Regulation of Access to the Telecommunications Network in New Zealand: A Review of the Literature

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Summary

The rapid widespread technological change and concomitant deregulation of network industries has engendered a burgeoning demand for connection between technologically like as well as technologically unlike, networks. The processes by which contracts are reached and the nature of these contracts is important for the performance of these industries.

This is a review of the state of the economic literature about interconnection. While its focus is on telecommunications, the principles it reviews are more or less relevant to other networks depending upon their particular characteristics. The review considers only the pricing element of an interconnection contract, leaving other issues such as risk sharing, transactions costs and technological agreement aside. It does not consider the direct or political economy costs of regulation. Even so, it reveals that the pricing issues have not been solved.

It is apparent from the review that interconnection pricing can only be appraised in the wider context of the regulation and competition of the market as a whole. For example, the properties of the now-famous Baumol-Willig (ECPR) rule are different when there is a retail price cap than without it. It is critical for the special treatment of interconnection contracts that there are natural monopoly elements in the network. Where these are absent or bypass is economically viable interconnection contracts will generally not pose special competition concerns.

The survey reviews the conceptual basis of proposed regulatory schema and measurement issues that arise in their use. In particular, it considers various price-cap mechanisms. It does not systematically review the literature on industry and regulatory performance under the different regulatory regimes.

Where there are natural monopoly elements, the review suggests that, for one-way access, the two leading approaches to regulation appear to be price caps or access price caps combined with deregulated retail tariffs. These approaches would include a form of the Baumol-Willig rule. The review emphasises that two-way access is characterised by both potential exclusion and potential collusion. It suggests that a regulatory approach would seek to concentrate on keeping access charges low. Light-handed regulation would then come in the form of deregulated retail tariffs. Taken together, this suggests that, in a system with both one-way and two-way access, there might be access price caps, possibly with two baskets, one for one-way access and one for two-way access charges. At the same time, retail would be deregulated. In New Zealand the regulatory price cap has been on household access.

The literature surveyed on private negotiations is quite thin. It suggests that where regulators can step in as backups if private negotiations fail, it would allow regulators to concentrate on contentious issues, while the “technical” issues would be resolved privately. In such circumstances regulatory determination can become the common mechanism by default.

1. Introduction

The structure of this review reflects recent advances in the treatment of telecommunications network access in the economics literature. In particular, recent work emphasizes the difference between an access model and an interconnection model or, in more accepted language, between *one-way access* and *two-way access*. One way access (or the access model) is concerned with the provision of bottleneck inputs by an incumbent network provider to new entrants, while two-way access (or the interconnection model) emphasizes reciprocal access between two networks that have to rely upon each other to terminate calls. The distinction arose for two reasons. First, the issues to be dealt with can be entirely different. Under one-way access, the problem is one of the provision of a monopoly input by a vertically separated or a vertically integrated monopolist. Under two-way access, the problem is one of coordination of an essential input between two firms in more or less symmetric situations. Second, as competition in the telecommunications industry matures, the two-way access problem becomes increasingly relevant.

The review therefore has two main parts, reflecting one-way access and two-way access. Within these parts, the sections deal with pricing and negotiations. One-way access has been the center of controversies. Ramsey prices are quite uncontroversial, though impractical for direct implementation. After treating Ramsey prices we therefore turn to more implementable alternatives. These include the efficient component-pricing rule (ECPR), cost-based access charges, price caps and the deregulation of retail prices. Following optimal pricing are regulatory approaches to negotiations. Two-way access has been much less controversial and much less studied than one-way access. Part 2 of the review therefore concentrates on two papers by Laffont, Rey and Tirole (1998a and b).

2. One-way Access

2.1. Introduction

The one-way access problem is characterized by the presence of a vertically integrated dominant incumbent operator (DO), who owns an upstream bottleneck input that is essential for entrants competing with the DO in a downstream market. The upstream input may, at the same time, be an output ("local services") that is offered monopolistically to endusers by the DO. This last feature, however, is not part of all models discussed below.

2.2. Pricing Rules

2.2.1. Optimal regulation of access and retail: Ramsey prices

Theoretically optimal interconnection prices can be determined under the Ramsey pricing approach taken by Laffont and Tirole (1993 and 1994). This approach simultaneously determines optimal interconnection and final goods prices, and it

makes no a priori assumptions about demand relationships, technology and type of competition. Rather, the assumptions vary, like in oligopoly models in general. Depending on which assumptions are made, the approach leads to different results. In general, these results are complex in that they have to deal with the DO's budget constraint, demand relationships, cost relationships and types of competition. This complexity reflects complicated relationships that need to be dealt with and is the price to be paid for general rather than partial optimization. For example, a model by Masmoudi and Prothais (1994), based on Cournot competition between the entrant and incumbent in the retail market, yields interconnection prices with the following components:

- the marginal cost of interconnection,
- a Ramsey markup, consisting of inverse (super-) elasticities, market shares and the type of competitive interaction,
- an interconnection charge elasticity term relating the interconnection charge to the entrant's output. The less elastic the demand for this output is to the interconnection charge the higher the interconnection charge should be.
- a differential efficiency term reflecting the difference in efficiency between the DO and the entrant in providing the final good. This term has two opposing components: The more efficient the entrant the more it should produce relative to the incumbent, thus the lower the interconnection price. Conversely, the more stringent the DO's budget constraint the less weight is given to the entrant's efficiency.

Armstrong, Doyle and Vickers (1996) identify an expression that seems to combine the second and third terms above. A particular role is played here by the displacement ratio - the marginal change in the incumbent's output over the marginal change in the entrant's output as a result of a marginal access price change.

Also, the optimal final goods prices themselves obey a complicated markup formula.

Since regulators would need a large amount of information and the ability to solve complex conceptual problems to implement Ramsey prices directly, the question has arisen if there are simpler ways to determine access charges (and final goods prices) that have desirable properties. In the following sections, we discuss four possible solutions:

- the efficient component-pricing rule (ECPR),
- cost-based access charges,
- price caps for access and/or endusers,
- deregulation of enduser prices.

2.2.2. The Efficient Component Pricing Rule (ECPR)

2.2.2.1. The simple ECPR

After a number of years, the Baumol-Willig efficient component-pricing rule (ECPR) remains the interconnection-pricing rule most hotly discussed in the literature.[1] It says

[1]The ECPR is widely attributed to Willig (1979) and Baumol (1983). See, however, Baumol, Ordover, and Willig (1997), who attribute the rule to Willig (1979). For an extensive discussion, see Baumol and

the DO should charge an interconnection price equal to the incremental resource costs of interconnection plus the so-called "opportunity cost" of interconnection. This opportunity cost is the foregone profit contribution of the DO by providing interconnection to a competitor who might use interconnection to displace services provided by the DO. Thus, the ECPR is driven by the DO's retail prices. If (a) interconnection and final outputs are generated in fixed proportions and if (b) the DO's and the entrants' final outputs are perfect substitutes and if (c) entrants take the DO's price of the competing final output as given, then the opportunity cost is simply the profit contribution or quasi-rent generated by the DO's final output (simple ECPR).

Distinctive for this simple ECPR is the assumption that the price for the final output is given (and chosen optimally). The only function of competitive entry therefore becomes to provide part of the network service at lower cost than the DO. The ECPR is therefore a partial rule that deals only with a specific aspect of network pricing and competition. It has nevertheless proven to be highly policy relevant. The reasons are that, with the simple version of opportunity cost,

- it is easily understood and practiced,
- it is usually embraced by incumbents,
- It does not require a change in (regulated) prices of final services and does not interfere with politically popular cross subsidies (and universal service policies).

2.2.2.2. New versions of the ECPR

While there have been major controversies about the ECPR in the academic literature (notably, in the Yale Journal on Regulation and in the Antitrust Bulletin), it appears that the academic debate has somewhat subsided. This is mostly due to the increased rigor introduced into the analysis. The debate in the Yale Journal on Regulation and, to some extent, in the Antitrust Bulletin has been about concrete examples rather than about economic models. Once models are used, all assumptions have to be revealed and, under the same assumptions, models have to reach the same results. Thus, as a trivial matter, the ECPR can only be welfare-optimal if it yields the same result as a model that explicitly solves for welfare-optimal access charges. This is the Ramsey model, which generally results in access prices that differ from the simple ECPR. Thus, the questions are

(a) under what conditions do the ECPR and Ramsey pricing coincide, [2]
(b) if these conditions are not met, what is the difference in outcome between the ECPR and Ramsey prices, and,
(c) does the ECPR represent a simple and doable way of calculating interconnection charges?

Laffont and Tirole (1994) and Larsen (1995) have answered the first question. The conditions they give for equivalence of the simple ECPR and Ramsey prices include:

Sidak, 1994, and the Winter 1994 edition of *The Yale Journal on Regulation* and in the Fall 1995 issue of the *Antitrust Bulletin*.

[2]The relationship between the simple ECPR and the Ramsey approach is akin to the one between partial and general equilibrium analysis. However, in the case of interconnection the legitimacy of partial analysis is called into question because interactions between the relevant markets are bound to be very strong.

- The downstream services of the DO and the entrant(s) are perfect substitutes.
- The entrants have no market power (Bertrand competition downstream).
- The downstream industry produces at constant returns to scale.
- The benchmark pricing rule is marginal cost pricing.
- There is no bypass in the upstream market.

The second and third questions have been analyzed thoroughly by Armstrong, Doyle and Vickers (1996). According to them, it takes a more sophisticated version of opportunity costs for the ECPR to be theoretically attractive in a more general and realistic setting. The resulting formula is, at the same time, much more demanding on the regulator than the simple ECPR. The opportunity cost then needs to reflect cross elasticities of final demands, technical substitution and types of downstream competition (sophisticated ECPR).

It is best to discuss the ECPR in five different contexts:

1. *Fully regulated retail prices of the vertically integrated DO.* In this case, the original assumptions of Baumol and Willig would hold. This is spelled out most clearly in Baumol and Sidak (1994). This case is not particularly interesting, because it requires originally optimal price regulation downstream. It would be more interesting if optimal input prices came out automatically through private negotiations, provided output prices are regulated optimally. Baumol and Sidak (1994) maintain that this will be so and that these input prices will follow the ECPR. However, if entrants' costs for the competitive inputs are lower than the DO's costs, then the DO would be able to bargain access prices higher than under the ECPR. Thus, imposing the ECPR would be constraining the access price bargaining process.
2. *Retail price caps with freedom of the vertically integrated DO to adjust the retail price structure*. This is hinted at in Baumol and Sidak (1994) but it is, to my knowledge, not worked out anywhere.
3. *Global price caps.* This is discussed below in Section 2.2.4, based on Laffont and Tirole (1996 and forthcoming).
4. *Separate price caps for access and retail.* This is currently done in the UK. It avoids some of the problems of global price caps because it provides a more dependable way of preventing anticompetitive behavior by the DO. However, it reduces flexibility and may prevent fully optimal outcomes.
5. *Unregulated retail prices and regulated access prices.* This is analyzed in Armstrong and Vickers (1998) and Lewis and Sappington (1999) and is discussed below (in Section 2.2.5). The ECPR (as a partial equilibrium rule) will, under some types of competition, ex post be satisfied by any equilibrium retail market outcome (of a two-stage game) if access prices are regulated at any level and if retail pricing is left to the market. For example, homogeneous Bertrand competition will always ex post yield the ECPR (in the sense that the interconnection charge will equal the incremental cost of interconnection plus the foregone profit contribution). It is also plausible for some cases of heterogeneous goods and other types of competition, since all it means is that the incumbent would expand in the retail market up to the point where the marginal profit contribution from more retail sales equals that from more sales to interconnectors. In those cases the ECPR would appear as an equilibrium result of competition rather than as a starting point of interconnection price setting by an incumbent

with market power. However, we see below in Section 3.2.1.6 that the ECPR is not always satisfied ex post (Economides et al., 1996).

6. *The ECPR in the context of two-way access* has been analyzed by Laffont, Rey and Tirole [in the following: L-R-T] (1998a) and is discussed below in the current section and in Part 3).

Among new results on the ECPR, two opposing ones stand out:

1. L-R-T (1998a) analyze circumstances, where the ECPR facilitates retail collusion.
2. Weisman (1999a) analyzes a dynamic setting, where the ECPR can hurt the incumbent and can lead to zero profits.

L-R-T (1998a):

The last section of L-R-T (1998a, analyzed extensively below, in Section 3) provides a discussion of the ECPR. In their interpretation, the ECPR is changed from a definitive pricing rule to a price ceiling. The authors' main result is that the ECPR may soften price competition and may even lead to the perfectly collusive outcome. At the same time, the paper makes clear that the ECPR is well defined only for fairly narrow circumstances, which include a regulated incumbent and an (unregulated) entrant. Otherwise, the definition of the ECPR is open to interpretation. L-R-T define two types of the ECPR in addition to the one by Baumol and Willig: the *marginal cost ECPR* (based on marginal rather than average incremental costs) and the *ex post opportunity cost ECPR* (based on the retail price that results from entry). The former takes care of the fact that a marginal cost based ECPR provides better incentives at the margin than an average incremental cost based ECPR. However, the entry decision may be distorted by using marginal costs. The latter takes care of the fact that, once the incumbent is not regulated, the retail price, from which the efficient component price is calculated, becomes an endogenous variable. Since theirs is a single-period model, L-R-T have no conceptual difficulty identifying an equilibrium with that property. In practice, however, the ECPR would have to be determined in a discrete dynamic model with lags, leading to an adjustment process (see Weisman 1999a, discussed below). More fundamental, once both firms are in the market and charge each other access prices, it is no longer clear to which of them the ECPR should be applied.

