Interconnection policy:
a theoretical survey

César Mattos
Professor at the Master's Programme in Regulation
University of Brasília

Key words
interconnection, telecommunications, access pricing.

JEL Classification L12, L22, L42.

Abstract

This article surveys the theoretical foundations of interconnection policy. The requirement of an interconnection policy should not be taken for granted in all circumstances, even considering the issue of network externalities. On the other hand, when it is required, an encompassing interconnection policy is usually justified. We provide an overview of the theory on interconnection pricing that results in several different prescriptions depending on which problem the regulator aims to address. We also present a survey on the literature on two-way interconnection.

Palavras-chave
interconecção, telecomunicações, preço de acesso.

Classificação JEL *L12, L22, L42.*

Resumo

Este artigo faz uma resenha sobre os fundamentos teóricos da política de interconexão. A necessidade de uma política de interconexão não pode ser tida como um dado em todas as circunstâncias, mesmo em se considerando a questão das externalidades de rede. De outro lado, quando tal política é requerida, uma política de interconexão abrangente tende a ser usualmente justificável. Provemos uma visão geral acerca da teoria do preço de acesso a qual resulta em várias prescrições diferentes a depender de qual problema o regulador deseja enfrentar. Também apresentamos uma resenha da literatura sobre interconexão em duas vias.

1_ Introduction

This article aims to survey the theoretical foundations of interconnection policy. The importance of this topic for the success of telecommunications regulation hinges on the incentive that the vertically integrated incumbent company owning a local and a long distance network has to deny (or charge a high price for) interconnecting competitors from the long distance market in its local loop bottleneck. This occurred in the US telecommunications market, given the dependence of the new long distance competitors, MCI and Sprint, on the AT&T local networks to connect with end users. AT&T was charged with using its market power to reduce downstream competition, raising rival costs through refusal to deal high local interconnection charges and reducing the quality of access.[1]

In this regard, Viscusi, Vernon and Harrington (1995, p. 504-505) summarise the history of AT&T negotiations with MCI about the requests for local network interconnection:

> *The initial response of AT&T to entry in 1969 by MCI was simply to refuse to interconnect with them. In the FCC decision in 1971, the FCC said AT&T should interconnect with their competitors, but the terms were left open to AT&T. This did not improve the situation, because AT&T placed considerable restrictions on the specialised common carriers. Only on 1974 did the FCC order interconnection in its Bell System Tariff Offering decision. When MCI expanded entry into message toll service, the same problem arose. Their entry was approved by the US court of appeals in 1975, but not until 1978 was AT&T forced to interconnect with MCI's Execunet service. Only in 1978 were firms like MCI allowed to interconnect with the local operating company as long lines. Even after achieving this right, the competitors to AT&T in the Intercity Telecommunication Market were still not treated equally. It is generally believed that AT&T's competitors were given poorer quality connections by Bell operating companies. Customers had to dial twenty digits to make a long distance call with MCI, but only eleven with AT&T. The result was that consumers saw AT&T as offering a higher-quality product, which forced its competitors to offer a discount to compete. It was this type of behaviour that led to the original antitrust suit against AT&T.*

In the UK, these problems also appeared after the privatization of

[1] Noll and Owen (1995, p. 342); Laffont and Tirole (2000) describe in more detail other means of reducing the quality and/or increasing the costs of a rival through interconnection.

British Telecom (BT), given the absence of a policy of vertical break-up as implemented in the antitrust suit in the US and the lack of an appropriate interconnection policy in that country (Armstrong, Cowan and Vickers, 1994, p. 239).

The first theoretical question is whether an active interconnection policy is always required, which is addressed in the next section. Section III discusses what is the best approach for interconnection policy enforcement (if any): general or detailed ruling? In section IV, the question is what is the optimal regulated access price. While it is well established that an active interconnection policy is required when a dominant incumbent owns a local loop bottleneck in telecommunications, it is less clear in an environment where two facility-based networks are competing in the market place. Section V surveys the recent literature on this issue.

2_ Is an active interconnection policy always required?

The strategic importance of interconnection in telecommunications comes from the existence of consumption network externalities in the sector. These externalities confers a prominent role to interconnection as a competitive weapon. In this section, we address the following question: Can we justify interconnection enforcement by the government everywhere in the telecommunications sector?

