these losses arise from prices which unduly restrict demand[3] and from costs inflated by the lack of market disciplines.[4] Under these circumstances, however, the BW rule will prevent entry from occurring.

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3 That is, prices which dissuade some consumers from purchasing the service even though they value it at more than the cost to society of its provision.

4 It is worth noting that costs will be higher under monopoly not only because of "X-inefficiency" — that is, the wasting of resources which occurs when firms do not face competitive pressures to keep costs down — but also because the monopolist will make socially wasteful efforts (for example through investments in public relations) to buttress its privileged position. In the limiting case, a firm's entire monopoly rents could be dissipated in outlays aimed at preserving market dominance. See Tullock, 1967, and Posner, 1975.

This is readily shown with a numerical example which mirrors the main features of the more general formulation given below. The incumbent is assumed to charge a profit-maximizing price for long distance service of 20 at which it sells 100 units, securing a long distance revenue of 2000. Its total costs of providing service are 1000, of which 200 are attributable to the long distance service. As a result, the interconnect fee (which is a lump sum amount payable if the entrant takes the market) is set at 1800 (the long distance revenue of 2000 minus the attributable cost of 200). Given that the entrant's costs for providing long distance service are higher than 200, its prices must allow it to recover more than 2000 in revenue if it is to break-even — that is, they need to be higher than the prices set by the incumbent. The entrant consequently cannot compete successfully in the market.

In contrast, when the entrant's costs are ***lower*** than those of the incumbent, the BW rule will allow entry to occur — but it will preserve intact the incumbent's monopoly profits.

To see this, reconsider the example given above. Were the entrant's costs 180 (as compared to the incumbent's 200), it could seek to undercut the price of 20 the incumbent originally posted. By setting its long distance price very slightly above the original level (say from 20 to 21), the incumbent would allow entry to occur but fully retain the profits it earned as a monopolist. Facing a price of 21 the entrant as a profit maximizer would set a price of 20 just undercutting the incumbent. There would be some gain in social welfare as a result of the freeing up of the 20 resource units no longer needed to supply long distance service; but the welfare losses arising from the monopoly pricing of the long distance service would remain intact.

In short, the BW rule does little to allow the welfare gains which competition is intended to bring. Are there alternatives which perform better?

Even relatively simple interconnect rules can be shown to meet this test. Consider, for example, a rule which defines the interconnect fee as the difference between the revenues generated by the local service and its costs — that is, as the lump-sum amount by which local service revenues (for connections and local calls) fail to cover local service costs.[5] Three outcomes can be shown to flow from such a rule: prices in the long distance market are just sufficient to cover this fee plus the avoidable costs of long distance service; competition can occur in both price and quality without the perverse incentives generated by the BW rule; and there is no incentive for the entrant to wastefully duplicate the incumbent's long distance infrastructure.

These points can be more formally demonstrated.[6] In the model an incumbent and one or more entrants compete to supply long distance. It is assumed monopoly provision is profitable, and demand is standard (see below). Incumbent's commonly claim they need downstream, e.g. long distance profits, to cover losses incurred on the upstream access network—the access deficit. To

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5 It is not important for this purpose whether the short-fall results from a deliberate cross-subsidy or merely from the fact that demand for local service alone is insufficient to cover the stand-alone costs of that service. Treating the amount as a lump-sum avoids the disincentive effects which would occur were these fixed costs converted into a per-unit tax (since such a tax would reduce the number of units of the down-stream commodity ultimately sold).

6 The following material is largely drawn from Ralph 1996. The underlying model comes from Chapter 2, while the application to the BW rule is from Chapter 3.

allow for this, it is assumed provision of local telephony is not profitable as a stand-alone operation. In the case that the incumbent is the most efficient provider, it is also assumed that some entrant's costs are still low enough that at monopoly prices it can profitably fund that part of the access deficit which is unavoidable.

(i) Demand.

No assumptions are made about demand in the upstream market, $\Delta(.)$.[7]

The long distance price, p, is assumed to be an integer multiple of δ (discrete prices are used to ensure agents' best response functions are well-defined).

Demand is given by a strictly decreasing function, D(p), with the properties:

there exists a $\bar{p} < \infty$ such that $D(\bar{p}) = 0$; and

[7] With the exception of δ, ε, and $\chi(.)$ Greek letters refer to the local market

total revenues in the long distance market pD(p) are single-peaked, that is

$$p^1 < p^2 \leq p^M \qquad p^1D(p^1) < p^2D(p^2) \text{ for all } p^1 \text{ and } p^2,$$
$$\text{where } p^MD(p^M) \equiv \max_p pD(p) \equiv m,$$

and

$$p^M \leq p^3 < p^4 \qquad p^3D(p^3) > p^4D(p^4) \text{ for all } p^3 \text{ and } p^4.$$

Define the set of entrants {1, 2,.., E} indexed e, but allow E to be as small as 1; $\underline{p}_e = \min_e p_e$ for e {1, 2,..., E}; $\underline{E}$ as the number of entrants with price $\underline{p}_e$; $\underline{p} = \min(p_i, \underline{p}_e)$; and $\chi(.)$ be the function which equals 1 when its argument is true, and 0 otherwise.

Demand splits in the usual Bertrand fashion: For e {1, 2,..., E}:

$$D_i(p_i, p_1, p_2,..., p_E) = \begin{cases} D(p_i) & \text{when } p_i < \underline{p}_e \\ D(p_i)/(\underline{E} + 1) & \text{when } p_i = \underline{p}_e \\ 0 & \text{when } \underline{p}_e < p_i; \end{cases}$$

and

$$D_e(p_i, p_1, p_2,..., p_E) = \begin{cases} D(p_e)/(\underline{E} + \chi(p_i = \underline{p}_e)) & \text{when } p_e = \underline{p}_e \leq p_i \\ 0 & \text{when } \underline{p} < p_e. \end{cases}$$

Thus: $$D(\underline{p}) = D_i(p_i, p_1, p_2,..., p_E) + \sum_{e=1}^{E} D_e(p_i, p_1, p_2,..., p_E).$$

(ii) Costs.