Weisman (1999a):

Weisman (1999a) moves from the conventional static framework to a dynamic analysis of the ECPR. He shows that a relatively inefficient, but not "grossly inefficient," vertically-integrated provider would earn positive profits in equilibrium under marginal cost access pricing, but zero profits in equilibrium under the ECPR in a *Cournot* framework. The reason is that, in successive periods, the market price would fall because the more efficient rival(s) gain market share over the incumbent. Each time the market price falls, so does the access charge. Thus, Weisman (1998a) would suggest that the ECPR only benefits the (mildly inefficient) incumbent DO at the time of entry, while the DO later loses all advantages. In contrast, Weisman (1999b) argues that, under *Bertrand* competition, the ECPR is the unique access-pricing rule that simultaneously eliminates price squeeze and discrimination incentives. That begs the question, what would happen to Weisman (1999a) if Bertrand competition prevailed. It turns out that, as long as the vertically integrated provider and the rival are not equally efficient downstream, there will never exist a

Bertrand equilibrium in which both participate in the downstream market. Hence, under the ECPR and under Bertrand competition, either the vertically-integrated provider is a monopolist in the downstream market in which case there is no *opportunity* to exclude, or the vertically-integrated provider does not participate in the downstream market in which case there is no *incentive* to exclude. In other words, the ECPR "solves" the exclusionary behavior problem essentially by ensuring there is no other entity against which to discriminate.

2.2.2.3. The M-ECPR and enduser charges to complement

Sidak and Spulber (1996) have developed an ECPR with a market adjustment, reflecting bypass opportunities of entrants. In this case, the costs of bypass for an entrant or the stand-alone costs (whatever is smaller) would provide an upper bound for access charges. Sidak and Spulber call the resulting rule the M-ECPR. Because it is based on a market-adjusted retail price, the incumbent DO is not necessarily made whole by the sum of retail and access charge revenues. Sidak and Spulber therefore suggest adding end-user charges on outputs (of rivals only?).

Armstrong (1999) makes a related suggestion, derived from a simple optimization model (which Sidak and Spulber fail to do). Whereas the Sidak-Spulber M-ECPR with tax is complicated, the Armstrong approach is simpler. Armstrong considers the purchase of unbundled network elements (UNEs). According to Armstrong, the charge for UNEs should be set at marginal cost (to adjust optimally the quantity purchased), while the tax on rivals' outputs (actually, on subscribers) reflects the profit lost by the incumbent. While the tax is levied on the input, it would be paid independent of whether the input was purchased from the incumbent or not. Thus, the tax has no distorting effects on bypass decisions and simply makes sure that only efficient entry occurs. Since the model used is extremely simple, it is hard to judge if it holds for more realistic circumstances. Armstrong also suggests such a tax to compensate for geographic price averaging. In the case of Telecom NZ, it could be considered as a compensation for the Kiwi share obligation.

Laffont and Tirole (forthcoming, Part II, Section 2) also note that a retail tax (i.e., a markup on the retail price that goes to the incumbent) would be more efficient than a markup on access, because it does not distort the entrant's choice of bypassing the incumbent's network.

2.2.2.4. The relationship between the ECPR and imputation

The ECPR is related to issues of cross subsidization raised in US telecommunications as early as the 1960s. In particular, it is related to Baumol's burden test. Foreclosure incentives of the DO's simultaneous pricing in the interconnection market and in the retail markets can be curtailed with the requirement of *imputation*. Imputation means that the incumbent may not price interconnection (resale, network elements) at a lower price to itself than to others. While internal prices, in contrast to external transaction prices, do not usually have direct allocative effects (because internal payments cancel each other out), they can be used as an accounting device to discover cross-subsidies. The imputation requirement shall thus guarantee that the retail stage is not cross-subsidized. This is the essence of the Hausman and Tardiff (1995)

suggestion that retail prices should not be lower than the access charge plus the incremental cost of the downstream stage. Laffont and Tirole (1998a) equate the imputation requirement with the ECPR. However, imputation implies upper bounds for interconnection charges (or, minimal internal transfer prices), while the ECPR declares these upper bounds to be optimal. If the interconnection charge equals the efficient component price the imputed internal transfer charge cannot be smaller than the retail price minus the (incremental) resource costs of the retail stage, meaning that the internal transfer charge cannot be smaller than the efficient component price. If the interconnection charge exceeded the ECP the imputed internal transfer charge would be such that the retail stage would be cross subsidized.

Imputation is a minimum principle to make sure that the incumbent uses no exclusionary practices.[3] It still leaves the incumbent with all the benefits from economies of scope, if any, because, under imputation, the incumbent could charge stand-alone costs for the interconnection services and still beat competitors, who do not benefit from economies of scope. For this it is important to remember that the total cost of a retail service equals the stand-alone cost of the intermediate input plus the incremental cost of the retail stage. If an entrant has no economies of scope (and no other cost advantage over the incumbent) the entrant could not break even at an interconnection charge equal to the incumbent's stand-alone cost unless the incumbent makes economic or excess profit.

If imputation is required, it makes the incumbent's retail pricing options depend on the level and structure of access charges. Therefore, if the incumbent wants to implement optional pricing (nonlinear tariffs) at retail, it may have to offer nonlinear (discriminatory) access charges (Laffont and Tirole, forthcoming, Part III, Sections 2 and 3).

2.2.3. Cost-based Prices

2.2.3.1. Rationale and approach

The third approach in the literature is to base interconnection prices plainly on costs. In the form of marginal-cost-pricing the cost-based approach to public utility pricing was dominant among economists for the better part of the 20th century. It is thus not surprising that cost-based pricing resurfaces, as public utilities enter the competition age. Instead of marginal costs, it is incremental costs that have taken center stage now. Incremental costs have become the basis for interconnection charges in many countries, including the UK, most of the remaining EU and the US. Incremental costs equal marginal costs for small output changes but may differ substantially from marginal costs if they include large output changes up to entire services or network components. In addition, stand-alone costs play an important role. They are the costs of a single-product entrant for providing that single service. Under a cost-based approach the stand-alone costs of a (hypothetical) wholesale network operator would be an upper limit for interconnection prices charged by an integrated incumbent. This holds because prices above stand-alone costs would be unsustainable under (hypothetical) competitive conditions. Usually, the lower limit would be incremental

[3] Imputation is needed in connection with global price caps.

costs (or short-run marginal costs). Otherwise, the interconnection service would be cross subsidized.[4] While stand-alone costs are always an upper bound for competitive prices, there usually exist smaller upper bounds resulting from the fact that stand-alone costs of all combinations of services/consumer groups need to be considered. Also, the question arises, whose costs are relevant.[5] Imposing stand-alone costs as an *upper-bound constraint* on interconnection charges is therefore adequate, while setting them *at* stand-alone costs would often be too high.[6] For example, a bottleneck is defined by the fact that duplication of the facility by an entrant would not be economical, meaning precisely that supplying access at the entrant's stand-alone costs would render him not viable.

2.2.3.2. Incremental costs with markups

Arnbak et al., 1994:

As is well known, pricing at incremental costs can only be welfare optimal under specific conditions. In particular, there should be no regulatory incentive problem and the technology should exhibit no economies of scale and scope. Under these assumptions, however, the interconnection problem would be trivial to begin with. There would simply be no bottleneck. So, why have economists and regulators (for example, in the UK and US) advocated basing interconnection pricing on incremental costs with limited markups (usually staying below stand-alone costs)?[7]

The *first* reason is the presumption that economies of scale and scope in the telecommunications industry are no longer very pronounced. This is the basis for allowing competition in the first place. Econometric cost estimates are fairly ambivalent on the prevalence of economies of scale and scope in telecommunications networks.[8] At the same time economies of scale and scope appear to prevail at least in parts of networks. However, service-specific economies of scale can be captured in the average incremental costs of those services. Thus, all that would be left is true common costs that do not relate to service-specific scale. As observed by Burton, Kaserman and Mayo (1997), in practice, the size of such common costs tends to be overestimated.

The *second* reason is that interconnection provides for particularly large network externalities (conditional upon entry of other firms) that would justify reduced markups of interconnection prices on costs. These network externalities and the accompanying reciprocity of calling have, in the context of two-way access, generated proponents of a so-called "bill-and-keep" approach under which interconnection would be implemented with zero interconnection charges. If traffic is symmetric and

[4] We are here neglecting the possibility that network interconnection may efficiently be priced below marginal/incremental costs because of network externalities or because of imperfect competition in the retail market.

[5] See Panzar (1997).

[6] Similarly, calculating stand-alone costs is harder than calculating incremental costs. In particular, stand-alone costs of various output combinations need to be calculated in order to derive the relevant upper bound, because the DO's revenues should not exceed stand-alone costs for any output combination.

[7] See, for example, Arnbak et al. (1994), Mitchell et al. (1995), Mitchell and Vogelsang (1998).

[8] See, for example, Perl and Falk (1989) or Shin and Ying (1992).

transaction costs of interconnection charges are high bill-and-keep may be a desirable approach.[9]

The *third* reason is that markups over marginal/incremental costs for intermediate inputs create inefficiencies known as double marginalization. Since entrants have their own overhead and other common costs, they have to charge a markup on top of the interconnection prices they pay. Thus, viable competition in the retail market cannot be of the homogeneous Bertrand type. Rather, retail competition itself entails markups and quantity adjustments that reduce the optimal interconnection charge (possibly below incremental cost).

The *fourth* reason is that high interconnection charges are the best instrument for collusion between competing telecommunications carriers. This would, again, hold predominantly for two-way access. However, as noted by Laffont and Tirole (forthcoming, Part III), one-way access charges can also have competition-reducing effects.

Fifth, high interconnection charges would invite possibly inefficient bypass investments by entrants. This has led Sidak and Spulber (1996) to include stand-alone costs as an upper bound in their M-ECPR.

Arnbak et al. (1994), Mitchell et al. (1995), and Mitchell and Vogelsang (1998) have therefore suggested imposing a burden of proof on the DO. Starting out with interconnection prices at average incremental cost of the interconnection service the DO would have to justify any markups over and above average incremental costs. This approach deliberately makes the regulator refrain from optimizing over the whole set of markets, as done by Laffont and Tirole (1993 and 1994). At the same time, in contrast to the ECPR, the final goods prices would follow retail price caps with full rebalancing or be left to competition. The philosophy behind this approach is that interconnection and final goods can be sufficiently separated so that (for some time) interconnection can be regulated while the retail services produced with interconnection as an input can be left to market competition. Since access charges at average incremental cost do not cover common costs, markups will usually be required. Arnbak et al. (1994) and Mitchell et al. (1995) suggest maximum markups not to exceed the average retail markup applied by the incumbent. Laffont and Tirole (forthcoming, Part IV, Section 2) remark that such markups should be additive and not proportional to price, because otherwise the DO would have to increase the retail markups to make himself whole.

<u>Hausman and Tardiff (1995):</u>
Hausman and Tardiff (1995) combine an ECPR type approach with cost-based pricing. They argue that a DO's retail service should be priced at least as high as (1) the incremental cost of providing the service plus (2) the contribution foregone by selling the service rather than the access service[10] to competitors. This is the

[9] Generally, symmetric traffic will arise independently of the relative sizes of the networks if the characteristics of the subscribers are the same on each network.
[10] Hausman and Tardiff (1995) oppose unbundled network elements (UNEs). Rather, incumbents should only be obliged to provide services of essential facilities, for which a separate market exists.

imputation rule. Regarding the price of the access service, they argue that the analysis by Diamond and Mirrlees (1971) on optimal taxation implies that intermediate inputs should be priced at incremental costs. Thus, Hausman and Tardiff recommend pricing access (as an intermediate input) at incremental cost. However, since the DO would have joint and common network costs, they suggest a restructuring of retail tariffs such that joint and common costs are financed by an increase in the monthly subscriber line charge, which would act almost as a lumpsum tax.

2.2.3.3. Exclusionary practices resulting from low access rates

Cost-based access charges require markups to compensate for fixed and common costs. If these markups are insufficient, the incumbent is under perverse incentives to provide access at low quality or to exclude rivals (Laffont and Tirole, Part IV, Section 5]). Laffont and Tirole discuss as exclusionary categories:

- Refusals and delays of interconnection
- Raising rivals' costs
- Lowering rivals'demand.

They suggest a rule of reason approach to such exclusionary practices because some of the practices can actually be justified on efficiency grounds. Laffont and Tirole side with more light-handed regulation that avoids such exclusionary practices in the first place. At the same time, they argue that the incentive for exclusion is lower if retail prices are regulated.