While, based on the US experience, Noll and Owen (1995) show that interconnection is the key element for a pro-competitive policy in telecommunications, Mueller (1997, p. 183) calls the attention to the risks of an indiscriminate and active policy in this direction:

> *if networks are bundles, then a policy that equates bundling with restrictions on competition is bound to find anticompetitive behavior everywhere. Such a policy will be perpetually at war with the very basis of network efficiencies.*

In other words, some constraints on network interconnection imposed by operators **can** be desirable to guarantee efficiency in the sector. Muller (1997, p. 174 and 188) identifies two (intimately connected) trade-offs between a more and a less comprehensive interconnection policy. First, there is a trade-off between customization and uniformity of technologies that can diverge from the optimum. A more

comprehensive interconnection policy tends to generate more uniformity across networks than otherwise, and thus diversity can be lower than optimal. This lack of variety reinforces the tendency for the best technology to be less likely to be chosen as stressed in the literature of standards.[2]

This trade-off, though unambiguously valid in the short run, can be challenged in the long run. Competition in innovation is a long-run process and one of the necessary conditions for this process to happen is through short-run interconnection for the entrant. Initially, the entrant follows the incumbent standards and, later, creates its own (and perhaps improved) standards. The entry in the first (short-run) period is like a ticket to participate in the second (long-run) period. In practice, entrants are not often able to achieve instantaneously the size of the incumbents through different technologies. Some initial "learning by copying and by doing" can be required to be able to challenge established standards.

Second, a more comprehensive interconnection policy, at the extreme the requirement of complete unbundling, can stifle competition because no entrant will be willing to build new infrastructure if he can use the existing facilities of the incumbent. We can refine the idea of Mueller through the terminology of Laffont, Rey and Tirole (1998a; 1998b) of entry based on facility and unbundling. Comprehensive interconnection policies unambiguously dampens "facility based entry", but fosters "unbundling based entry". Thus, the real trade-off is between interconnection, that facilitates unbundling-based entry, and facility-based entry and not between interconnection and competition in general.

Laffont and Tirole (2000, p. 208) show that the incumbent can use the local loop rental charge to soften competition with the entrant in the case of the unbundling-based entry. So, the efficiency of this kind of entry in terms of fostering competition will depend crucially on the regulation of this variable. This means that policies designed to foster facility-based entry can be a preferable approach, mainly when the information asymmetry of the regulator is substantial.

According to Mueller (1997, p. 180-181), this trade-off is not new in telecommunications. He states that in

[2] See Katz and Shapiro (1994); Besen and Saloner (1994) for surveys on the economics of standards.

the beginning of the 20th century in the US, what dampened competition in telecommunications was not the resistance of AT&T to interconnect, but exactly the opposite. AT&T started to license independent companies discouraging facility-based entry. This challenges the conventional view that refusal to deal by AT&T was what reduced competition in telecommunications in the US. Mueller (1997, p. 185) concludes that abandoning access price regulation should not be disregarded at all, challenging a deep-rooted consensus in this area.

Katz, Rosston and Anspacher (1995) propose a two-stage process for government intervention in interconnection that stays in the middle of the extremes of the "non-interventionist" approach by Mueller (1997) and the usual policy of regulatory enforcement of "universal interconnection". Their proposal is basically a cost/benefit analysis that resembles the "rule of reason" approach of conventional antitrust standards. In the first stage, the regulator addresses the existence of market power. If market power of a company is not significant, regulatory interconnection enforcement is meaningless and the analysis should end, leaving the operator free to make or refuse interconnection agreements with other companies. In the presence of market power, the wedge created by network effects between social and private decisions become substantial, requiring intervention through an active interconnection policy.[3] Observing the presence of market power, the authors describe a second stage of the analysis that includes potential private and social benefits and costs of interconnection policy (p. 329 and 331), which includes the costs of constructing and operating interconnection facilities, restrictions on network design, planning and innovation and so forth.[4]

[3] According to the authors (p. 334-335), the "market power test" had already been applied in the US. While local exchange carriers with market power were obliged to allow commercial mobile radio service providers to connect them, the FCC refused to enforce interconnection between mobile providers. The relevant market was defined as the "termination of wireline and wireless calls". As only a very small percentage of total calls terminated on a cellular, the FCC concluded that there was no point to be concerned about the possibility that the Commercial Mobile Radio Service denies interconnection to other carriers as an anticompetitive strategy.