A key function of any interconnect mechanism is that it must be sustainable, this is it must ensure that revenues can be picked up in the long distance market to cover perhaps mandated short-falls in the local market. To focus on this problem, the incumbent is assumed to face a fixed, annualized, and sunk cost, κ, for local telephony, being the minimum best-practice replacement cost of the local network given any imposed social programs.[8]

Let μ be maximum monopoly revenues subject to legal and regulatory constraints in the local market, including any social access, pricing, and provision requirements. It is further assumed that

$$\rho \leq \mu < \kappa \qquad \text{(A1).}$$

This constitutes the interesting case—with an access deficit (A1 $\kappa - \rho < 0$) even an efficient incumbent needs downstream profits to ensure cost coverage.[9]

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8 The incumbent's actual costs may be higher if some of its factors of production claim some of the industry's monopoly rents, as is not uncommon when the incumbent's position in the local market is protected by statute. Such costs, however, may be treated as monopoly rents.

9 The restriction $\mu < \kappa$ may be relaxed without loss to what follows, however, A2 below must explicitly require $c_i - \kappa < m$ (downstream provision is profitable to the incumbent as a monopolist), and A4 should be weakened to $m > \underline{c}_e + \max(\kappa - \mu, 0)$.

It is assumed the marginal cost of a telephone call is zero (as is likely—see e.g. Brock 1995) so the total cost to the incumbent of supplying local and long distance service may be indicated by c_i. Despite this, much of what follows may be generalized to allow for non-zero marginal costs.

Monopoly provision by the incumbent in both markets is assumed to be profitable, that is:

$$0 < \kappa + c_i < \mu + p^M D(p^M)$$

$$\text{where } p^M D(p^M) = \max_p pD(p) - c_i \qquad \text{(A2).}$$

A1 and A2 imply $c_i + \kappa < p^M D(p^M)$.

Entrants respectively pay fixed costs, $c_1, c_2, \ldots, c_E$ to provide long distance. Let $\underline{c}_e = \min(c_1, c_2, \ldots, c_E)$.

If there are economies of scope in the incremental provision of long distance then

$$c_i - \kappa < \underline{c}_e \qquad (A3),$$

that is, the incumbent's incremental costs are less than the least cost entrant's start-up costs before interconnection fees. This is very reasonable. The contrary

$$\underline{c}_e \leq c_i - \kappa \qquad (\sim A3)$$

occurs if there are *dis*economies of scope between local and long distance calling (though switching, billing, advertizing, interconnection standards etc. all suggest the opposite), which cannot be avoided by operating separate subsidiaries, or some entrants have access to technology not available to the incumbent.

It will be convenient to strengthen ~A3:

~A3 and at least two entrants with long distance costs $\underline{c}_e$ (~A3').

Allowing at least two entrants with costs $\underline{c}_e$ is not controversial if it is believed that the downstream market is capable of supporting competition.

Finally, if A3 holds (note A2 and ~A3 A4), $\underline{c}_e$ is assumed to be sufficiently small that, ignoring interconnection fees, some entrant can at monopoly prices profitably provide long distance while subsidizing the local market, that is:

$$\underline{c}_e + \kappa - \mu < m \qquad \text{(A4).}$$

This ensures an entrant can provide effective competition.

(iii) Version 1—The unregulated game.

The players. There is an incumbent and some entrants, respectively subscripted i and 1, 2,..., E.

The strategies. The game has two stages. In the first the incumbent chooses its local retail pricing structure, generating local call revenues, ρ [0, μ]. The incumbent also announces an interconnect charge, γ [0, ∞), being a per call (or call minute etc.) charge for terminating the entrant's long distance traffic. In the second stage, the incumbent and each entrant simultaneously and respectively choose long distance prices, p_i, p_1, p_2,..., p_E (0, δ, 2δ, 3δ,..., $\bar{p}$).

The players' objective functions.

The incumbent's profit function is:

$$u_i(\gamma, p_i, p_1, p_2,..., p_E) = \rho + p_i D_i(p_i, p_1, p_2,..., p_E) + \gamma\sum_{e=1}^{E} D_e(p_i, p_1, p_2,..., p_E) - \kappa - \chi(p_i = \underline{p})(c_i - \kappa),$$

while the e {1, 2,..., E} entrants' profits are:

$$u_e(\gamma, p_i, p_1, p_2,..., p_E) = (p_e - \gamma)D_e(p_i, p_1, p_2,..., p_E) - \chi(p_e = \underline{p})c_e$$

For notational simplicity, sometimes some of the arguments of u_i, u_e, D_i, and D_e, for e {1, 2,..., E} will be suppressed.

Let SPE* indicate a sub-game perfect equilibrium (SPE) with no dominated strategies used in the Nash equilibrium of any round.

It is a straight forward matter to show that the industry, if unregulated, generates a sub-optimal outcome.

Proposition 1. The SPE* of the unregulated game is unique in price and profits—the monopoly price p^M prevails and the incumbent earns maximal industry profits, the community incurring the usual dead weight monopoly losses. Under A3' the incumbent excludes entry; under ~A3' the incumbent allows entry.

Proof: See Proposition 1 of Ralph 1996

If A3 is replaced by the assumption that solo production on the part of the incumbent maximizes industry profit, the proof holds with perfectly general costs functions. A version of the proposition also holds for the remaining case, ~A3 with only one least cost entrant, but requires the incumbent be granted a first mover advantage in setting long distance prices. A similar equilibrium can emerge even when there is a single least cost entrant and the incumbent does not have a first mover advantage, but it is no longer unique (for this and other variations see Appendix A.I). With more general cost functions and ~A3 there *may* be no equilibrium with entry, and possibly no equilibria at all.

(iv) Version 2—The BW regulated game.

Under the BW rule the incumbent announces its long distance price. This allows the interconnection fee to be determined. The regulator estimates the incumbent's average incremental cost (AIC) of long distance calling—no simple task as discussed below—and this is subtracted from the incumbent's long distance price.[10] The interconnection fee is then the incumbent's long distance price less the AIC.