A recent set of papers deals with the incentive of vertically integrated firms to use nonprice discrimination to disadvantage downstream rivals that have to buy an essential upstream input from the integrated firm.[11] Such nonprice discrimination is

[11] Weisman (1995, 1998), Sibley and Weisman (1998a and b), Economides (1998), Reiffen (1998), Beard, Kaserman and Mayo (1999). Weisman (1995) and Sibley and Weisman (1998a) deal with the important problem of RBOC entry in long-distance markets and the relationship between the DO's market share in the access market vs. the DO's market share in the long-distance market. In Sibley and Weisman (1998a) the RBOC is assumed to hold an upstream monopoly for local access, which is produced in fixed proportion to long-distance output. Local access charges are under price regulation. When entering the downstream long-distance market, the RBOC has to obey an imputation rule (to avoid a price squeeze) but is otherwise not regulated. In the downstream market the RBOC competes with n-1 equal-sized firms. In the main (dynamic) model, downstream competition is in capacities and outputs. The principal result is that the integrated upstream monopolist has no incentive to raise rivals' costs, as long as its market share in the long-distance market is small. Eventually, however, as the market share increases beyond a threshold level, an incentive to raise rivals' costs arises. If a requirement to run long-distance services through a separate subsidiary is imposed on the upstream monopolist, then the incentive to raise rivals' costs may actually occur at a lower market share. Since the monopoly access price is given through regulation, the incentive to raise rivals' costs cannot be expressed as an increase of the access price. Rather, the paper defines the incentive by the derivative of the integrated firm's profit (at its maximum) with respect to its rivals' unit costs. This is a sensible definition because it excludes any direct revenues or cost reductions that would otherwise be generated from raising rivals' costs (e.g., through deterioration of access quality to rivals). Given this definition, what is the intuition behind the paper's results? Consider the two extremes of zero and 100% market shares in the downstream market. At zero market share all profits of the RBOC come from selling access to long-distance companies. Raising these companies' costs (without gaining direct revenues or saving costs from this) obviously cannot benefit the RBOC. At the other extreme, as a downstream monopolist, the RBOC can reap the overall combined profit maximum (assuming that the regulated access price is not exorbitantly high). In that case, it can only do worse if there are rivals. So, it will

called “sabotage”. This literature is discussed in Mandy (forthcoming). The author starts out from the diverse results in the theoretical literature and traces these differences to eight different assumptions made by the different authors. The author continues by reanalyzing the model by Economides (1998). While Economides concludes that the vertically integrated firm always chooses to use sufficient sabotage to foreclose the downstream market, Mandy finds that foreclosure depends on three parameters: the access charge markup, the extent of downstream competition and the relative inefficiency of the integrated firm in the downstream market (assuming that there are no economies of scope benefiting the integrated firm). He identifies combinations of these parameters that would lead to sabotage and combinations that would not. In line with Economides (1998), if sabotage occurs it leads to the foreclosure of all downstream rivals. Mandy then looks at the US telecommunications market and applies his results to the 1996 Telecommunications Act, Section 271, cases of allowing RBOCs into the long-distance markets of their local customers. Mandy finds that the markup given by interstate access prices and local network costs is low compared to hypothetical unregulated access prices. As a result, even if RBOCs were quite inefficient in providing long distance and if long-distance markets were quite competitive, RBOCs would still have strong incentives for sabotage.[12]

2.2.3.4. Cost measurement in the US and UK

The problem with cost-based access prices is that their regulation is never “light-handed”, because the regulator needs to measure costs, something that can be intrusive on the regulated DO. Firms have always measured some form of their costs.[13] The measurement of *economic* costs of individual services or network components (elements) in telecommunications, however, is a difficult undertaking because economic costs are forward-looking, because of rapid technical progress and because of economies of scale and scope, resulting from the use of long-lived assets. There is consensus today that cost measurement requires three sources or techniques to be used in combination. Bookkeeping is essential for providing most of the quantity and price data for inputs and outputs. Statistical/econometric analysis is important for establishing empirical regularities between variables. Engineering analysis is needed to establish technical relationships that are the basis for functional forms, for example, for economies of scale and scope and for deriving forward-looking cost data.

In the US and the UK, cost models are being used to establish universal service costs, costs of interconnection and retail services and costs of individual network elements and the retail function. Measurement of local network costs was pioneered by Mitchell (1990) and is now done by all large US ILECs (incumbent local exchange

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want to keep rivals’ costs high. In between are the interesting cases where the profits from supplying access are traded off against the profits from selling long-distance. The relative size of these profits and the equilibrium market shares depend on the relative efficiency of the RBOC in the long-distance stage and on the allowed markup in the access market. Ceteris paribus, the higher the markup in the access market and therefore the higher profit from there, the less incentive to raise rivals’ costs.

[12] Another recent paper dealing with the relationship between access charges and the effects of RBOC entry into long-distance markets is Biglaiser and DeGraba (1999).

[13] See, for example Gabel and Gabel (1997) for a history of cost measurement in the US telephone industry.

carriers). Most of them have their own cost models, which use modules that are often provided by Telcordia Technologies (formerly Bellcore, the common research unit of the Bell operating companies). The advantage of these firm-specific models is that they can, in principle, best reflect local geographic and market conditions. At the same time, they and their data inputs are less open to outside scrutiny than models developed and run by independent institutions. However, to the extent that firm-specific models are used in regulatory proceedings, they are getting scrutinized by regulators and adverse parties. For this purpose, other cost models have been developed on behalf of (a) firms competing with the ILECs (the Hatfield Model)[14], (b) the National Association of Regulatory Utilities Commissioners (the Gabel/Kennet Model, which forms the basis for the German cost models and for the work of Gasmi, Laffont, and Sharkey, 1998) and (c) a mixed industry group (the Benchmark Cost Model and its derivatives). Rather than accept one of these models as the basis for its universal service policy the FCC constructed its own model. All of these are so-called proxy models that, without modifications, can be applied to all regions of the US. Only the data input changes from locality to locality. Proxy models tend to depend on a smaller number of data than firm-specific models for which all necessary data are available to the ILECs (but are proprietary). They can be used to check the accuracy and dependability of firm-specific models. In the UK, BT and an industry group (that included BT) developed competing cost models (BT a top-down model and the industry a bottom-up model) that were reconciled by Oftel/NERA.

In all these measurement processes, a fairly strong consensus across models and jurisdictions emerged about the long-run incremental costs of some network elements, switching and transport in particular. In contrast, the cost measurement for local loops and for operating costs remains contentious. A major controversy has, in this context, arisen around the use of options methods in evaluating the costs of network elements. Hausman (1997)[15] argues that these costs should include the options value created by the sunk nature and natural uncertainty of investment. He sees this as a problem of downside risks created by the fact that the buyers of access do not have the same long-run commitment to the assets that the integrated DO has. As a result, if demand by the entrants vanishes the assets can get stranded. Hausman calculated very high capital costs resulting from this problem of sunk assets. In contrast, Hubbard and Lehr (1999) emphasize the importance of balancing this downside risk by the upside potential. However, one can argue that such upside potential can only emerge after deregulation.

Measuring costs has been an ongoing and controversial issue. Cost measurement problems arise for a number of reasons.

- There can be conflict about the appropriate economic cost category to be measured. The candidates are marginal costs, incremental costs, stand-alone costs (and fully allocated costs).
- Once agreement has been reached on the cost category, a method of measurement has to be chosen. At stake are the proper mix of bookkeeping, engineering and

[14] A variant of the Hatfield model was used to estimate the effect on local telephony costs of New Zealand's population density vis á vis the USA, UK Australia and Sweden (see Alger, Dan, and Joanne Leung, *The Relative Costs of Telephony Across Five Countries*,New Zealand Institute for the Study of Competition and Regulation, March, 2000 (*http://www.iscr.org.nz*).

[15] See also the comments by Rosston in the same source.

econometric methods as well as bottom-up versus top-down and firm- or location-specific versus general (proxy) model.
- Last, the data inputs for the models have to be collected. These can be actual purchase and consumption data, which are often proprietary and therefore unavailable to outside analysts, or they can be publicly available data from statistics and the trade press.

Cost measurement based on actual data appears to be naturally superior to measurement based on estimated or average data. For that reason actual data are usually made available to the regulator. An incumbent TO cannot complain that data used by outsiders are incorrect but at the same time withhold the correct data. But the stated superiority of actual data may not hold at all, for the following reasons:
- Future and efficient costs are being measured, and the actual data may reflect cost inefficiencies. These could include waste, old technologies, excess capacities and more.[16]
- The way data are presented may distort cost measurement. For example, Burton, Kaserman and Mayo (1997) argue that regulated monopolists in the US have an incentive to overstate common costs relative to directly attributable costs.
- Uncertainty in cost measurement can lead to two types of errors. The actual costs may be lower than measured, leading to a windfall gain for the incumbent; or, actual costs may be higher, burdening the incumbent.

The use of actual cost data in regulation (and long-term contracts) is known to provide weak incentive effects. In contrast, because proxy models are built on (price and quantity) data that are not firm specific and location specific, they can function as benchmarks with strong incentive effects. Thus, it is not clear that, for regulatory purposes, firm-specific models are superior to proxy models.

No good models currently exist for operating costs and for the costing of the retail stage. In these cases, bookkeeping costs have been used at least as the starting point. This is not so bad because, in this case, most of the costs are incurred simultaneously with their expenses so that depreciation and valuation issues hardly arise. However, they may still be inefficient. What could, in principle be done is the estimation of the frontier cost function for these items from the standardized bookkeeping data of all ILECs, although this will not generally provide certainty.

[16] Kahn, Tardiff and Weisman (forthcoming) make a case for using the regulated firm's actual costs rather than an efficient firm standard as the basis for interconnection pricing. Their argument is that an entrant would always want to buy access at efficient costs rather than build its own network. Thus, the efficient firm standard does not allow the most efficient (among imperfect firms) to provide the service, whereas the use of the firm's actual costs would make the entrant bypass the incumbent's facilities whenever the incumbent is less efficient. There are two problems with this argument. First, it implies the use of short run costs because, in the long run, all costs can be changed so that it is unclear, what actual costs would be. Second, actual (short-run) forward-looking costs do not include sunk costs. Thus, it is unclear if the efficient firm standard leads to higher or lower costs than the actual cost standard. Lehman and Weisman (1999) conceptually analyze and simulate the relationship between embedded and forward-looking costs. They conclude that, under plausible parameter values, the difference should be small and that, therefore, the FCC's cost models severely underestimate actual costs.

One might think that, if at all, measurement of its network costs would Telecom NZ's problem. However, if interconnection charges are to be based on costs, cost measurement becomes a general problem for the telecommunications sector.

In terms of costing, New Zealand could, in principle, learn from the US experience about cost models. This experience could provide data. At the same time it provides insights from the lengthy and controversial process (just like the one about the ECPR in New Zealand provided insights for other countries). Costing itself is such a controversial issue that the incumbent DO and the entrants are unlikely to agree on the types of costs to be applied and on cost figures corresponding to each cost type. Thus, it is important to find a way to bridge the gaps. What the US (and UK) experience suggests is that the regulator should function as a mediator for cost modeling efforts by the industry. In most countries the regulator is the only institution that can question the DO's *cost data*.[17] That does not, however, preclude others, such as the entrants and researchers, from developing alternative *cost models* (and their own cost data). It also does not preclude the regulator (or competition commission) from sharing the cost modeling efforts with the industry and experts. In order to agree on such a model, the regulator would establish a group of experts representing the licensed telecommunications operators, the regulatory body and independent experts.

2.2.4. Price Caps for Access and Global Price Caps

2.2.4.1. Rationale

In practice, a regulator cannot hope to capture all the effects of the Ramsey pricing formula at the same time,[18] and the sophisticated ECPR is not much more feasible. Since the determination of costs is tedious and contentious and since it always lags behind cost developments, it is advisable to adjust interconnection charges over time under price-cap formulas rather than through new cost determinations.[19] Price caps solve two pricing problems. First, the adjustment formula ("RPI-X") cuts the tie between price and (firm-specific) cost development and thereby provides incentives for cost reduction.[20] Second, the use of a price-cap index (baskets) allows for price rebalancing and therefore potentially relieves the regulator of the informational burden to establish (Ramsey-) optimal price structures.[21]

The main issues of any price cap system are

- The setting of initial prices,
- The determination of X-factors and inflation adjustments,
- The scope of price caps and the selection of baskets,
- The determination of weights for the price-cap index.

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[17] These data can also be revealed and questioned in Court whether or not there is a regulatory disclosure requirement.

[18] These effects do not yet include incentive effects as discussed in Laffont and Tirole (1993). The absence of incentive effects can be justified if the incentive-pricing dichotomy holds.

[19] Price adjustment formulas of similar kinds would even be advisable for privately negotiated interconnection agreements.

[20] Provided the X-factor is in fact set independently of firm performance. Often this difficult because of the link between X, investment and quality issues.

[21] This goes back to Vogelsang and Finsinger (1979).

Setting initial prices is easier for mature markets where the going prices can be used. This, however, does not work well for interconnection charges for which no experience exists. Thus, a different method, such as cost-based pricing has to be used to initiate price caps. Any distortions created by the initial method would then have to be eliminated over time, using the freedom of adjustment allowed for by the price cap method. The X factor and inflation adjustment should induce cost-reducing incentives for the firm. The use of baskets restricts the firm's ability to rebalance prices, and the weights provide incentives to choose an efficient price structure.

Relevant for the access problem are three types of price caps, retail price caps, access price caps and global price caps. Because we concentrate on light-handed regulation, we will be short on retail price caps and concentrate on access price caps and global price caps.