[4] Notice, however, that although interconnection policy should not be enforced on non-dominant carriers, it should be required to guarantee reciprocity from them to the terms of interconnection enforced by the regulator and/or provided by the incumbent.

3_ General x detailed rulings in interconnection

An important aspect of an interconnection policy is whether the regulatory framework should contain detailed provisions or just general principles. Deliberate delay to supply interconnection was responsible for a great part of the delay in the introduction of competition in telecommunications around the world.[5] Indeed, all countries that reformed their telecommunications showed a common pattern of hard negotiations on interconnection. Since interconnection agreements have several sources of transaction costs, including those stemming from incomplete contracts, the incumbent tends to use this to undertake a foreclosure behavior. We briefly comment on the transaction costs in interconnection contracts in telecommunications.

First, there were several unforeseen contingencies in the first interconnection regulatory orders and agreements between incumbents and entrants worldwide. This was extensively demonstrated in the recurrent negotiations of MCI with AT&T before the AT&T break-up that last for more than a decade. Second, even with previous international experience in interconnection affairs, there are new problems raised every day in these negotiations, since the incumbent will always tend to restrict them to the minimum. The introduction of new technologies in telecommunications will remain as an important source of unforeseen contingencies for a long time yet.

Legal expenses can be partly avoided if the regulator enforces its rulings adequately. Being the first administrative instance, the ruling is supposed to supply general guidance for the solution of disputes at the judicial level. The threat of the regulatory body to impose administrative penalties (including the cancellation of the grant) on the incumbent companies should avoid frequent resort to the judiciary by the incumbent as a postponement device. Furthermore, given the lesser degree of information asymmetry between the operators and the regulator compared to the courts, his role as the first arbitrator in interconnection matters can reduce the problems of "observability" and "verifiability" of the fulfillment of the interconnection contract provisions.[6] Moreover, as the

[5] One of the charges on AT&T under the lawsuit that caused its divestiture was the deliberate "abuse of process" aiming to delay competition.

[6] See Tirole (1988, p. 38) for the differences of these concepts.

agency is not one of the parties, the courts may rely in the regulator's reports as a neutral informed party to decide, given their lack of expertise. In sum, comprehensive rules on interconnection do not seem an excessive intervention, although the risk of inadequate interference always arises in the routine of the day-by-day regulation. This seems an unavoidable cost.

4_ Pricing access in "one-way" interconnection

4.1_ Optimal access pricing in theory

The first candidate rule for optimal access pricing is the marginal cost.[7] However, there are several critiques to marginal cost pricing rule in general. One is particularly important to telecommunications: the existence of consumer network externalities, formalized by Willig (1979).[8] The author uses the conventional consumer theory to derive first-best regulated prices to the networks in a Ramsey-like problem. The requirement to correct the market imperfection due to consumer network externality through access prices comes from the standard argument that any new consumer linked to the network does not internalize the externality generated by himself. This market failure should be corrected by picking an access price below the marginal access cost. But, as Mitchell and Vogelsang (1991, p. 55) stress, the importance of network externalities has been weakening as penetration of telephone service gets closer to 100% in most developed countries (which does no hold for developing countries like Brazil). Therefore, this critique to marginal cost pricing and the prescription to choose optimal regulated access prices below marginal cost has also weakened.

While the network externality reasoning suggests that optimal access prices should be **lower** than the marginal cost, the other main critique, as quoted by Laffont and Tirole (1993, p. 23-30), goes in the opposite direction. The main critique stems from the presence of increasing returns, mainly because of the existence of substantive fixed costs, which is very usual in telecommunications. In this case, marginal cost pricing implies a deficit that raises the requirement to cover it, including costly public funds.

To cover fixed costs in an economically sound basis, the most

[7] As stressed by Laffont and Tirole (1996, p. 240), the principles that were built for final goods can be perfectly extended to intermediate goods, just thinking about the access good as another final good.