For simplicity first assume demand is perfectly inelastic up to p^M, that is, $D(p) = D$ for all $p \leq p^M$, and then falls to zero. AIC on the incumbent's network are then $(c_i - \kappa)/D$. If the incumbent continues to charge p^M the interconnect charge that the entrant faces is $p^M - (c_i - \kappa)/D$, and it cannot profitably enter the market: $m < c_e + m - c_i + \kappa$ by A3.

This result extends *a fortiori* to the more general demand conditions assumed above.

Proposition 2. The BW rule maintains the monopoly price, p^M, and guarantees the incumbent at least the profits it could earn in

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10 It is not clear whether the incumbent's own AIC where its operations are not efficient, or the least cost AIC, should be used in this estimation. It turns out this distinction is unimportant for the model presented here. As a result the least cost AIC is used rather than the incumbent's actual AIC.

the absence of an entrant, $\mu + m - c_i$. Its outcomes only differ from those of no regulation if there are diseconomies of scope ($\underline{c}_e < c_i - \kappa$) *and* a single entrant, both of which are unlikely, particularly in telecommunications. In this case the incumbent earns $\mu + m - c_i$ rather than $\mu + m - \kappa - \underline{c}_e$ and the entrant claims the difference, $c_i - \kappa - \underline{c}_e$.

Proof: Lemma 1a provides the case when there are no diseconomies of scope between local and long distance production, i.e. $c_i - \kappa \leq \underline{c}_e$. Lemmas 1b and 1c deal with the case of diseconomies of scope, $\underline{c}_e < c_i - \kappa$, respectively when there is a single entrant, and multiple identical entrants.

Lemma 1a. At the SPE under the BW rule when $c_i - \kappa < \underline{c}_e$ the incumbent excludes entry and earns monopoly profits, $\mu + m - c_i$, that is social welfare is unchanged from the unregulated case.

Proof: Any announced price by the incumbent makes entry unprofitable: if an entrant were to supply long distance (that is, $p_e \leq p_i$) its profits would be $(p_e - p_i)D(p_e) - c_e + c_i - \kappa < 0$ for $p_e < p_i$ ($\gamma = p_i - (c_i - \kappa)/D(p_e)$), or $(p_e - p_i)D(p_e)/2 - c_e < 0$ for $p_e = p_i$ ($\gamma = p_i$).

The incumbent therefore simply chooses p_i to maximize its profits. At equilibrium $p_i = p^M$, and $\underline{p}_e > p^M$ (entry does not occur), $u_i = \mu + m - c_i$, and $u_e = 0$ for all e {1, 2,..., E}.

Comments:

- This result is also a Nash of the one-shot game where the incumbent must announce its long distance price simultaneously with the entrant (the entrant does not know the interconnect price before announcing its long distance price).

- The proof holds with perfectly general cost functions if A3 is replaced with the assumption that industry profits are maximized by solo production on the part of the incumbent. Define the jth firm's total long distance costs $C_j(.)$, a function of output, such that $C_j(0) = 0$, and $C_j(q) < C_j(q')$ for $q < q'$, and redefine $p^M = \arg\max_p pD(p) - C_i(D(p))$, and let $p^M D(p^M) - C_i(D(p^M))$ maximize industry profits. It is easy to show any entrant's profits are negative whenever it sets the lowest price and $p_i = p^M$:[11]

$$u_e = p_e D(p_e) - C_e(D(p_e)) - p^M D(p_e) + C_i(D(p^M)) - C_i(D_i(p^M, p_e))$$

$$\leq p_e D(p_e) - C_e(D(p_e)) - p^M D(p_e) + C_i(D(p^M)) - \kappa$$

$$< p_e D(p_e) - C_e(D(p^M)) - p^M D(p_e) + C_i(D(p^M)) - \kappa$$

[11] If average costs decline at all, e.g. due to a fixed cost, this holds *a fortiori* when the market is shared, including when $p_e = p^M = p_i$.

< 0 (since $p_e D(p_e) - p^M D(p_e) < 0$, and $p^M D(p^M) - C_e(D(p^M)) + \kappa < p^M D(p^M) - C_i(D(p^M))$ by definition).

Thus by setting a price $p_i = p^M$ in the game's first round entry is made unprofitable.

(v) Reversing the cost advantage to favor the entrant.

Consumer welfare is also unaffected in the unlikely case that ~A3 holds ($c_e \leq c_i - \kappa$). However, under the BW rule, if there is a single least cost entrant, it at least claims some market rents, providing an incentive for investment in cost reduction. This is not true if the market is contestable, i.e. there are at least two least cost entrants. Proponents of the BW rule also note it promotes technically efficient entry.[12] While this is true (Lemmas 1b and 1c below), this is also true of the unregulated case (see

12 Baumol, 1993, 76 ff; Kahn and Taylor, 1994, 226, 229; McCormick, 1995, 13-4; Privy Council, 1994, 396, 397, 407.

Proposition 1, and Lemmas 1A and 2A of Ralph, 1996). In any case, welfare may be improved by technically *in*efficient entry since this reduces the allocative inefficiencies of monopoly pricing engendered by the BW rule (Economides & White, 1995).

Lemma 1b gives the case of a single entrant with lower costs than the incumbent, and Lemma 1c the case when there are at least two potential lower cost entrants. In both cases monopoly profits are perpetuated.

Lemma 1b. Under the BW rule for δ arbitrarily small, if $c_e < c_i - \kappa$, and there is a single entrant, then the unique SPE of the game is $p_i = p^M + \delta$, and $p_e = p^M$, with $u_e = (c_i - \kappa) - c_e$, and $u_i = \mu + m - c_i$ (monopoly profits).

Proof: If $p_e > p_i$, then $u_e = 0$.

If $p_e < p_i$, then $u_e = (p_e - \gamma)D(p_e) - c_e = (p_e - p_i)D(p_e) + c_i - \kappa - c_e$, which is maximized by $p_e = p_i - \delta$, being $-\delta D(p_e) + c_i - \kappa - c_e > 0$ for δ small.

If $p_e = p_i$ then $u_e = (c_i - \kappa)/2 - c_e$, which is less than $-\delta D(p_e) + c_i - \kappa - c_e$ for sufficiently small δ.