2.2.4.2. Retail price caps

Retail price caps should protect endusers of telecommunications services from the abuse of market power of a DO. Once the markets are open to entry, competition operates as a second policy instrument to constrain the DO's behavior. The two constraints interact, and, at any time, one or both can be binding. There also arises the question, to what extent retail price caps influence the incentives of the DO in providing access to its downstream competitors. Thus, should access and interconnection be regulated along with retail price caps and, if so, what form should such regulation take? The U.K. and US have, so far, opted for a combination of retail and access price regulation, while New Zealand has a retail price cap on specified basic services and no regulation of access charges.

2.2.4.3. Access price caps

Access price caps were introduced in the UK in 1997. At the time, this was seen as a major step towards more light-handed regulation, opening the possibility to deregulate retail services in the next price-cap round. Whether that will happen, is at this time an open question. The regulation of access charges gives regulators control over the competitive process in that it constrains the DO. The question is if access charge regulation can do two things: (1) avoid exclusionary practices, including squeezing and predatory behavior, and (2) sufficiently constrain retail prices. Assuming that the Kiwi share stipulation in New Zealand continues, the latter can be answered in the affirmative.

The possibility of rebalancing within the set of interconnection services also potentially reduces the issue that interconnection is unbundled into many services with possible economies of scale and scope within the set of interconnection services. For example, economies of scale and scope may be imperfectly captured under the cost-based approach with initially uniform markups for common costs. These common-cost issues justify a separate Ramsey pricing approach within this unbundled set. The main characteristic of this approach is that this Ramsey pricing problem can be seen as separate from the full Ramsey pricing problem that involves the interaction between interconnection prices and final goods prices and that has been treated in the

global price cap approach by Laffont and Tirole (1994 and 1996). Any Ramsey approach that restricts itself to a subset of markets is theoretically inferior to one that includes more markets. However, this view does not take into consideration incentives for cost reduction and for information revelation that are associated with competition, even if it is restricted to a subset of the markets. The question is if the beneficial effects from competition in such markets can compensate the mistake from not including all markets under a single regulatory constraint relative to the effects from modeling and estimation errors in solving the Ramsey problem. We are confident that it can.

2.2.4.4. Global price caps

Global price caps differ from ordinary (retail) price caps in that they include access charges along with retail prices under the same cap. Laffont and Tirole (1994 and 1996) have made a strong case for global price caps. They argue that making the integrated firm choose its overall price structure under a common constraint on the price level can align the incentive for optimal pricing in both markets. The asymmetry created by unequal treatment of access charges and end-user prices would vanish under global price caps. The DO would use its superior information in a welfare-enhancing way.[22] They do, however, assume that the price-cap index uses optimal weights to begin with. In addition, Laffont and Tirole want to reduce any incentives for anticompetitive behavior by imposing an imputation rule for access pricing in addition to the price caps. Thus, any individual access charges would have to obey both the price cap and the imputation rules. The reason why they suggest imputation is not the DO's incentive for exclusion (which means exclusion of rivals which is profitable at the time of pricing) but rather the possibly remote danger of predation (meaning non-profitable exclusionary pricing now in order to make excess profits later).

Optimal weights for the price-cap index would be the correctly predicted output levels. Making such predictions looks doable for a regulator. However, it actually means solving the Ramsey pricing problem discussed above in Section 2.2.1. This would be very hard and would make the use of price caps superfluous because, by solving the problem, the regulator would have to know the Ramsey prices and therefore could prescribe them directly. Thus, in applying global price caps one will probably have to compromise on weights that are either quantities of past periods or quantities projected from past trends.

In theory, global price caps provide the integrated DO with the ability and incentive to generate Ramsey prices overall. The imputation requirement may reduce this ability, but that would only happen in those cases where Ramsey prices imply market foreclosure of rivals. Nevertheless, global price caps have so far been too bold for any regulator to implement. One reason is the common knowledge that regulators cannot commit to a specific regulatory scheme in the long run. Thus, under global price caps, the integrated firm may use aggressive tactics against rivals, in order to keep its

[22] Even if the DO itself is not fully informed about its costs, about demand and about the competitive strategies of its rivals it would at least have the incentive to use its incentives optimally and would bear the responsibility for being informed.

overall market position, in case regulation changes in the future. Global price caps may otherwise be ideal for the New Zealand setting because they imply very light-handed regulation (even under inclusion of the Kiwi share stipulation).

2.2.5. Access prices when retail is deregulated

2.2.5.1. Armstrong and Vickers (1998)

With sufficient competition there should be no problem of deregulating retail prices (with possible exception of some basic services for the poor and needy). Sufficient competition could, in this case, be measured by the absence of dominant market power of any supplier. However, due to essential inputs, the vertically integrated incumbent is likely to be dominant in that it has power over the other suppliers. The essential facility creates a barrier to entry. However, one can argue that access regulation, which makes the facility available to competitors under regulated terms, could make the retail market contestable even if the vertically integrated incumbent maintains a dominant position in terms of its market share. Thus, deregulated retail in connection with regulated access could be an attractive form of light regulation. Armstrong and Vickers (1998) provide a treatment of this situation. They analyze the case of welfare maximizing access regulation and of optimal markup regulation, using a very simple model that builds on Armstrong, Doyle and Vickers (1996). The incumbent has economies of scale and scope, while the entrant has an upward-sloping supply curve (is price taker).

Armstrong and Vickers consider two cases: perfect substitution between the entrant's and incumbent's outputs and heterogeneity of the retail services. The main result under perfect substitutability is that optimal access price regulation can lead to an access price above or below marginal cost of access. To get this result, Armstrong and Vickers assume a price leadership model downstream so that the entrant always sells at his marginal costs, while the incumbent sells above marginal costs. Since there is only one downstream price, there are two sources of inefficiency. First, the entrant produces at a level, where its marginal cost exceeds that of the incumbent. We thus have productive inefficiency. Second, there is a deadweight loss from the incumbent's retail output margin above its cost. Output-wise the two distortions go in opposite directions. The access charge is a single instrument to correct both these inefficiencies, leading to a compromise (or second best) outcome. Setting a low access charge leads to more productive inefficiency by the entrant while setting a high access charge leads to too high a monopoly markup by the incumbent.

Armstrong and Vickers also consider optimal regulation of the incumbent's margin between retail price and access charge. The outcome is an ex post ECPR. Optimal access price regulation leads to higher welfare than optimal margin regulation. In particular, consumer welfare and entrant profit are higher under optimal access charge regulation (lower retail price and lower access charge). At the same time, optimal margin regulation increases welfare over access charges that the incumbent would set in the absence of any regulation. If, in the US, retail prices were deregulated, then the provisions in the Telecommunications Act of 1996 on resale could be interpreted as margin regulation.

Last, Armstrong and Vickers derive optimal access charges for the case of heterogeneous retail services. These access charges equal the sophisticated ECPR, however, corrected by a downward adjustment factor that takes care of the sensitivity of the retail price with respect to the access charge. Marginal cost pricing of access turns out to be optimal for *linear* demands (and a nonbinding profit constraint). Reducing the access charge would reduce the market power of the incumbent in the downstream market but at the same time create a distortion in the consumer choice between the two differentiated goods. Marginal cost pricing of access is then a compromise between these two effects.

2.2.5.2. Ergas and Ralph (1997)

Ergas and Ralph (1997) take as the point of departure the Privy Council decision that gave the ECPR legitimacy. As in the case before the Privy Council, the authors assume a basically unregulated environment (like in New Zealand) where the incumbent dominant operator is free to set its prices in the retail market. This is obviously a legitimate starting point for a critique of the ECPR because Baumol and Willig had proposed the rule in the New Zealand setting. Nevertheless, this is not the setting in which the ECPR has been claimed to be efficient by its main proponents. Baumol in particular only claims the efficiency for the ECPR in the presence of Ramsey efficient retail prices. The authors then suggest more efficient alternatives to the ECPR. These alternatives make use of the well-known superiority of nonlinear pricing. In particular, they show that a lump sum interconnection fee, combined with usage fees, generally improves welfare over the unregulated case. They argue that this holds for a large range of parameter values so that improvements would occur even if the regulator does not prescribe optimal fees. However, the authors give little explanation and intuition as to why these alternatives are superior.

2.2.5.3. Lewis and Sappington (1999) on asymmetric information

Lewis and Sappington (1999) deal with the access pricing problem in the context of a downstream monopolist selling access to another firm that sells a downstream substitute to the monopolist's downstream service. Downstream markets are not regulated, while the access market is regulated under a scheme where the monopolist receives a linear payment from the regulator while the regulator receives a two-part tariff from the downstream competitor. The authors consider three cases:

1. Full information and no regulatory budget constraint. This case establishes that (a) in general, the first-best outcome cannot be reached because the regulator cannot differentially influence both downstream prices with only one policy instrument, (b) for an equally efficient rival the regulator subsidizes the rival's variable access price. However, in my view, this subsidy could be compensated by the fixed fee (that the authors do not consider in this context). Also, the monopolist receives a higher variable charge than the rival pays. (c) The optimal access price is further reduced if the downstream firm's costs are lower and this effect is stronger the closer substitutes the two services are. Thus, the regulator favors the more efficient downstream firm.
2. Full information with a regulatory budget constraint. This case differs from the previous one only if the budget constraint is binding. In this case, the variable access charge needs to be increased in order to reduce the net subsidy. The

authors do not deal with the ability to collect the fixed fee as the rival's variable profits suffer from the increase in the variable fee.[23]

3. Asymmetric information about the rival's downstream costs. Two sub-cases are considered: a public mechanism (where the monopolist learns the rival's costs through the revelation principle) and a confidential mechanism (where only the regulator learns those costs). It turns out that the public mechanism is Pareto superior to the confidential mechanism. Thus, only the results for the public mechanism matter. They are qualitatively similar to the full information cases, but differ between the high cost and the low cost case. If the rival has high cost she only receives the reservation profit, while she can make an economic (excess) profit if she has low costs.

The main normative insight of the model is that the regulator, in setting access charges, should tilt the playing field in the direction of the more efficient downstream firm and that this tilting should decrease in the intensity of downstream competition.

The paper is set up in the tradition of Bayesian incentive regulation. This means, the accounting convention is used that all revenue streams flow via the regulator. Also, this revenue stream in principle allows the regulator to provide subsidies to the firms involved. This relates, in particular, to the wedge between prices paid by the downstream firm for access and prices received by the upstream monopolist. One could argue that the regulatory budget constraint could be set at zero, and then the setup of channeling money through the regulator would be only an accounting convention. However, the two tariffs (that is, the one received by and the one paid out by the regulator) differ in structure. Thus, there exists no easy translation into a framework where the regulator only sets a tariff and lets the firms transact with each other. The question therefore is if the proposed scheme corresponds to one, where the regulator only sets tariffs, or if this would require another mediator (such as the independent system operator [ISO] in electricity markets).

2.2.5.4. 2.2.5.4 Burnell, Evans and Yao (1995) on bypass

Burnell Evans and Yao (BEY) examine the access pricing problem of a vertically integrated firm that owns a network and a retail firm that competes via Cournot competition with another retail firm. There is some product differentiation.[24] The second retail firm may build a network that bypasses the DO'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.[25] The vertically integrated firm behaves as a Stackelberg leader in designing a two-part tariff contract for the use of its network taking cognisance of the ability of the second retail firm to construct a bypass network and its output reaction function. [26]

[23] The authors assume the fixed fee to be a lumpsum payment.

[24] Demand and retail and network cost functions are linear. Cost functions have fixed costs so there are economies of scale.

[25] This is also affected by the extent of product differentiation.

[26] Quantitatively different but qualitatively similar results are obtained if the vertically integrated firm is not a conglomerate that chooses the network contract and its retail firm's output jointly: but instead treats its retail arm as a distinct profit-maximising entity, given the network contract. The same

When the full network has to be bypassed, 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. In another set up, the second retail firm can partially bypass the DO's network and use a combination of its own and the DO's network to service customers. Assuming that if the second retail firm did partially bypass it would do so by bypassing targetted network segments that are densely populated by potential subscribers (e.g. the central business district) partial bypass disciplines the DO to the point that the contract written is much more efficient. The paper assumes that the contract does not differentiate between segments of the network. The vertically integrated firm designs a contract that raises the variable component of the network contract as much as possible while ensuring that the outside retail firm does not bypass much of the network. This threat of bypass forces, in the examples of BEY, a relatively efficient outcome and a contract that approximates the DO's network cost function. Although the 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.

2.3. Regulatory approaches to negotiations

The models and approaches discussed so far either assume that the regulator prescribes access charges or that the DO sets access charges. This captures the monopoly or bottleneck situation in the access market quite well. However, entrants may have options other than accept an offer by the owner of an essential facility. Such options could come from the availability of bypass or the threat of regulatory interference. It is the latter possibility that is captured in the work of Brock and Katz (1997) and King and Maddock (1999).