[8] See also Mitchell and Vogelsang (1991, p. 57-60) for the introduction of network effects in Ramsey formulas. The signal of the departure of the optimal price from marginal cost becomes ambiguous.

important theoretical alternative has been the Ramsey pricing rule. Supposing that there are *n* line of business and designing a generic line of business as *k*, the Ramsey formulas will be the result of a problem that maximizes the total surplus of the economy, considering the break-even constraint of non-negative profits of the firm. The general formula for the price in every line of business *k* will be given by:

$$\frac{P_k - \frac{\partial C}{\partial q_k}}{P_k} = \frac{\mu}{1+\mu}\left(\frac{1}{\eta_k(p_k)}\right) \qquad (1)$$

where $\mu \geq 0$ is the shadow price of the constraint of the problem directly related to the magnitude of the fixed costs. η_k is the elasticity of demand for *k*. Notice that if $\mu > 0$ and η_k finite for all *k*, the optimal price of every good or service *k* will always exceed its marginal cost. The optimal access price will be more distant from marginal cost, the lower the price elasticity of demand of the specific service. This happens since the greater is this last variable, the higher the impact of price increases in the quantity demanded, increasing the negative impact of a high price in a given line of business *k* on welfare.[9]

In the case of access pricing, Laffont and Tirole (1993, p. 255-258) add some further considerations. The fact that the cross-price elasticity of demand between the incumbent final product or service and the entrant's is strictly positive changes the solution of the Ramsey problem. Assuming a dichotomy property (prices **must** not and are not used to provide incentives), the new optimal final and access price formulas substitute the ordinary price elasticity of demand η_k, by a "superelasticity" formula that includes η_k, cross-price elasticities and the differential between the social value of the incumbent profit and that of the competitor's. The importance of introducing cross-price elasticities in the Ramsey setting relates to the fact that any "cream-skimming" strategy of the entrant, "stealing" business from the incumbent (the services are substitutes), reduces the amount of resources available to cover the incumbent fixed costs. The optimal access price has to increase to fill this gap of revenue and also to reduce the amount of market stolen. Laffont and Tirole (1993, p. 260 and 1994, p. 1678) provide the results for the case of one vertically integrated company operating the local loop (0)

[9] See Mitchell and Vogelsang (1991, p. 57-60) for the formal introduction of network effects in Ramsey formulas.

and a long distance service (1) competing with a non-integrated long distance carrier demanding access (2):

$$\frac{p_0 - c_o}{p_0} = \frac{\lambda}{1+\lambda}\frac{1}{\hat{\eta}_0}$$
$$\frac{p_1 - c_1 - c_0}{p_1} = \frac{\lambda}{1+\lambda}\frac{1}{\hat{\eta}_1} \qquad (2)$$
$$\frac{a - c_0}{a + c_2} = \frac{\lambda}{1+\lambda}\frac{1}{\hat{\eta}_2}$$

being c_i the constant marginal cost of each service and "*a*" the optimal access price. Note that c_0 is the marginal cost of the vertically integrated incumbent in providing local service and also local access for himself and for the competitor. $\lambda > 0$ is the shadow cost of the firm deficit represented by the fixed costs. $\hat{\eta}_1$ and $\hat{\eta}_2$ are the superelasticities.[10, 11]

Note, however, that just like in the case of marginal cost pricing, the inclusion of costs in the formula provides low incentives for efficiency in (2). That is why Laffont and Tirole (1993, p. 258-266 and 1994, p. 1679-1684) provide further steps to address optimal pricing (final and access), considering the proper incentives to reduce costs. The optimal rule is a variant of the basic trade-off incentives/rent-extraction modeled by Baron and Myerson (1982) and developed in chapter 2 of the textbook of Laffont and Tirole (1993). There are two basic cases. First, the "common network case" where there is no cost difference between producing the intermediate access service for internal consumption or for sale to the competitor. The optimal regulated access prices for this case are solved with and without complete information of the regulator about the efficiency of the regulated company. When there is less than complete information about the efficiency of the company, the optimal regulated access price has to be corrected by an incentive term. This term can increase or decrease the optimal access prices, depending on whether an increase in the production of the network good raises or not the informational rents to the firms.

[10] $\hat{\eta}_0 = \eta_0$;

$\hat{\eta}_1 = \eta_1 \dfrac{\eta_1\eta_2 - \eta_{12}\eta_{21}}{\eta_1\eta_2 - \eta_1\eta_{12}}$;

$\hat{\eta}_2 = \eta_2 \dfrac{\eta_1\eta_2 - \eta_{12}\eta_{21}}{\eta_1\eta_2 - \eta_2\eta_{21}}$, being

$\eta_{12}(\eta_{21})$ cross-price elasticities of demand from the price of service 2 (1) to the quantity of service 1 (2).

[11] Note that if the services are substitutes, there is cream-skimming, cross-price elasticities are positive, and the "super elasticity " will be lower than the ordinary elasticities, decreasing the denominator of the Ramsey formulas and thus increasing the equilibrium values of p_1 and a.