Thus for δ small, the entrant will set $p_e = p_i - \delta$ in the game's second stage.

The incumbent's profit in the game's second stage then is $\mu + \gamma D(p_e) - \kappa = \mu + p_i D(p_i - \delta) - c_i$, which is maximized by $p_i = p^M + \delta$, giving $u_i = \mu + m + \delta D(p^M) - c_i$: The incumbent wishes to maximize $p_i D(p_i - \delta)$. Setting $p_i = p^M$ delivers $p^M D(p^M - \delta) < m$; setting $p_i = p^M + \delta$ delivers $(p^M + \delta)D(p^M) = m + \delta D(p^M)$ and setting $p_i = p^M + 2\delta$ delivers $(p^M + 2\delta)D(p^M + \delta) = (p^M + \delta)D(p^M + \delta) + \delta D(p^M + \delta) < m + \delta D(p^M)$.

The BW rule then delivers an important benefit in the case that there are diseconomies of scope between local and long distance *and* a single entrant—the low cost entrant is rewarded for its efficiency by Bertrand profits (the difference between its own and its rival's costs), thereby strongly encouraging cost reduction. Unfortunately, this benefit does not obtain if there are no diseconomies of scope between local and long distance (Lemma 1a), or if there is more than one potential entrant:

Lemma 1c. Under the BW rule, if $\underline{c}_e < c_i - \kappa$ and there are two or more least cost entrants then the unique SPE of the game is p_i such that $p_i D(p^M) = m + (c_i - \kappa) - \underline{c}_e - \varepsilon$ (ε small and positive), $\underline{E} = 1$ and $\underline{p}_e = p^M$, with one entrant earning δ and all others 0, and $u_i = \mu + m - \kappa - \underline{c}_e$.

Proof: The incumbent can earn arbitrarily close to maximal industry profits, $\mu + m - \kappa - \underline{c}_e$, by setting p_i in the first round such that $p_i D(p^M) = m + (c_i - \kappa) - \underline{c}_e - \varepsilon$.

The only Nash in the second round has a least cost entrant setting price p^M ($< p_i$), with all other entrants' prices exceeding this. Such entry is profitable—$u_e = (p^M - p_i)D(p^M) + (c_i - \kappa) - \underline{c}_e = m - m - (c_i - \kappa) + \underline{c}_e + \delta + (c_i - \kappa) - \underline{c}_e = \varepsilon$—but not sufficiently so to invite further entry—if $p_e = p^M - \delta$, $u_e = (p^M - \delta - p_i)D(p^M - \delta) + (c_i - \kappa) - c_e < (p^M - \delta)D(p^M - \delta) - m + \varepsilon < -\delta D(p^M - \delta) + \varepsilon < 0$ for sufficiently small ε (and similarly if the market is shared).

Despite the failure of the BW rule to improve social welfare where there are diseconomies of scope (illustrated by Lemmas 1b and 1c), it may lead to welfare improvements over the unregulated case in two circumstances: (a) if there is a single entrant, and the incumbent does not have a first mover advantage, since the equilibrium price in this case *can* exceed p^M—see Ralph 1996, Appendix A.1, or (b) if it is profitable for the incumbent to exclude entry (not so in the model of this paper, but see Whinston 1990, Hart and Tirole 1990; Rey and Tirole 1996).

(vi) Welfare improvements may be brought by alternative mechanisms.

This sub-section illustrates that a wide range of lump sum and per unit interconnection fees increase social welfare (by differing amounts) without forcing the incumbent to operate at a loss, or allowing inefficient entry. This provides regulators with a wide margin of error in choosing these interconnection fees, and so they may be implemented with relatively poor information. A third mechanism—the local cap—also has these characteristics for implementation (see Ralph 1996).[13] In contrast, it was shown in the previous sections that while the BW rule does ensure both

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13 Of these mechanisms the local cap is the least demanding informationally, arguably followed by the lump sum fee (see Ralph 1996).

that the incumbent is able to cover local network costs, and entry by the least cost supplier, it fails to increase social welfare.

Define:

p^B as the smallest $p|\ pD(p) \geq \kappa - \mu + c_e$; and

p' as the smallest $p|\ \mu + pD(p) - c_i = 0$.

Proposition 3 shows that both a lump sum and fixed fee may be estimated with a wide range of error and still lead to welfare increases over the unregulated case without forcing losses on the incumbent. The proposition is given for the case when there are no diseconomies of scope between up- and downstream markets ($c_e \leq c_i - \kappa$). When the contrary is true the proofs are virtually identical, but require the existence of at least two entrants, one of which supplies long distance. In addition, the respective lower bounds for the lump sum fee, Γ, should be $\kappa - \mu$ rather than c_i -

$\mu - c_e$, and of the fixed per unit fee, γ, $(\kappa - \mu)/D(p^B)$ not $c_i - \mu - c_e/D(p')$.

Proposition 3. For δ sufficiently small and $c_e \leq c_i - \kappa$, any lump sum interconnect fee, Γ $[c_i - \mu - c_e, m - c_e)$, and any fixed per unit interconnect fee, γ $[c_i - \mu - c_e/D(p'), m - c_e/D(p^M))$ will ensure the least cost producer supplies long distance, the deficit in the local call market is always covered, and price lies below p^M, that is social welfare is improved over the unregulated game.

The proposition is proved through Lemmas 2a and 2b and their corollaries.

The Lump Sum Game.

For simplicity only two players are considered. In the first round of the *Lump Sum Game* the incumbent is assumed to maximize local market revenues ($\rho = \mu$) and a lump sum interconnect fee, Γ, is set by the regulator. Then both players simultaneously choose long distance prices.

Lemma 2a. At the Lump Sum Game's unique SPE* when $c_i - \kappa < c_e$, $\Gamma < m - c_e$, and for δ small, the incumbent supplies long distance ($p_i < p_e$), p_i ($< p^M$) equals the smallest $p|\ pD(p) - \Gamma - c_e > 0$, and u_i is close to $\mu + \Gamma + c_e - c_i$ ($< \mu + m - \kappa$).

Proof: Only if $\Gamma < m - c_e$ can entry ($p_e < p_i$) be profitable to the entrant (e.g. if $p_e = p^M < p_i$).