2.3.1. Brock and Katz (1997)

Under the US Telecommunications Act of 1996, interconnection agreements are in principle reached voluntarily between carriers. Brennan (1997) establishes a tension between the US 1996 Telecommunications Act and the FCC's Local Competition Order of August 1996. In particular, he feels that the Act emphasizes private negotiations while the FCC's order expects regulatory interference. Indeed, a lot of regulatory intervention is anticipated in the FCC's order. However, in my view, that interpretation does not necessarily signal disagreement with the Act. The Act is quite clear with respect to voluntary agreements. So, the FCC did not have to deal with those at length. The FCC only comes into play when private parties fail to agree. That this is a very major concern was abundantly clear at the time of the FCC's order. At that time, AT&T was in arbitration procedures almost everywhere in the country, and so were Teleport and others. So, regulatory interventions (as arbitrators) were certainly going to prevail.

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network contract is offered to both retailers, but it is as if a contract is offered only to the non-owned retail firm because for the network-owning firm it is simply a transfer that nets out.

Thus, only if negotiations fail do regulators come in as arbitrators. In the latter case, arbitration is binding. Also, negotiations are guided by the contents of the 1996 Act. Thus, while state regulators and the FCC only come into play if the parties do not agree, it is not surprising that (because of the new and untested provisions of the 1996 Act) arbitration was the rule rather than the exception. This is the background for the papers by Brock (1997) and by Brock and Katz (1997). They consider the usefulness of FCC guidelines in helping negotiations, asking three questions: (1) are guidelines useful, (2) at what level should guidelines be imposed, and (3) do the FCC's guidelines conform to economic principles?

In answering the first question, Brock and Katz use insights from economic bargaining theory. They make the case that guidelines can reduce the chance that private negotiations will block otherwise efficient entry. They also make clear that guidelines may actually eliminate the need for further regulatory intervention: clear guidelines would increase the incentives of private negotiators to reach private agreements. These conclusions coincide with the recommendations of Economides (1995) for New Zealand, although Economides fails to make the case as clearly as Katz.

In answering the second question, Brock and Katz make a case for federal rather than state guidelines.

Regarding the third question the authors find that the FCC's incremental cost pricing rules were not based on full economic analysis. They find that this is more crucial for unbundled network elements (UNEs) than for call termination.

Thus, the evaluation of guidelines hinges on their contents and on the credibility of the regulatory agency that administers them.

2.3.2. King and Maddock (1999)

While the background of King and Maddock (1999) is the Australian institutional setting, the article is actually a strongly simplified theoretical bargaining model of access pricing that could apply to any jurisdiction. The main assumptions are the following:

- There is a bottleneck facility controlled by the incumbent. In the absence of an access agreement with a (single) entrant the incumbent would hold a monopoly in the market downstream of the bottleneck facility.
- The incumbent and entrant negotiate about an access charge. There is no retail regulation. The access charge therefore determines the size and division of total industry profits.
- The authors do not specify how competition in the downstream market plays itself out. In principle, the two firms could collude here. Thus, the access price is not necessarily linear. Rather, there could be side payments in the form of fixed fees.
- In case the firms do not reach an agreement, either of them or both can call for regulatory arbitration, which is binding. In particular, King and Maddock assume that in private negotiations the outcome always yields monopoly profits, while regulatory arbitration leads to a reduction in total profits.

- The model follows the framework pioneered by Rubinstein (1982), where players make alternating offers. Since these offers take time, the effect of not reaching an agreement now is that the status quo continues for another period. The length of such periods and the applicable discount rates therefore play a major role.

It is clear that, under the assumptions made, the incumbent would always stall negotiations if regulatory arbitration were not available. That way, the incumbent would continue to earn monopoly profits.[27] In the presence of such arbitration, however, the incumbent has to weigh continuation of monopoly profit for another period (until the arbitration decision has been made) and the regulated outcome thereafter against sharing the monopoly profit with the entrant immediately. This tradeoff depends largely on the profit reduction of the incumbent under arbitration, the profit of the entrant under arbitration and the (common) discount rate. Although it is clear that the entrant and incumbent both have an interest in avoiding arbitration, a dispute may still come about.

King and Maddock get the following results:

- If players are patient (have low discount rates, or if periods are short) the equilibrium profits form a large range. This range is bounded between the arbitration outcome and a negotiated outcome (with total monopoly profit) in which the incumbent concedes to the entrant the discounted profit that the entrant would receive under arbitration.

- If players are impatient the entrant will always seek arbitration, when it is his turn. Now, we get two possible outcomes, depending on the level of impatience. If players are very impatient there will be a unique negotiated outcome, where the incumbent will just concede to the entrant the discounted profits under arbitration. If players have an intermediate level of impatience, the entrant will concede to the incumbent only what the incumbent would have gotten under arbitration (that is, monopoly profit for one period and the regulated profit thereafter). Note that these results are both gained without arbitration actually taking place. Note also that the regulator could switch the outcome from one to the other by announcing a longer or shorter time for the arbitration.

Note that arbitration will occur only if players are sufficiently patient. In this case, there could be many equilibria so that arbitration is only one of many possible outcomes.

King and Maddock add three procedural options to their model. All of these would be imposed in an effort to reduce the amount of arbitration.
The regulator could

- Introduce *last chance bargaining*. Under this the arbitration decision would be made only after the parties engaged in further bargaining. King and Maddock find that the outcome in this case depends crucially on who makes the last offer inside the waiting period (that is, if there is an even or odd number of periods inside the

[27] This point is also made by Katz (1997).

waiting period). If the incumbent makes the last offer the entrant is favored and, vice versa, the incumbent is favored by the last offer of the entrant.

- Act only if the parties have already bargained long enough. This is a requirement under the US Telecommunications Act of 1996. Again, the outcome depends crucially on who makes the last offer. However, the incumbent will always wait to make an agreement until right before the minimum bargaining period ends. Interestingly, in the US few agreements (under the 1996 Act) were reached voluntarily. Those few voluntary agreements involved comparatively small entrants with substantial two-way traffic. One can speculate that regulatory arbitrage was favored, first, because arbitration was based on a new and untried law. Thus, sufficient uncertainty existed about the outcome under arbitration. Second, under the 1996 Act, the most favored nation principle applies. Thus, early agreements would benefit from a head start and from later adjustment if other entrants got a better deal through arbitration. This probably made small entrants free ride on the larger ones.
- Make biased decisions that either favor or punish the party seeking arbitration, while simultaneously punishing or favoring the other party. This makes the threat outcome of arbitration more punishing for the other party and thus favors voluntary outcomes.

Like all very stylized models, those by King and Maddock (1999) contain some simplifying assumptions that seem to go against essential properties of a situation. In particular, it appears that the absence of antitrust enforcement is at odds with the relevant empirical facts. However, the assumption may not be so bad. First, it substantially facilitates the analysis because it restricts the negotiated outcome to a division of a unique monopoly profit. With antitrust enforcement, the authors would have had to model the possible types of competition, resulting in a myriad of possible outcomes. Second, the qualitative insights are unlikely to change, because any type of competition can be expressed in terms of a profit distribution. Third, while the negotiations are adversary, the parties would have incentives to agree on keeping industry profits high. This is precisely what comes out when these firms do not go to arbitration. It does, however, mean that all types of access prices have to be admissible.

3. Two-way Access

3.1. Issues: Collusion versus exclusion

Two-way access has been around for a long time in the form of international calling arrangements between countries (settlements) and the arrangements between adjacent local exchange companies in the U.S..[28] These involve carriers that do not compete with each other and are therefore quite different from the situations of interest to Telecom NZ. The absence of competition can lead to extreme double marginalization problems, because the carriers can charge monopoly access charges from each other and then put a monopoly margin on top when they sell their output. In contrast, the two-way access problems that Telecom NZ is concerned with occur between

[28] In the US, this has often led to pooling arrangements. See Lehman and Weisman (1996).

competing carriers that operate at the same level of integration and offer local and long-distance services. The issues arising in this context are collusion and exclusion. Collusion means seeking joint benefits, while exclusion means hurting and being hurt by the other party.

The current contentious relationships between incumbent DOs and entrants do not raise the imminent specter of collusion. The telecommunications sector is probably subject to most of the same collusion problems as other concentrated industries. On top of those, however, telecommunications may become particularly prone to collusion for reasons similar to those that favor integration of telecommunications companies. Besides competing with each other, telecommunications firms have to collaborate with each other in the form of interconnection, provision of unbundled network elements and in the resale of services. All these collaborations occur, in principle, between all competing firms in the industry and on an ongoing basis. The collaboration is also sufficiently complex that it requires close relationships. Such collaboration between multiproduct firms in the form of reciprocal dealings has, in the past, been viewed as one of the reasons for reduced competition in some other sectors, such as the oil industry. Beyond the international settlements process, we have little experience in this respect with the telecommunications industry. Due to the antagonistic political process that jump-starts competition, initially the problem of collusion will be minor. However, over time it may well increase significantly. This is further enhanced by merger activities among new competitors in local networks. Such consolidation could be more of a problem in New Zealand than in the US, since in New Zealand the number of interacting competitors is likely to remain smaller. Collusion then need not occur in explicit forms but will be more subtle and therefore less subject to antitrust scrutiny. The question then arises if regulatory intermediation in collaborations between competitors would reduce the incentive to collude.

3.2. Interconnection pricing models

3.2.1. Laffont, Rey and Tirole [L-R-T](1998a and 1998b) and related work

3.2.1.1. Model assumptions

The literature on interconnection pricing (or access pricing) has largely focused on bottleneck situations in which at least one of the participating firms is regulated. The typical situation in this literature is that of a vertically integrated monopolist who experiences competitive entry by a firm that requires an essential input from the monopolist. Usually, regulation of the DO relates to final output prices or the price of the essential input or both. This describes the past situation in local telephone markets in the US and UK or in electricity markets quite well. However, these markets are quickly progressing to a more competitive state where the distinction between incumbent DO and entrants gets blurred and where deregulation has already been implemented (telephony in New Zealand) or is on the horizon (electricity in the UK

and the US). It is these markets of networks with more mature competition that L-R-T (1998a and b)[29] address.

The authors set up a model that might best fit local services in the telecommunications industry. They assume two competing firms that own networks and supply individual consumers who each subscribe to only one network (following from a discrete choice model). Thus, consumers consecutively have to decide on which network to subscribe to and how much to call. If consumers want to communicate with someone on the other network interconnection between the networks is required. Although they could play a major role in such networks, the usual telephone network externalities and call externalities (based on incoming calls) are not specifically modeled. Rather, consumer utility only depends on outgoing calls. This has the advantage that any "network externalities" discovered in the models described by the two papers are more easily identified as being of a different kind. Additional consumer-related assumptions include

- that networks are differentiated in a Hotelling framework, meaning that consumer preferences are spread along a line and networks make product differentiation choices by locating at a point on the line. In this case, they are assumed to be located at the opposite extreme points of the line. The degree of substitutability between networks is given by the size of transport costs on the line.
- that there are isotropic calling patterns, meaning that, at the same calling charge, the inbound and outbound calls are balanced.
- L-R-T allow users to subscribe to only one network.

Cost structures of full coverage networks are assumed to be the same. Except for subscriber-specific fixed costs, there are no network size related or density related production economies. The two L-R-T papers assume unregulated retail markets, while the access market may or may not be regulated.

3.2.1.2. Symmetric, full coverage networks, and linear pricing:

In the first part of L-R-T (1998a) interconnection charges are assumed to be *reciprocal* by law. The authors first establish a Ramsey-pricing solution as a benchmark. The outcome here is that the access charge is <u>below</u> marginal costs, because, due to imperfect retail competition firms have positive markups in the retail market. This result is unambiguous because of constant returns to scale. Under economies of scale, Ramsey access charges could be below or above marginal costs, depending on the degree of scale economies and the size of the retail markup.

L-R-T then check the existence of competitive equilibria, derive equilibrium retail prices and undertake comparative statics with respect to two parameters: the access price and the degree of substitution between the networks. Their main results here are the following:

- Existence of a (pure strategy) equilibrium requires the access price and/or the substitutability between networks not to be too high.[30]
- In equilibrium, retail prices are symmetric.

[29] See also Laffont and Tirole (forthcoming), where these articles are explained in more intuitive ways.
[30] L-R-T give no precise indication what is too high substitutability.

- The equilibrium retail price increases with the access price.
- The equilibrium retail price decreases with the substitutability between networks and converges against the Ramsey price (if, at the same time, the access price is low enough to allow for existence of the equilibrium). This is a typical result of the Bertrand pricing assumption.
- The firms agree on access charges so that joint profits are maximized.[31]

To understand the last outcome consider the effects of access charges above marginal costs. First, the access charge above marginal costs raises each firm's marginal costs for outgoing calls, thus increasing the optimal resale price. Thus, isotropic (balanced) calling patterns do not imply an indifference to the size of the (reciprocal) access charges. The reason is that the balanced outcome is an equilibrium, but would not result if retail prices differed. Second, lowering the retail price has two effects: It lures away subscribers from the other network; and it increases the call volume of given subscribers. Lowering the retail price therefore has a negative effect on access profits. Another way of seeing this is that, at an access charge above the marginal cost of access, the marginal costs faced by a firm for an outgoing call increases in the other firm's market share. This "endogenous marginal cost effect" is due to the increased share of off-net calls. It further lessens the incentive to compete at retail. Another interpretation of the same phenomenon is given by Armstrong (1998), whose paper is very similar to the first part of L-R-T (1998a). In Armstrong's interpretation, when access charges are set according to the collusive equilibrium rule, then firms have no incentive to deviate from the collusive retail price because the gain in profits from undercutting the rival is just compensated by the increase in access payments needed for the increased number of calls going to the other network (and the reduced number coming from there).