As firm rents are undesirable to the regulator, optimal access prices will increase if the production of the network good raises rents.

While in the case of perfect information, the optimal access price is always higher than marginal cost, this conclusion is not so universal when the authors introduce the incentive correction term. To be precise, we can only be absolutely sure that optimal access prices are higher than marginal costs when the firm type is the most efficient one and thus the incentive term vanishes. For the other less efficient types, an increase in the production of the network good can either decrease or increase the informational rents if it, respectively, decrease or increase the "ability" of the firm to lie about its characteristics. In the first case, the incentive correction term will be designed to reduce the optimal access price and can more than offset the other terms.

The second basic case presented by the authors (1993, p. 263-266) is the "network expansion case", where to provide access to its competitors, the regulated firm has to increase capacity. The authors in this case are more concerned with the incentive of the regulated firm to exaggerate the cost of increasing capacity to provide access and thus inflate access pricing. The net result of introducing asymmetric information is always in the direction of increasing access price.

The possibility of the government to undertake transfers or not to the regulated firm is very relevant here, since what we are discussing are optimal departures from the basic rule of price equal to marginal cost in order to raise funds to cover part of the fixed costs. This is assessed in Laffont and Tirole (1994, p. 1686-1688). The authors show that while the ratios of Lerner indices remain constant when the possibility of monetary transfers are dropped from the model, the whole price structure is shifted upwards or downwards, including the optimal access price, depending on how binding is the budget constraint. The tightness of the budget constraint will be basically dependent on the magnitude of fixed costs. The greater they are, the higher the whole set of optimal regulated prices of the firm have to be, including the optimal access price. However, for fixed costs low enough, those optimal prices, including optimal access prices,

can be even lower than in the presence of government transfers. This apparently paradoxical result holds because, in the absence of transfers, firms have to pay more attention to reduce variable costs than otherwise, and so, the requirement for higher prices, including the access price, can be reduced.

The presence of market power by competitors also alters the computation of optimal access pricing. Assuming that cross-price elasticities are zero, Laffont and Tirole (1994, p. 1688-1689) show that market power **decreases** optimal access prices. This result resembles the conventional argument that a per unit subsidy can increase welfare in a monopoly situation. In this case, the subsidy comes indirectly through a reduced regulated access price.

Another important effect on optimal access pricing is the possibility of bypass. The main point raised by Laffont and Tirole (1994, p. 1690-1692) is the risk of inefficient bypass when an access price high enough is settled to help in the funding of fixed costs. To conciliate avoiding inefficient bypass and allowing the coverage of incumbent fixed costs, one theoretical alternative would be to decrease the access price closer to marginal cost and charge a per-unit service tax on the entrant and transfer it to the incumbent. This would avoid the inefficient combination of inputs (efficient access through the incumbent local network/alternative technology) and at the same time allow the coverage of the incumbent fixed costs. However, in most countries including Brazil, this is not a legally feasible alternative. When this occurs, an inefficient bypass is inevitable.[12]

The main problem of these exercises based on Ramsey principles is the huge amount of information required to choose the optimal access price. The general skepticism about the feasibility of practical implementation of Ramsey-based rules generated the policy debate over two basic views, as mentioned by Laffont and Tirole (1996, p. 229). There are proponents of accounting allocation rules for the access deficit, known as "fully distributed costs" rules and proponents of "usage-based rules" in which the famous Efficient Component Pricing Rule (ECPR) is included. The authors (1994, 1996, 2000 and 2000b) also propose a second way: Global price caps that induce optimal Ramsey access

[12] Despite the fact that bypass is not always bad for welfare as shown by Laffont and Tirole (1993, chapter 6).

and final prices. In the next subsection, we discuss a little about fully distributed cost rules for pricing.

4.2_ Fully distributed costs

A common procedure used by regulators worldwide to regulate prices, including access prices, is the "Fully Distributed Costs" (FDC). The FDC rule consists of some *ad-hoc* mechanical accounting rule to appropriate joint costs, existing in an infinity of potential rules as such. Spulber (1989, p. 128-130) presents three possible FDC rules based on the:

i. shares of common fixed costs and also nonattributable components of variable cost on relative outputs;
ii. relative revenues;
iii. relative attributable costs (ratio of stand-alone variable costs to total variable costs).