Entry will not occur if p_i is no larger than the smallest $p|\ pD(p) - \Gamma - c_e > 0$ for δ small by the elimination of weakly dominated strategies (for any $\Gamma \geq 0$, any p_e less than or equal to the smallest $p|\ pD(p) - \Gamma - c_e > 0$ is weakly dominated by $\bar{p}$ for δ sufficiently small—proof similar to

Lemma 1, Chapter 2). This implies if $\Gamma > m - c_e$ the incumbent can behave as an unconstrained monopolist—$p_i = p^M < p_e$ at the game's SPE*.

Subject to entry $\max u_i \leq \mu + \Gamma - \kappa$.

Subject to no entry, u_i is maximized by the smallest $p|$ $pD(p) - \Gamma - c_e > 0$ (since the revenue function is single-peaked and such a $p < p^M$). Thus

subject to no entry $\max u_i = \mu + pD(p) - c_i > \mu + \Gamma + c_e - c_i > \mu + \Gamma - \kappa$ (by A3),

so the incumbent, and entrant, will price as indicated in the Lemma.

Corollary to Lemma 2a: If $\Gamma < c_i - \mu - c_e$ then $u_i < 0$ for δ sufficiently small ($\max u_i = \mu + pD(p) - c_i$ approaches $\mu + \Gamma + c_e$

$- c_i$ (< 0) as δ does zero). As a result social welfare is improved and cost recovery ensured when $\Gamma \quad [c_i - \mu - c_e, m - c_e)$.

The Fixed Per Unit Fee Game.

Again for simplicity only two players are considered. In the first round of the *Fixed Per Unit Fee Game*, the incumbent is assumed to maximize local market revenues ($\rho = \mu$) and a per call (call minute, etc.) interconnect fee, γ, is set by the regulator. Then both players simultaneously choose long distance prices.

Lemma 2b. For δ sufficiently small and $c_i - \kappa < c_e$, any fixed per unit interconnect fee, $\gamma \quad [c_i - \mu - c_e/D(p'), m - c_e/D(p^M))$, will ensure the least cost producer supplies long distance, the deficit in the local call market is always covered, and price lies below p^M, that is social welfare is improved over the unregulated game.

Proof: Consider $\gamma < m - c_e/D(p^M)$. The arguments of Lemma 2a follow for the Fixed Per Unit Fee Game, and an equivalent corollary holds for $\gamma = c_i - \mu - c_e/D(p')$.

3 THE BW RULE WITH PRODUCT DIFFERENTIATION

All of this is premised on the assumption that the entrant and the incumbent compete solely on price, which is rarely the case. Rather, account must also be taken of the possibility of ***competition in quality***, for example as firms opt for differing levels of investment in after-sales service.

The BW rule continues to perform poorly in such circumstances. Not only is it again outperformed in terms of social welfare by simple alternative mechanisms, but it can lead to an outcome worse than the monopoly outcome which arises if the industry is not regulated at all:

(i) all consumers pay more (because the incumbent raises its long distance price above the unregulated monopoly price);

(ii) the entrant is excluded (because the rise in the long distance price increases the interconnect fee by an amount sufficient to offset any gain the entrant could make from targeting high-end consumers);

(iii) the incumbent does not invest in increasing service quality (since this is not required for it to maintain market share).

The key factor here is that the BW rule essentially makes price competition irrelevant (Lemmas 1a-c). This section then expands the strategy spaces of the incumbent and entrant to allow competition in quality as well as price. It then compares the BW rule in this more complex environment with alternative approaches. Proposition 4 gives the extent of the failure of the BW rule in this case:

Proposition 4. Under the BW rule, allowing competition in quality as well as price affects social welfare ambiguously compared with no regulation. On the other hand a simple lump sum tax designed to cover the access deficit never reduces welfare, and in most cases improves it.

Proof: Lemma 3 gives the unregulated outcome. The impact of the BW rule is Lemmas 4a and 4b give the outcome under the BW rule, and Lemma 5 for the lump sum interconnection fee.

(i) The model with quality.

The model is as before, except the game has three stages—in the first the incumbent chooses γ, in the second the firms simultaneously announce long distance quality, and in the third long distance prices. This captures the idea that quality is less readily adjusted than price (see for example Shaked and Sutton 1982, 3).

For simplicity, quality is assumed to be binary k {0, 1}, where the cost of quality is given by $f(0) = 0 < f(1)$. Again long distance costs are only incurred if the firm experiences positive demand. Demand is assumed to strictly increase with quality at all prices: let demand be given by, abusing notation slightly, D(p, k), where D(p, 0) = D(p) as defined before, and D(p, 1) > D(p, 0) for all p, but otherwise has in price the same characteristics as D(p, 0).

Several definitions will be helpful. Let

p^{Mk} = arg $\max_p$ pD(p, 1),

$m^k = \max_p$ pD(p, 1),

p^{Bk} be the smallest p| pD(p, 0) ≥ $c_e + \kappa - \mu + f(1)$,

and

s(p, k) represent consumer surplus at price p and quality level k.

As before let subscripts i and e indicate the incumbent and entrant.

The market is split equally between the incumbent and entrant if is(p, k) = s_e(p', k').

Preserve assumptions A1-A4, and additionally assume

$$m_k > c_e + \kappa - \mu - f(1) \qquad \text{(A5),}$$

that is, $f(1)$ is sufficiently small that the entrant can profitably provide long distance service with quality while subsidizing the local market.

(ii) The unregulated game with quality—Monopoly emerges.

In the first round the incumbent announces ρ. In the second both the incumbent and entrant announce their intended investments in long distance quality, k_i, and k_e. In the third, both parties announce their long distance prices, p_i and p_e.

Lemma 3. An unregulated incumbent prices to exclude its downstream rivals in order to claim monopoly profits: $\rho = \mu$ in the local market, and in long distance $p_i = p^M$ if $m > m^k - f(1)$ and otherwise sets $p_i = p^{Mk}$.

Proof: The proof is straight forward, and virtually identical to that of Proposition 1 in Ralph 1996.

(iii) The simple BW rule.