In the case of *nonreciprocal* access charges the authors apply a two-stage game approach in which both access charges and retail prices are determined noncooperatively. In the noncooperative framework the access charges in both directions are independent of each other. They therefore do not act as a coordinating device.[32] Rather, they lead to the problem of double marginalization. This is the more severe, the less substitutable the networks are for each other. Armstrong (1998) observes that these noncooperatively chosen access charges will be higher than the cooperatively chosen reciprocal charges. L-R-T's additional main results in the noncooperative case are:

- If substitutability is sufficiently low there exists a symmetric equilibrium in access charges and retail prices, involving double marginalization. Thus, reciprocal access charges are an equlibrium outcome in this model!
- As long as the equilibrium exists, higher substitutability implies a lower equilibrium retail price, while the effect of higher substitutability on the equilibrium access price is ambiguous.

[31] Noncooperatively determined access charges may even lead to higher than monopoly retail prices.

[32] Recall that this is a one shot game. The authors therefore do not ask if collusion could arise in a repeated game framework.

3.2.1.3. Competition between large incumbent and small entrant

Next, the authors look at a situation involving an incumbent firm with full coverage and an entrant, who can choose its level of coverage. The incumbent's overall market share is now the average between its monopoly in the area not covered by the entrant and its market share in the remaining, competitive (= duopoly) area.[33] A crucial assumption in this model is the absence of retail price discrimination between the two areas and between on-network and off-network calls.[34] The main results here are:

- If the access price is mandated at some low rate close to marginal costs:
    - The entrant undercuts the incumbent in the retail price and incurs an access charge deficit.
    - The entrant underinvests in coverage in order to soften price competition (entrant as puppy dog).
- The authors only sketch an equilibrium determination of the access price through bargaining. They suggest that:
    - The incumbent may use the access price (or the bargaining process) to corner the market and maintain a monopoly.
    - The entrant may overinvest in coverage in order to keep the access price down.

The rationale for these results comes directly from the assumption that the incumbent cannot price discriminate geographically by charging a lower price in the duopoly area than in the monopoly area. The aggressiveness of the incumbent's pricing behavior is therefore linked to the size of the entrant's coverage. If the entrant covers only a small territory, the incumbent is pricing less aggressively than if the entrant's territory is large. The reason is that the incumbent would like to exploit its monopoly position in its captive area. Hence, the entrant's market share in the duopoly area is going to be larger if that area is small than if it is large.

The entrant's strategy very much depends on the rules for determining price and conditions of access (call termination). Because the entrant prices more aggressively than the incumbent does, the entrant wants low termination charges. At the same time, the entrant may also want to use the termination charge as a collusive device. These incentives combine with the default rule on access in case negotiations fail. If the default rule is "no interconnection" the entrant has incentives to invest in high coverage so that the incumbent would be more interested in interconnection. If the default rule is guaranteed interconnection at a maximum price the entrant will underinvest in coverage, in order to soften the incumbent's retail pricing behavior. If expanded coverage by the entrant is a credible possibility, the incumbent may therefore actually prefer mandated, low price access to a default rule of no access or high priced access.

In a related approach, Armstrong (1998) considers a large incumbent and a small entrant, using the assumption that consumers prefer the incumbent over the entrant so that, at the same retail prices, the entrant's market share would vanish. It is then clear that the entrant can only survive at lower prices. This implies (with isotropic calling

[33] In my view, the area does not have to be interpreted in a geographic sense. It could also refer to types of customers. Thus, the entrant could be restricted to large business users.
[34] Price discrimination is covered in L-R-T (1998b).

patterns) that the entrant incurs an access charge deficit with the incumbent. As a result, the entrant will prefer lower access charges than the incumbent. Armstrong shows that the access pricing problem in this case is similar to that of one-way access, interpreting the entrant's demand for access as its net demand (or access charge deficit).

3.2.1.4. Nonlinear pricing

The last two-way access model developed in L-R-T (1998a) concerns retail competition in nonlinear pricing for two full coverage networks. Since firms are fully informed about consumer utility (there is only one type of consumer), they can achieve optimum (= perfectly discriminating) outcomes through two-part tariffs. Two-part tariffs make sense because of customer-specific fixed costs. The main results are:

- Equlibrium exists if access prices and substitutability are not too high.
- Such an equilibium is symmetric.
- Optimal usage fees (for endusers) are firm specific marginal costs (that include access charges.
- Optimal fixed fees equal marginal costs of adding a customer (net of the net access charge revenue generated) plus a markup reflecting substitutability.
- The profit in equilibrium is independent of the access charge. Thus, the access charge creates no incentive to collude.

The last result comes about because the firm uses the fixed fee to take away subscribers from the other network, while the usage fee stays constant to balance calls between the networks. Thus, both firms use the two parts of the retail tariffs as distinct instruments, one to influence market share and the other to influence calling volume.

The assumption of homogeneous subscribers is responsible for the clarity of the two-part tariff outcome. Had subscribers been heterogeneous, usage prices would optimally depart from marginal costs. The collusive impact of high access charges would therefore not be fully eliminated (Armstrong, 1998).

3.2.1.5. Discriminatory pricing (L-R-T, 1998b)

The new item over L-R-T (1998a) is that networks can discriminate between calls that terminate within the call originating network (on-network calls) and those that terminate on the other network (off-network calls). Such discrimination has been common in the US telephone industry (originally introduced as "Friends and Family" by MCI in the 1980s).

The authors first establish that price discrimination of this kind has no value in the benchmark Ramsey optimum and that both networks attain the same market share (and full coverage). Price discrimination is not welfare optimal because it leads to different marginal rates of substitution between on-net and off-net calls. The authors then determine existence of market equilibria and market shares in equilibrium. This is a fairly tricky endeavor because the market share of a firm depends on the

expectation of consumers about how market shares will be distributed in equilibrium. Multiple equilibria are therefore possible (but L-R-T argue that is not a major issue). Next, equilibrium prices are derived. The existence of equlibrium depends (as in 1998a) on the access price and the substitutability between networks not being too high. In symmetric equilibrium the on-net retail price decreases with substitutability and with the access price. The off-net price is proportional to the on-net price, where the proportionality factor itself rises with the access charge. Also, if substitutability is sufficiently small, the off-net price increases in the access charge. Again, the intuition is that through a low on-network price you encourage on-network calling, whereas with a high off-network price you discourage off-network calling.

The main insight of L-R-T (1998b) is to show the existence and working of price-induced network externalities. Belonging to a larger network allows a consumer to do more lower priced on-network calls. Thus, a high access charge that leads to a high off-network retail price hurts a network with a small market share. A full coverage incumbent can squeeze a small coverage entrant through a high access price. This is important for access charge regulation and for regulatory permission of price discrimination in the retail market. Another, not too surprising insight of the paper is that banning price discrimination may hurt social welfare. This holds for networks that are poor substitutes and for positive markups of access charges over access costs.

In this model, an increase in access charge may actually increase retail competition, because an access charge increase drives a wedge between the marginal cost of an off-net call as opposed to an on-net call. High access charges therefore are not necessarily a good collusion device. Rather they induce firms to increase their market shares in order to have more on-network calls (avoiding the access charge). In a second best sense, therefore, the price discrimination can improve welfare by reducing double markups (on access and retail) if networks are sufficiently differentiated. This will happen, because the high off-net price will not have many users. The problem is that, at the same time, the incumbent could foreclose a small entrant. This problem suggests that a regulator would want to forbid such price discrimination, when competition is in its infancy, while such price discrimination would be advisable, once entrants are viable (having large coverage sunk networks).

3.2.1.6. Economides, Lopomo and Woroch (1996)

Economides, Lopomo and Woroch (1996) have an approach similar to L-R-T (1998a). However, their main model differs from L-R-T by the assumption that consumers first choose, which network to subscribe to. Then networks set their prices and then subscribers make their consumption decision. While this sequence seems to reflect the reality that subscription decisions are more long term than usage decisions, it has the unrealistic implication that networks become monopolists with respect to the usage decision of subscribers. As a result, the model is close to one on international settlements. This means that there will always be monopoly pricing for usage. However, if access charges (for termination of calls) are determined unilaterally there will, in addition, be a double markup problem, which vanishes if reciprocity is imposed as a regulatory rule. The authors also look at first mover advantages (Stackelberg leader in access charges), which, again, are severe for the case of independent setting of access charges, while first-mover advantages disappear under

reciprocity. The conclusion on reciprocal access charges is thus in stark contrast to L-R-T. The authors also show that the ECPR does not hold ex post under independent setting of access charges by a firm with first mover advantages.

3.2.1.7. Carter and Wright (1999)

The paper by Carter and Wright (1999) is in many respects a simplified version of L-R-T (1998a). They provide some additional insights. For example, they show that, even if a regulator imposes marginal cost pricing at retail but regulates access charges only by requiring reciprocity, the networks can sustain monopoly profits by agreeing on high access charges. Thus, Carter and Wright emphasize the fact that negotiation over access charges leads to collusion that would be forbidden in the retail market. As a consequence, Carter and Wright recommend regulation of access charges rather than regulation of retail prices.

3.2.1.8. General critique of L-R-T (1998a and b)

The L-R-T (1998a and b) models of two-way access suggest that reciprocal access charges may be perfect tools for collusion. However, several features counterbalance the collusive effects:

- incentives to build market shares (tough competition that destroys equilibria),
- the use of two-part tariffs at retail,
- discrimination between on-net and off-net calls.
- In addition, Laffont and Tirole (forthcoming) suggest that the collusion incentive would be reduced if firms could subsidize their subscribers for incoming calls. The intuition here is that firms would want to do that if access charges exceed marginal costs, making calls coming from the other network profitable.

The rationale for the last three mechanisms for reducing collusion is that they introduce a second price as an instrument that undermines collusion. At the same time, it is well known that these mechanisms all work imperfectly, because firms do not have full information about the customers' demands. Thus, the incentive to collude may override the effects of these mechanisms.

Like all theoretical analysis, L-R-T use simplifying assumptions and get some restrictive results. The following observations concern the generality of the model:

No economies of scale. L-R-T use a constant returns to scale framework. This assumption allows them to concentrate on issues that are not cost driven. However, some of the results are driven by this assumption. L-R-T indicate how those results would change under economies of scale. In my view, the assumption of economies of scale would not change the main qualitative results.

Nonexistence of equilibria. Nonexistence of equilibria (and, to some extent, the existence of multiple equilibria) is a major result of the papers. It does not become clear, how severe and common such nonexistence would be. The reason for nonexistence is that close substitutability and high access charges cannot hold in equilibrium, because high access charges imply a high retail price. However, at high

substitutability a firm can undercut the other in the retail market and get all customers, thus bypassing the access charge. This is a problem with Bertrand models.

Is nonexistence the result of important economic phenomenon or just a modeling problem (that could be solved through the admission of mixed strategy equilibria)? L-R-T argue that it the result of an economic phenomenon they call "endogenous marginal cost effect." By this they mean that, if access charges exceed the marginal cost of access, then the marginal costs of an outgoing call (on average) increases in the other firm's market share, because of the increased likelihood that it will be an off-network call. However, at high substitutability, market share can be gained easily by slightly undercutting the price charged by the other network. The problem with nonexistence of equilibria is that one cannot learn from the model, what actually will happen. L-R-T suggest an unstable situation. This, according to their model, could well prevail if networks are close substitutes.

One shot Bertrand model. A related problem with the model is that it uses a one-shot Bertrand approach. The telecommunications industry is characterized by long-lived sunk assets. Then it does not make sense to have a model where price cannot be adjusted after capacity is set. Price is usually a short term variable. Our discussion of Economides, Lopomo and Woroch (1996) suggests that allowing the firm to set price last will change the outcome, though not in a more convincing way. The question then is if a Cournot model would be more realistic.

Dependence on high demand elasticity. L-R-T use a constant demand elasticity framework. It is well known that, in such a case, demand has to be elastic in order to allow for finite collusive prices. Empirically, telecommunications demand tends to be inelastic, however. In my view, the high demand elasticity is harmless, at least for the models that yield collusion. They would have even stronger collusive implications (in the sense that markups would be even higher) with inelastic demand.

Hotelling assumption. Hotelling product differentiation is not a completely general model. For example, it does not capture very well perceived quality differences (incumbency advantages) that hold for essentially all consumers. Although the Hotelling model may not ideally characterize product differentiation in telecommunications, it so far is the only game in town for the main results on collusion. Similar results are now available from Armstrong (1998), Buehler (1999) and Carter and Wright (1999), who use either the same or only slightly different demand frameworks. Armstrong makes market shares depend on the difference of utility gained by subscribing to one network rather than the other. Armstrong's contains the Hotelling framework as a special case. In the case of Buehler, demand functions for the two networks depend on randomly distributed tastes (logit random utility model). Buehler does not discuss this assumption. So, it is hard to judge. Carter and Wright use a market share function for network subscription of the form $s(p_1,p_2)$ that also reduces to the Hotelling model as a special case. Brennan (1997), using a homogeneous goods model with Bertrand competition, provides some nice insights on the incentive to collude and on the effects of free entry through which excess profits are competed away while the inefficiencies created by collusion are maintained.

Isotropic (balanced) calling patterns. In the US, CLECs (competitive local exchange carriers) were initially afraid that they would have much more outgoing than incoming traffic (due to multiple lines of business customers, who would use the CLECs for their outgoing traffic, but keep their ILEC (incumbent local exchange carriers) lines for incoming traffic). However, due to the Internet, the actual calling patterns were often reversed. These experiences suggest that balanced calling patterns are unrealistic. Dessein (1998), building on L-R-T (1998a and b), shows that violation of the balanced traffic assumption strengthens some and weakens some of the L-R-T conclusions. He assumes that there are high volume customers with more outgoing than incoming calls and low volume customers with more incoming than outgoing calls (at the same prices). The high volume customers are increasing usage more for a given price reduction than the low volume customers (higher price elasticity). As a result of this (sensible) set of assumptions:

- The endogenous marginal cost effect is strengthened and an access charge above marginal costs has an even larger collusive effect than in the L-R-T model for linear prices. At the same time, large users are attractive as subscribers, so that competition for them is increased.
- The L-R-T result on two-part tariffs (and other non-linear prices), however, is confirmed.
- In the case of partial coverage by an entrant, under linear pricing, the incumbent can exclude the entrant and enjoy monopoly profit. Under nonlinear pricing, the entrant can avoid such fate by specializing on target groups with special calling patterns and offering them low fixed charges and high usage charges, thus creating an access charge surplus with the incumbent.

Overall, L-R-T (1999a and b) are ambitious papers, containing a lot of propositions and insights about two-way access pricing. The main questionable assumption appears to be the Bertrand pricing approach, which leads to nonexistence of equilibria in cases of close substitutability between the networks. The results on incentives for collusion created by reciprocal pricing is shared by other models and appears to be quite robust.

3.2.2. Other models

3.2.2.1. Bill and keep (peering)

In the past, the interconnection arrangements between Internet Service Providers (ISPs) were of the bill-and-keep kind, meaning that reciprocal services were provided free of charge. These so-called “peering arrangements” have induced some economists, such as Brock (1995) to call for similar arrangements among (competing) telecommunications network providers (ILECs and CLECs in particular). More recently, the Internet arrangements have changed. Now, peering arrangements without charge only continue between core ISPs, while non-core ISPs have to pay. The core ISPs have negotiated separate interconnection agreements on a one-to-one basis. These agreements make core ISPs accept traffic from each other for their own customers, but that does not include transit traffic to other core ISPs. In contrast, non-core ISPs have to use transit and pay for that. Milgrom, Mitchell and Srinagesh (1999) use a non-cooperative bargaining framework to analyze the incentives of a core ISP to enter into or refuse peering with another ISP. They hypothesize that in early stages of

the Internet market development network size did not convey a major bargaining advantage so that bill-and-keep arrangements would be likely outcomes independent of relative sizes. In contrast, in the later stage, with increasing market penetration the larger ISPs gain a bargaining advantage over smaller ones because their own customers value outside communications less highly than before. Milgrom, Mitchell and Srinagesh argue that the resulting peering arrangements (and the lack thereof) are efficient, as long as there are enough core ISPs competing with each other.

3.2.2.2. Haring and Rohlfs, IEP 1997 (proposal for light regulation):

Haring and Rohlfs do an insightful analysis of costs saved by ILECs when interconnecting with CLECs. This analysis calls for *a*symmetric pricing. As far as I can see, there are two underlying reasons for this. The first is sunk costs. A large part of the ILEC network represents sunk costs that cannot be saved. The second is the relative size and coverage of the ILEC network compared to the CLEC network. A CLEC with a small network provides less reciprocal services to an ILEC than a CLEC with a large network. This second reason comes out clearest if both networks are in place so that the sunk cost argument would cut both ways. The two networks would still have to interconnect to realize the network externality.

Haring and Rohlfs suggest an approach to competition in local telecommunications that would be substantially less regulatory than the current US policy. They suggest that the ILEC get flexibility in their retail pricing and be allowed to price interconnection and unbundled network elements at will, with the provision that the CLEC prices interconnection symmetrically (at the same level). This suggestion comes somewhat as a surprise after the authors' cost analysis indicates that for most types of unbundled services the ILEC's costs are quite different from those of the CLEC. At the same time, the authors argue that the ILECs would want to price these services at cost because otherwise there would be inefficient bypass by the CLECs. There is obviously one simple explanation for at least part of this apparent contradiction. Having lower costs, ILECs would price these services at (or epsilon below) CLEC costs. That is precisely what the CLECs are afraid of. In the very short run, their costs are often infinite and in the short and medium run, their costs are still quite much higher than the ILEC costs. Haring and Rohlfs also argue that CLECs have large influence on the direction of traffic. Therefore, if ILECs set (symmetric) interconnection charges too high, CLECs would induce ILECs to incur an access charge deficit. This argument is obviously informed by the observation that CLECs in fact seem to accumulate surpluses with ILECs.

Haring and Rohlfs point their finger at a possibly glaring gap in the US development, and that is deregulation (or at least structural flexibility) of local retail prices charged by ILECs. They see this step as a prerequisite for their suggestion of freely negotiated interconnection agreements between ILECs and LECs with the proviso that prices are symmetric in both directions.

3.3. Regulatory approaches to negotiations

3.3.1. U.K. on negotiations between landline and cellular

Because fixed and mobile services are just beginning to compete with each other, two-way access charges between landline and cellular networks pose problems somewhere between those between international carriers and those between competing networks. Armstrong (1997) discusses the UK process of finding termination charges between landline and cellular networks. Under this process, the regulator only comes in if private negotiations fail. Once the regulator is asked to do so, the yardstick is "fully allocated costs". Armstrong notes that this process has a drawback if a landline network owns (or partially owns) the cellular network. In that case, privately agreed termination charges may not be in the public interest, but the regulator is not asked to interfere. Thus, pressure would have to come from other cellular operators.

3.4. One-way and two-way access combined: Unbundled network elements (UNEs)

As we have seen, in one-way access problems high access charges exclude competitors, while in two-way access problems they can either hurt competitors or be an instrument of collusion. Often, one-way and two-way access problems occur between the same firms. This happens in the case of unbundled network elements (UNEs). UNEs have been introduced by regulators in the US and some other countries (Germany) as a tool to facilitate entry in the local exchange and complement partial networks of entrants. They are controversial because their provision can be very intrusive on incumbents and involve potentially high physical and transaction costs. At the same time, they potentially help reduce wasteful duplication of facilities. While the provision of UNEs can be justified under the essential facilities doctrine, the FCC (1999) recently created "necessary" and "impair" standards. The "necessary" standard requires that an entrant would be unable to offer a service without access to that element, while under the "impair" standard the ability of the entrant to offer the service without access to that element would only be materially diminished. Since the "necessary" standard is stronger, the requirement of fulfilling this standard applies even to proprietary UNEs (such as certain data bases) that an ILEC would not have to supply under the "impair" standard.

3.4.1. Laffont and Tirole (forthcoming)

UNEs, while helping entrants and being a means of regulatory and competition policy (based on the essential facilities doctrine), therefore also have competition-reducing effects. First, they reduce excess capacity that could lead to fierce competition. Second, the price to be paid for UNEs is a cost to the entrant and a source of revenue to the incumbent (Laffont and Tirole, forthcoming, Part V, Chapter 6). Thus, to the extent that UNEs are profitable, they make the incumbent compete less for retail customers. Incumbents, nevertheless, tend to oppose UNEs because they speed up entry that otherwise could be delayed or avoided altogether and because price regulation tends to make UNEs unprofitable.

Entrants using UNEs often have their own networks (built partially or fully through the UNEs). They therefore require the incumbent's termination services and the incumbent requires their termination services. As a result, UNEs represent a situation with both one-way and two-way access. Because of scale economies, at least one of the charges has to exceed marginal costs, in order to make the incumbent break even. Both, the termination charge and the UNE charges could then be used as a coordination device by the network providers. Laffont and Tirole (forthcoming, Part V, Section 6) advise regulators to let termination charges be at or below marginal costs and the UNE charge above marginal costs because low termination charges preserve a level playing field without expropriating the incumbent. They recommend a markup that takes care of the joint and common costs of the network (spread over UNEs, including those imputed to the incumbent).

3.4.2. Farrell's suggestion for deregulation of UNEs

Farrell (1997) suggests deregulating UNEs, once they are provided by more than one firm. Thus, if the incumbent DO faces an entrant who duplicates a UNE, that particular UNE would be offered under deregulated terms. Farrell does not define the geographic scope of this deregulation. However, his arguments seem to imply that the geographic scope would follow the alternatives that entrants without such UNEs would have. The suggestion assures the entrant that he does not face competition from an incumbent who is forced to offer that UNE at incremental costs. At the same time, the incumbent DO has little incentive to hinder the entrant's investment, since it opens the door to deregulation. Farrell even believes that the incentives to invest could be larger than optimal, because third entrants providing UNEs may not be profitable.

3.4.3. Noam's deregulatory approach

Noam (forthcoming) suggests a highly deregulatory approach to access pricing. His third party neutrality (TPN) framework gives the incumbent (or any other) carrier full freedom to connect with other carriers or not. This includes charging any access price. However Noam gives the incumbent's subscribers a right (directly or indirectly) to accept traffic from any other network. And, the prices for monopolistic bottleneck segments, charged by the incumbent (or any other carrier), have to be piggy-backed on competitive prices, by setting the price for monopolistic segments equal to the average of competitive segments (adjusted for lower densities, etc.). While the TPN principle itself may be weak in promoting competition, the piggybacking suggestion is innovative and implementable.

4. Conclusions

This is a review of the state of the economic literature about interconnection. While its focus is on telecommunications, the principles it reviews are more or less relevant to other networks depending upon their particular characteristics. The review considers only the pricing element of an interconnection contract, leaving aside other issues such as risk sharing[35], transactions costs and technological agreement. It does

[35] For a discussion of aspects of risk bearing in interconnection contracts see Evans and Quigley (2000).

not consider the direct or political economy costs of regulation. Even so, it reveals that the pricing issues have not been solved.

It is apparent from the review that interconnection pricing can only be appraised in the wider context of the regulation and competition of the market as a whole. For example, the properties of the now-famous Baumol-Willig (ECPR) rule are different when there is a retail price cap than without it. It is critical for the special treatment of interconnection contracts that there are natural monopoly elements in the network. Where these are absent or bypass is economically viable interconnection contracts will generally not pose special competition concerns.

The survey reviews the conceptual basis of proposed regulatory schemes and measurement issues that arise in their use. In particular, it considers various price-cap mechanisms. It does not review the empirical literature on industry and regulatory performance under the different regulatory regimes.

Where there are natural monopoly elements, the review suggests that, for one-way access, the two leading approaches to regulation appear to be price caps or access price caps combined with deregulated retail tariffs. These approaches would include a form of the Baumol-Willig rule. The review emphasises that two-way access is characterized by both potential exclusion and potential collusion. It suggests that a regulatory approach would seek to concentrate on keeping access charges low. Light-handed regulation would then come in the form of deregulated retail tariffs. Taken together, this suggests that, in a system with both one-way and two-way access, there might be access price caps, possibly with two baskets, one for one-way access and one for two-way access charges. At the same time, retail would be deregulated. In New Zealand the regulatory price cap has been on household access.

As usual in economics, the academic literature on network access and interconnection has concentrated on issues of optimal pricing. This survey reflects that emphasis. Nevertheless, the pricing issues have not been solved. In the one-way access case, it appears that the two most promising approaches to light-handed regulation are global price caps or access price caps combined with deregulated retail tariffs. These approaches would include the ECPR in the form of an imputation rule that would prevent the dominant DO from using exclusionary practices. Since the two-way access problem is characterized by both potential exclusion and potential collusion, any regulatory approach will want to concentrate on keeping access charges low, probably at or below marginal cost. Light-handed regulation would then come in the form of deregulated retail tariffs. Taken together, this suggests that, in a system with both one-way and two-way access problems, there should be access price caps, possibly with two baskets, one for one-way access and one for two-way access charges. At the same time, retail should be deregulated.

The literature surveyed on private negotiations is quite thin. It suggests that regulators can step in as backups if private negotiations fail. This would allow regulators to concentrate on contentious issues, while the “technical” issues would be resolved privately. At the same time, L-R-T (1998) suggest that private negotiations could lead to outcomes the regulator would not want.

References

Armstrong, Mark, "Mobile Telephony in the U.K.," mimeo, September 1997.

Armstrong, Mark, "Network Interconnection in Telecommunications," *The Economic Journal* 108, 1998a, pp. 545-564.

Armstrong, Mark, "Local Competition in UK Telecommunications", in *Regulating Utilities: Understanding the Issues*, edited by Michael Beesley, Institute of Economic Affairs, 1998b.

Armstrong, Mark, "Regulation and Inefficient Entry: Economic Analysis and British Experience," mimeo, Nuffield College, November 1999.

Armstrong, Mark, Chris Doyle and John Vickers, "The Access Pricing Problem: A Synthesis, *Journal of Industrial Economics* 44, 1996, pp.131-150.

Armstrong, Mark, and John Vickers, "The Access Pricing Problem with Deregulation," *Journal of Industrial Economics* XLVI, 1998, pp. 115-121.