The game under the BW rule is even simpler than the unregulated game, though the determination of the efficient component price (ECP) itself is more complex. In the first round the incumbent announces its long distance price (ρ is assumed to be set to μ). This determines the ECP (but see discussion below). In the second round both players announce the quality levels at which they intend to produce. Finally, the entrant announces its long distance price.

In Lemmas 4a and 4b a strict extension of the BW rule is used. That is investment in quality, $f(1)$, can only be an incremental opportunity cost saved by the incumbent due to entry if the incumbent would provide quality in an unregulated market, that is if $m_k - f(1) \geq m$. It turns out, however, that Lemmas 4a and 4b are not effected if quality is not featured in estimation of the

ECP (for example, if the regulator feels that it cannot guess what kind of quality investment would be made by an unregulated incumbent).

Lemma 4a. If $s(p_e, k_e) \geq s(p_i, k_i)$ and either $k_e \leq k_i$ or $p_e \leq p_i$ then $u_e < 0$ at equilibrium.

Proof: $s(p_e, k_e) \geq s(p_i, k_i)$ implies entry. $s(p_e, k_e) \geq s(p_i, k_i)$ and $k_e \leq k_i$ imply $p_e \leq p_i$. By proof virtually identical to that of Lemma 2, entry and $p_e \leq p_i$ imply $u_e < 0$.

Lemma 4b. Under the BW rule the SPE* only raises social welfare over the unregulated case, if: $m_k - f(1) < m$; there exists $p|\ pD(p, 1) \geq p^M D(p, 1) - c_i + \kappa + c_e + f(1)$; and $s(p, 1) \geq s(p^M, 0)$. However, social welfare may also be diminished in this circumstance.

Proof: Case 1: If $m_k - f(1) \geq m$ then by the elimination of weakly dominated strategies the incumbent earns cartel profits $\mu + m_k - c_i - f(1)$, by setting $p_i = p^{Mk}$, and $k_i = 1$; and the entrant sets $p_e > p^{Mk}$ (by Lemma 4a entry cannot be profitable, thus any $p_e \leq p^{Mk}$ is weakly dominated by $\bar{p}$ which guarantees $u_e = 0$).

Case 2: *If* $m_k - f(1) < m$ *and*

there exists *no* $p|\ pD(p, 1) \geq p^M D(p, 1) - c_i + \kappa + c_e + f(1)$ *and* $s(p, 1) \geq s(p^M, 0)$ (**)

then by the elimination of weakly dominated strategies in the third round the incumbent earns cartel profits by setting $p_i = p^M$, and $k_i = 0$: If the entrant sets $k_e = 0$ entry is ruled out by Lemma 4a and any $p_e \leq p^M$ is weakly dominated by $\bar{p}$; if k_e is set to 1 entry is ruled out by (**) because for some p either $s(p, 1) < s(p^M, 0)$ or $pD(p, 1) < p^M D(p, 1) - c_i + \kappa + c_e + f(1)$ and such a p is weakly dominated by $\bar{p}$.

Cases 3 and 4: *If* $m_k - f(1) < m$ and (**) does not hold *then* two further possibilities emerge. Consider the four possible situations faced by the entrant in the third stage of the game when it must announce p_e:

(1) $k_i = k_e = 1$. By Lemma 4a entry is not an equilibrium strategy and Case 1 applies.

(2) $k_i = k_e = 0$. By Lemma 4a entry is not an equilibrium strategy and Case 2 applies.

(3) $k_i = 1$ and $k_e = 0$. By Lemma 4a entry is not an equilibrium strategy and Case 1 applies.

(4) $k_i = 0$ and $k_e = 1$. Entry can occur if p_i is sufficiently high (for example if $p_i \geq p^M$, since (**) does not hold).

Let p*, if it exists, maximize pD(p, 0) subject to p'D(p', 1) $< p^* D(p', 1) - c_i + \kappa + c_e + f(1)$ *or* $s(p', 1) < s(p^*, 0)$ for all p', that is p* maximizes the incumbent's profit subject to no entry. Notice it is possible that $p^* > p^M$ since this raises the entrant's costs. Thus by choosing p* and then $k_i = 0$, the incumbent guarantees profit $u_i = \mu + p^*D(p^*) - c_i$.

It is now shown that allowing entry (which is only possible in situation 4) is not an equilibrium strategy.

> The incumbent can guarantee profits of $\mu + m_k - c_i - f(1)$ by setting $k_i = 1$ (guaranteeing situation 1 or 3) and hence $p_i = p^{Mk}$.
>
> If entry occurs the incumbent's profits are strictly less than this:

If p_i is chosen so that entry could be profitable (when $k_i = 0$, $k_e = 1$ under situation 4) then either

$$s(p_e, 1) > s(p_i, 0) \text{ and } u_e = (p_e - p_i)D(p_e, 1) + c_i - \kappa - c_e - f(1) \geq 0$$

or

$$s(p_e, 1) = s(p_i, 0) \text{ and } u_e = (p_e - p_i)D(p_e, 1)/2 - c_e - f(1) \geq 0.$$

In the first case the incumbent's profits are:

$$\mu + \gamma D(p_e, 1) - \kappa$$

$$= \mu + p_i D(p_e, 1) - c_i + \kappa - \kappa$$

$$\leq \mu + p_e D(p_e, 1) - \kappa - c_e - f(1) \qquad \text{since } u_e \geq 0 \text{ (i.e. entry is profitable)}$$

$< \mu + m_k - c_i - f(1)$ by A3;

in the second case the incumbent's profits are:

$\mu + p_i D(p_i)/2 + \gamma D(p_e)/2 - c_i$

$= \mu + p_i D(p_i)/2 + p_i D(p_e, 1)/2 - c_i$

$\leq \mu + p_i D(p_i)/2 + p_i D(p_e, 1)/2 - c_e - f(1) - c_i$ since $u_e \geq 0$

$< \mu + m_k - c_i - f(1)$ by $m < m^k$ and A3.