Arnbak, Jens, Bridger M. Mitchell, Werner Neu, Karl-Heinz Neumann, and Ingo Vogelsang, "Network Interconnection in the Domain of ONP," Final WIK/EAC Report of Study for the European Commission, Brussels, November 1994.

AT&T, "Reply Comments of AT&T Corp.", CC Docket 96-98, May 30, 1996.

Baumol, William J., "Some Subtle Issues in Railroad Regulation", *Journal of Transport Economics* 10, 1983, pp.1-2.

Baumol, William J., and J.Gregory Sidak (1994), *Toward Competition in Local Telephony*. Cambridge, Mass.: MIT Press and American Enterprise Institute Press.

Baumol, William J., Janusz Ordover and Robert Willig, "Parity Pricing and its Critics: A Necessary Condition for Efficiency in the Provision of Bottleneck Services to Competitors," *Yale Journal on Regulation* 14, 1997, pp. 145-163.

Beard, T. Randolph, David L. Kaserman, and John W. Mayo, "Regulation, Vertical Integration, and Sabotage," mimeo, 1999.

Biglaiser, Gary, and Patrick DeGraba, "The Economics of BOC Long Distance Entry when Access Rates are above Costs," University of North Carolina, Chapel Hill, Department of Economics Working Paper 99-08, 1999.

Brennan, Timothy J., "Industry parallel interconnection agreements," *Information Economics and Policy* 9, 1997, pp. 133-150.

Brock, Gerald W., "The Economics of Interconnection," Teleport Communications Group, Staten Island, New York, April 1995.

Brock, Gerald W., "Local Competition Policy Maneuvers", in G.L. Rosston and D. Waterman (eds.), *Interconnection and the Internet*, Selected Papers from the 1996 Telecommunications Policy Research Conference, Mahwah, NJ: Lawrence Erlbaum Associates, 1997, pp.1-14.

Burnell, Stephen, Lewis Evans, and Shuntian Yao, *Optimal Network Interconnection Contract under Partial Bypass in Oligopolistic Network Industries under Light Regulation*, paper presented to the International Telecommunications Society (Wellington, 1995 and Seville, 1996), and the Rutger Center for the Study of Regulated Industries (San Diego, 1996) *(*a version containing minor revisions can be found at *http://www.iscr.org*)

Gary W. Brock and Michael L. Katz, "Regulation to promote competition: A first look at the FCC's implementation of the local competition provisions of the telecommunications act of 1996," *Information Economics and Policy* 9, 1997, pp. 103-118.

Buehler, Stefan, "Network Competition under Asymmetric Interconnection Regulations: Lessons from the Swiss Case," mimeo, 1999.

Burton, Mark L., David L. Kaserman and John W. Mayo, "The Economics of Common Costs: Lessons from (and for) Regulatory Policy", Paper Presented at AEI Conference "Pricing and Costing a Competitive Local Telecommunications Network", Washington, November 4, 1997.

Carter, Michael, and Julian Wright, "Interconnection in Network Industries," *Review of Industrial Organization* 14 (1), February 1999, pp. 1-25.

Dessein, Wouter, "Network Competition when Customers are Heterogeneous," mimeo, June 10, 1998.

Diamond, Peter A., and Mirrlees, James A., "Optimal Taxation and Public Production. I: Production Efficiencies. II: Tax Rules," *American Economic Review* 61, 1971, pp. 8-27 and 261-278.

Economides, Nicholas, "Principles of Interconnection," a Response to "Regulation of Access to Vertically-Integrated Natural Monopolies" submitted to the New Zealand Ministry of Commerce, October 1995.

Economides, Nicholas, "The Incentive for Non-Price Discrimination by an Input Monopolist," *International Journal of Industrial Organiztion* 16, 1998, pp. 271-284.

Economides, Nicholas, Guiseppe Lopomo, and Glenn Woroch, "Strategic Commitments and the Principle of Reciprocity in Interconnection Pricing," mimeo, 1996.[36]

[36] There exists a 1999 version with failrly minor changes.

Ergas, Henry, and Eric Ralph, "Pricing Network Interconnection: Is the Baumol-Willig Rule the Answer?" Paper prepared for the Trade Practices Commission, Australia, 1997.

Evans Lewis T. and Neil C. Quigley, "Contracting Incentives for Breach and the Impact of Competition Law", *World Competition*, 23 (2), forthcoming, June, 2000.

Farrell, Joseph, "Prospects for Deregulation in Telecommunications", Speach as Departing Chief Economist of the FCC, 1997, available at http//www.fcc.gov/Bureaus/OPP/Speeches/jf050997.html.

FCC, *Implementation of the Local Competition Provisions in the Telecommunications Act of 1996,* First Report and Order, CC Docket 96-98, FCC 96-325, issued August 8, 1996.

FCC, *Implementation of the Local Competition Provisions in the Telecommunications Act of 1996*, Third Report and Order and Fourth Further Notice of Proposed Rulemeaking, CC Docket 96-98, FCC 99-238, November 9, 1999, available at http://www.fcc.gov/Bureaus/Common_Carrier/Orders/1999/index4.html.

Gabel, David, and Richard Gabel, "The Application of Cost Data in the Telecommunications Industry", Paper Presented at the 25th Telecommunications Policy Research Conference, Alexandria, Virginia, September 27-29, 1997.

Gasmi, Farid, Jean-Jacques Laffont, and William W. Sharkey, "Incentive Regulation and the Cost Structure of the Local Telephone Exchange Network," *Journal of Regulatory Economics* 12, 1997, pp.5-25.

Gasmi, Farid, Jean-Jacques Laffont, and William W. Sharkey, "A Technico-Economic Methodology for the Analysis of Local Telephone Markets," in J.K MacKie-Mason and D. Waterman, *Telephony, the Internet and the Media*, Mahwah, NJ: Lawrence Erlbaum, 1998, pp.. 15-36.

Haring, John, and Jeffrey H. Rohlfs, "Efficient competition in local telecommunications without excessive regulation," *Information Economics and Policy* 9, 1997, pp. 119-132.

Hausman, Jerry A., "Valuing the Effect of Regulation on New Services in Telecommunications," Brookings Papers on Economic Activity – Microeconomics, 1997, pp. 1-38.

Hausman, Jerry A., and Timothy J. Tardiff, "Efficient local exchange competition," *Antitrust Bulletin*, Fall 1995, pp. 529-556.

Hubbard, R. Glenn, and William Lehr, "Telecommunications, the Internet and the Cost of Capital," Paper presented at the Telecommunication Policy Research Conference, September 25-27, 1999, Arlington, Virginia.

Kahn, Alfred E., Timothy J. Tardiff, and Dennis L. Weisman, "The Telecommunications Act at Three Years: An Economic Evaluation of its Implementation by the Federal Communications Commission," *Information Economics and Policy*, forthcoming.

Katz, Michael L., "Economic Efficiency, Public Policy, and the Pricing of Network Interconnection Under the Telecommunications Act of 1996", in G.L. Rosston and D. Waterman (eds.), *Interconnection and the Internet*, Selected Paper from the 1996 Telecommunications Policy Research Conference, Mahwah, NJ: Lawrence Erlbaum Associates, 1997, pp.15-32.

King, Stephen P., and Rodney Maddock, "Light-handed regulation of access in Australia: negotiation with arbitration," *Information Economics and Policy* 11 (1), March 1999, pp. 1-22.

Laffont, Jean-Jacques, Patrick Rey, and Jean Tirole, "Network Competition: I. Overview and Nondiscriminatory Pricing," *RAND Journal of Economics* 29(1), 1998a, pp. 1-37.

Laffont, Jean-Jacques, Patrick Rey, and Jean Tirole, "Network Competition: II. Price Discrimination," *RAND Journal of Economics* 29(1), 1998b, pp. 38-56.

Laffont, Jean-Jacques, and Jean Tirole, *A Theory of Incentives in Procurement and Regulation*, Cambridge, MA: MIT Press, 1993.

Laffont, Jean-Jacques, and Jean Tirole, "Access Pricing and Competition," *European Economic Review* 38, 1994, pp. 1673-1710.

Laffont, Jean-Jacques, and Jean Tirole, "Creating Competition Through Interconnection: Theory and Practice", *Journal of Regulatory Economics* 10, 1996, pp. 227-256.

Laffont, Jean-Jacques, and Jean Tirole, *Competition in Telecommunications*, Cambridge, MA: MIT Press, forthcoming.

Larsen, Alex, "Interconnection and Access Pricing: A Derivation of the Efficient-Component Pricing Rule," mimeo, Southwestern Bell Telephone Company, October 1995.

Lehman, Dale E., and Dennis L. Weisman, "Telephone Pools and Economic Incentives," *Journal of Regulatory Economics* 10, 1996, pp. 123-146.

Lehman, Dale E., and Dennis L. Weisman, "The Telecommunications Act of 1996: The 'Costs' of Managed Competition," Book Manuscript, August 1999.

Lewis, Tracy R., and David E.M. Sappington, "Access pricing with unregulated downstream competition," *Information Economics and Policy* 11 (1), March 1999, pp. 73-100.

Mandy, David M., “Killing the Goose that May have Laid the Golden Egg: Only the Data Know Whether Sabotage Pays,” *Journal of Regulatory Economics*, forthcoming.

Masmoudi, Hautam, and Francois Prothais, “Access Charges: An Example of Application of the Fully Efficient Rule - Mobile Access to the Fixed Network,” mimeo, April 1994.

Milgrom, Paul, Bridger M. Mitchell, and Padmanabhan Srinagesh, “Competitive Effects of Internet Peering Policies,” Paper presented at the Telecommunications Policy Research Conference, Arlington, Virginia, September 25-27, 1999.

Mitchell, Bridger M., “Incremental Costs of Telephone Access and Use”, Report R-3909-ICTF, RAND Corporation, Santa Monica, July 1990.

Mitchell, Bridger M., Werner Neu, Karl-Heinz Neumann, and Ingo Vogelsang, "The Regulation of Pricing for Interconnection Services," in Gerald Brock (ed.), *Toward a Competitive Telecommunication Industry - Selected Papers from the 1994 Telecommunications Policy Research Conference*, Mahwah, NJ: Lawrence Erlbaum, 1995, pp. 95-118.

Mitchell, Bridger M., and Ingo Vogelsang, “Markup Pricing for Interconnection: A Conceptual Framework,” in D. Gabel and D.F. Weiman (eds.), *Opening Networks to Competition: The Regulation and Pricing of Access*, Boston: Kluwer Academic Publishers, 1998, pp. 31-47.

Noam, Eli, *Interconnecting the Network of Networks*, Cambridge, MA: MIT Press, forthcoming.

Panzar, John C., “The Proper Role of Costs in Deutsche Telekom Pricing,” report for Deutsche Telecom, February 1997.

Perl, Lewis, and Jonathan Falk, “The Use of Econometric Analysis in Estimating Marginal Cost”, in Telecommunications Costing in a Dynamic Environment, Proceedings of the Bellcore – Bell Canada Conference on Telecommunications Costing, Held 5-7 April 1989 in San Diego, pp. 825-846.

Reiffen, D., “A Regulated Firm’s Incentive to Discriminate: A Reevaluation and Extension of Weisman’s Results,” *Journal of Regulatory Economics* 14, 1998, pp. 79-86.

Rubinstein, Ariel, “Perfect Equilibrium in a Bargaining Model,” *Econometrica* 50, 1982, pp. 97-109.

Sibley, David S., and Dennis L. Weisman, “Raising Rivals’ Costs: The Entry of an Upstream Monopolist in Downstream Markets,” *Information Economics and Policy* 10, 1998a, pp. 451-470.

Sibley, David S., and Dennis L. Weisman, "The Competitive Incentives of Vertically Integrated Local Exchange Carriers: An Economic and Policy Analysis," *Journal of Policy Analysis and Management* 17, 1998b, pp. 74-93.

Shin, Richard T., and John S. Ying, "Unnatural Monopolies in Local Telephone", *RAND Journal of Economics* 23, 1992, pp.171-.

Sidak, J. Gregory, and Daniel F. Spulber, "Deregulatory Takings and Breach of the Regulatory Contract", *New York University Law Review* 71, 1996, pp. 851-999.

Vogelsang, Ingo, and Jörg Finsinger, "A Regulatory Adjustment Process for Optimal Pricing by Multiproduct Monopoly Firms," *Bell Journal of Economics* 10, 1979, pp. 157-171.

Vogelsang, Ingo, and Bridger M. Mitchell, *Telecommunications Competition: The Last 10 Miles*, MIT Press and AEI Press, 1997.

Weisman, Dennis L., "Regulation and the Vertically Integrated Firm: The Case of RBOC Entry into Interlata Longdistance," *Journal of Regulatory Economics* 8, 1995, pp. 249-266.

Weisman, Dennis L., "Regulation and the Vertically Integrated Firm: A Reply," *Journal of Regulatory Economics* 14, 1998, pp. 87-91.

Weisman, Dennis L., "The Efficient Component Pricing Rule: Friend or Foe?", mimeo, 1999a.

Weisman, Dennis L., "A Note on Access Pricing and Exclusionary Behavior in Network Industries," mimeo, 1999b.

Willig, Robert D., "The Theory of Network Access Pricing," in Harry Trebing (ed.), *Issues in Public Utility Regulation*, East Lansing: Michigan State University, 1979, pp. 109-152.