By backward induction the incumbent will choose (Case 3) p^* in the first round if $\mu + p^*D(p^*) - c_i \geq \mu + m_k - c_i - f(1)$, and $k_i = 0$ in the second. Otherwise (Case 4) it will chose $p_i = p^{Mk}$ and $k_i = 1$. The entrant in all cases earns zero profits. In both cases social welfare may improve compared with the unregulated case, but it may worsen (in Case 3 welfare improves only if $p^* < p^M$; in Case 4 if p^{Mk} exceeds the price defined in (**) welfare may fall, but otherwise is improved).

(v) Alternative interconnect mechanisms bring greater welfare than the simple BW rule.

Finally it remains to show that setting simple interconnect fees gives welfare superior outcomes to the BW rule. In particular, consider a lump sum interconnect fee of $\kappa - \mu$ to be levied on successful entry and paid to the incumbent, unless the market is shared, in which case $(\kappa - \mu)/2$ is levied. The game has two rounds. In the first quality is announced, and in the second price (it is assumed ρ is set to μ).

Lemma 5. Under a lump sum interconnect fee, for δ small, and with the elimination of weakly dominated strategies in the second round, social welfare is generally improved compared with the unregulated case, and never is worse.

Proof: The game's second round may begin in one of four ways depending on the players' quality selections. In each case, the elimination of weakly dominated strategies leaves a unique Nash. This allows the first stage of the game (quality selection) to be modelled as a normal form game. The four possibilities at the game's second stage are:

(1) $k_i = k_e = 1$: By proof similar to that of Lemma 1, the Nash after the elimination of weakly dominated strategies, is unique: $p_i = p^{Bk}$ (the lowest price that prevents entry), $p_e = p^{Bk} + \delta$, the incumbent's profits are, for sufficiently small δ, $c_e - c_i + \kappa$, and the entrant's zero.

(2) $k_i = k_e = 0$: Lemma 1 applies—the unique Nash after elimination of dominated strategies, is $p_i = p^B$, $p_e = p^B + \delta$, the incumbent's profits are, for sufficiently small δ, $c_e - c_i + \kappa$, and the entrant's zero.

(3) $k_i = 0$ and $k_e = 1$: Profit maximizing *exclusion* requires setting p_i such that $s(p_i, 0) > s(p^{Bk}, 1)$. If $s(p^B, 0) < s(p^{Bk}, 1)$, then to prevent entrance the incumbent must set p_i below p^{Bk} earning profits of less than $c_e - c_i + \kappa$. Figure 1 illustrates a possible case. Note that if $a > b$, that is $s(p^B, 0) < s(p^{Bk}, 1)$, then p_i must be set below p^B to prevent entry. It is also possible that $p^{Bk} \leq p^B$ which immediately implies $s(p^B, 0) < s(p^{Bk}, 1)$. If an entry preventing p_i exists such that $u_i > 0$, this defines the second round Nash. If not the entrant supplies long distance at the Nash (entry guarantees the incumbent zero profit). After the elimination of dominated strategies the Nash (entry or no entry) is unique: no firm will set prices below their break-even levels, and the supplying firm will set price as high as possible without inducing undercutting.

(4) $k_i = 1$ and $k_e = 0$: Profit maximizing exclusion requires setting p_i such that $s(p_i, 1) > s(p^B, 0)$. If $s(p^{Bk}, 1) < s(p^B, 0)$, then to prevent entrance the incumbent must set p_i below p^{Bk} earning profits of less than $c_e - c_i + \kappa$. Notice that this reverses the situation in (3) immediately above. The Nash here is similarly unique.

By backward induction, the first round of the game, where the players announce their quality levels, may thought of as a one-shot game, the Nash of which depend on whether or not $s(p^B, 0)$ exceeds $s(p^{Bk}, 1)$. The two possible cases are illustrated in Figures 2A and B.

Figure 1

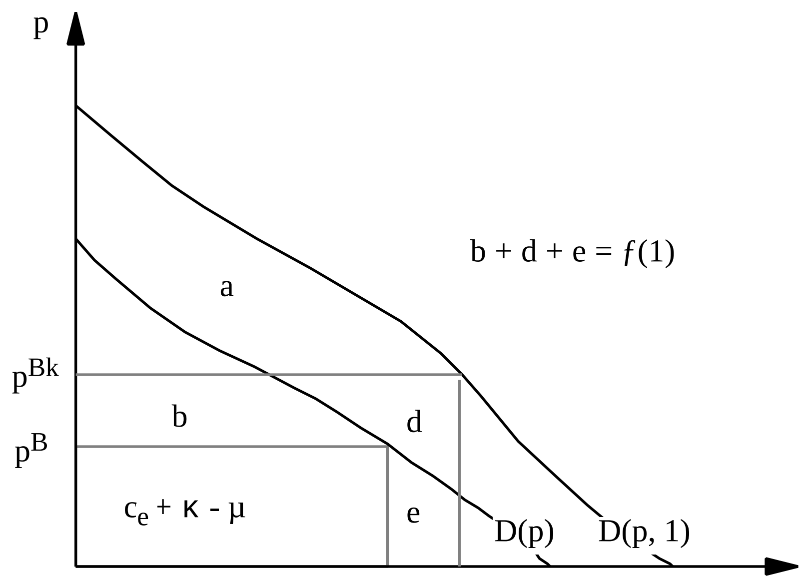

Figure 2A.

$s(p^B, 0) < s(p^{Bk}, 1)$		Entrant	
		$k_e = 1$	$k_e = 0$
Incum-bent	$k_i = 1$	$u_i = c_e - c_i + \kappa$ $u_e = 0$	$u_i > c_e - c_i + \kappa$ $u_e = 0$
	$k_i = 0$	$0 \le u_i < c_e - c_i + \kappa$ $u_e \ge 0$	$c_e - c_i + \kappa$ $u_e = 0$

Figure 2B.

$s(p^B, 0) > s(p^{Bk}, 1)$	**Entrant**	
	$k_e = 1$	$k_e = 0$

Incum-bent	$k_i = 1$	$u_i = c_e - c_i + \kappa$ $u_e = 0$	$0 \leq u_i < c_e - c_i + \kappa$ $u_e \geq 0$
	$k_i = 0$	$u_i > c_e - c_i + \kappa$ $u_e = 0$	$c_e - c_i + \kappa$ $u_e = 0$

In both cases the incumbent is the row player. The bottom right four boxes give the players' respective pay-offs for δ small. The entrant can only earn positive profits by entering (when the incumbent earns zero)

In either case the following Nash (SPE of the larger game) are possible:

If $s(p^B, 0) < s(p^{Bk}, 1)$ (Figure 2A) then either $k_i = k_e = 1$ and $p_i = p^{Bk} = p_e - \delta < p^{Mk}$ for sufficiently small δ, or $k_i = 1$ and $k_e = 0$ and $p_i > p^{Bk}$ (and if $s(p^{Mk}, 1) > s(p^B, 0)$ then $p_i = p^{Mk}$).

If $s(p^B, 0) > s(p^{Bk}, 1)$ (Figure 2B) then either $k_i = k_e = 0$ and $p_i = p^B = p_e - \delta$, or $k_i = 0$ and $k_e = 1$ and $p_i > p^B$ (and if $s(p^M, 0) > s(p^{Bk}, 1)$ then $p_i = p^M$).

Finally, note $s(p^{Mk}, 1) > s(p^B, 0) \quad s(p^{Mk}, 1) > s(p^M, 0)$ and similarly $s(p^M, 0) > s(p^{Bk}, 1) \quad s(p^M, 0) > s(p^{Mk}, 1)$, thus the lump sum interconnect fee improves or leaves welfare unchanged over the unregulated case.

4 THE REGULATORY BURDEN

The proponents of the BW rule recognize that it leaves many problems unsolved. They variously argue, however, that these problems fall outside the proper remit of interconnection pricing; that doing better would impose a greater regulatory burden than that required by the BW approach; and that the BW approach, whatever its failings, is minimally intrusive on the incumbent's property rights. Several of these arguments are echoed by the New Zealand High Court, which takes a relatively narrow view of the tasks set to it.

The first of these arguments is largely definitional. It is difficult to see why the BW rule and its consequences should fall within the proper function of interconnection pricing, while other approaches should not. Clearly what counts is whether alternative mechanisms for interconnection pricing could out-perform the BW rule — and it has been argued that they do. The second argument — that the BW rule minimizes the regulatory burden — is equally weak.

To begin with, what is required here is a cost-benefit assessment: that is, a comparison of the costs of regulation with the extent of the benefits it may bring. The minimization in absolute terms of the costs of regulation, regardless of the effects this might have, would not be widely accepted as a legitimate objective of public policy. But even putting this aside, the BW rule does not seem especially sparing in the regulatory burden it creates.

Even taking the rule in its simplest form (where interconnection charges are set relative to market prices and the avoidable costs of the entrant-provided facilities), implementation involves knowledge of prices and costs. The prices themselves may well be highly complex variables, notably when the incumbents' charging structures involve significant nonlinearities (for example, because services are bundled and then subject to volume discounts) and an extremely wide-range of services (long distance services alone cover a vast matrix of call types).

As for the cost data required, the difficulties involved in their estimation are at least as complex as those which affect other, solely cost-based, approaches to interconnect pricing. The BW rule requires estimation of incremental costs saved in the *absence* of a competitor or competitors. Given the wide range of services for which such estimates need be made, the problems of appropriately accounting for network redundancy and blocking probabilities, and of allocating incremental cost savings among several competitors, the rule is almost surely impossible to administer. Armstrong and Vickers 1995, 8 ff, 17, further show that if downstream outputs are not produced in fixed proportion to upstream inputs, or if by-pass is open to the entrant, then calculation of the BW price requires a knowledge base similar to that needed to estimate Ramsey prices which Baumol, 1993, 32 himself accepts as beyond regulators' abilities.

These information requirements would then become all the greater if any efforts were to be made to monitor against the distortions identified above: for example, by trying to control socially wasteful investments in product differentiation. Similar problems could be expected to arise from the incentives the BW rule creates for costs to be shifted from the "competitive" to the “monopoly” service.[14]

The implementation complexities become formidable when attempts are made to implement the rule in a manner consistent with economic efficiency. This would have to involve using “second best” prices (rather than the actually observed prices) as the starting point in setting the BW charge. The regulator would be required to calculate say, the Ramsey prices corresponding to the efficient provision of the services operated by the incumbent. This would necessitate a knowledge of both cost and demand functions, ideally at a level of considerable detail. Moreover, since these prices would not correspond to the current charges, some means would need to be found for managing the transition from the one to the other; and the fact that the Ramsey prices are themselves vulnerable to strategic

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14 In addition to pure cost shifting, the BW rule creates incentives for the incumbent to distort its choice of technique as between the essential facility on the one hand and the facilities specifically used to service the final product market on the other. Thus, TCNZ would be well advised to choose techniques which minimized the incremental cost of the long distance service while placing the greatest part of the costs of this service in the local network, since this would increase the amount payable under the interconnect charge. One would therefore expect to see TCNZ making especially rapid strides to “flatten” its network architecture, thus reducing to a minimum the rebate credited to Clear for the provision of its own inter-exchange facilities. Monitoring against such conduct would add to the rule’s administrative costs.

manipulation by the incumbent would create a need for further regulatory controls.

It is true, on the other hand, that implementing the BW rule using current charges as the base for calculation should allow the incumbent to continue to finance any Community Service Obligations purely through internal transfers and cross-subsidies — since it leaves the incumbent with the resources to do so. However, it is broadly accepted that these transfers are not an efficient means of providing for social goals: rather, they reduce accountability, remove the pressure to minimize the costs these Obligations impose, and place the onus of what should be political decisions on the incumbent service provider. The trend — evidenced in the New Zealand *State Owned Enterprises Act* of 1986 and the *Australian Telecommunications Act*, 1991 — is consequently to more tightly specify the extent and nature of these Obligations, seek separate accounting for their costs, and allow for some degree of competition in their provision. This cannot but reduce the value of the BW rule's consistency with pervasive cross-subsidization.

In short, the best that can be said for the BW rule is that it is minimally intrusive on the incumbent's property rights.

However, this freedom from intrusion is bought at a price — and there is little reason to believe that this price is justified.

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