Spulber also shows that FDC pricing has the potential appeal that it can be properly chosen consistent to subsidy-free pricing, avoiding the break-up of the regulated company under competitive pressure and inefficient bypass.

FDC pricing has the virtue of simplicity that is absent in Ramsey-pricing. On the other hand, FDC pricing does not have a theoretical rationale like the Ramsey pricing. The main critiques of FDC pricing are summarized by Laffont and Tirole (1996, p. 235) who stress that FDC pricing, being cost-based, does not encourage cost minimization, subsidises inelastic-demand lines of business to the detriment of elastic demand ones, lacks the flexibility needed to deal properly with large customers through nonlinear tariffs, creating inefficient allocation of resources, including inefficient bypass and entry.

4.3_ Optimal access pricing and the efficient component pricing rule (ECPR)

The basic mechanics of the ECPR as a guideline to regulate access prices was first proposed by Willig (1979). We present the same original formulation, but in a slightly different way. Suppose there is an entrant that "steals" x units of a long distance market at a constant price p from the vertical integrated incumbent owning the local loop. The remaining quantity for the incumbent is defined as y units. There are some relevant cost functions. First, the cost function of the incumbent when there is no entrant is defined as $C_i(x + y)$.

Second, the cost function of the entrant (net of access prices expenses) when he/she enters and "steals" x units from the incumbent is $C_e(x)$. Third, the cost function of the incumbent when x units of the long distance market is stolen by the entrant and the former has to provide x units of local access to the entrant in respect of these units is $C_i(x, y)$. Finally, the regulated access price per unit of product is a. Willig (1979, p. 139) states that:

> *the analysis of technical access prices rests on the fundamental desiderata that they yield profit incentives for the entry of firms that would lower total industry costs and that they discourage socially undesirable entry.*

The main question is how to define the access price that achieves this double purpose. There are two main equations in this setting. First, the entrant will have an incentive to enter if and only if:

$$P_x x - C_e(x) - ax > 0 \qquad (3)$$

The revenues of the entrant are strictly higher than the costs, including access costs. Also, entry will be considered desirable only if entry lowers total industry costs:

$$C_i(x + y) > C_e(x) = C(x, y) \qquad (4)$$

Willig's purpose is to find the optimal access pricing (of) a^* in such a way that two conditions are satisfied:

Condition 1: If:

$$C_i(x + y) < C_e(x) = C_i(x, y) \qquad (5)$$

or total industry costs do not diminish with entry, and so, entry is not considered socially desirable, then:

$$P_x x - C_e(x) - ax < 0 \qquad (6)$$

implying that (3) does not hold and the potential entrant does not enter.

Condition 2: There is an incentive for entry or (3) holds only if (4) holds total industry cost decreases with entry, which means that entry is socially desirable.

One solution for this problem is to pick a^* such that:

$$P_x x - a^* = C_i(x + y) - C_i(x, y) \qquad (7)$$

To see that this is a solution for Willig's problem, suppose that there is no incentive for the entrant to enter and $p_x x - C_e(x) - a^* x < 0$. Replacing (7) in this equation, we have $C_i(x + y) - C_i(x, y) - C_e(x) < 0$. Rearranging, we can check that condition 1 is always satisfied. On the other hand, suppose that there is an incentive to enter and then (3) holds.

Replacing (7) in (3), we get: $C_i(x+y)-C_i(y)-C_e(x,y)>0$, that is (4) holds and thus condition (2) is also always satisfied. Therefore, (7) satisfies both conditions 1 and 2 and $a=a^*$ solves Willig's problem.

The main appeal of (7) is that it is **always** a solution, regardless of the specific values of the cost functions, which does not happen otherwise. The interpretation of (7) is that the difference between the revenues obtained by the network and that it would obtain from the access charges to the entrant is equated to the difference between the levels of costs incurred by the network in the two situations. This means that this access price keeps the network's profit unchanged. Isolating a^* in (7), we find:

$$a^* = p - \frac{C_i(x+y)-C_i(x,y)}{x} \qquad (7')$$

The optimal access price that satisfies Willig's conditions equals the price per unit of the final good (part of it "stolen" by the entrant) minus the difference between the average cost without and with entry. In other words, the optimal access price equals the forgone profit per unit of "stolen" quantities by the entrant. This is nothing but the opportunity cost of providing access and has the property of keeping the incumbent indifferent between providing the final service himself/herself or through the entrant.[13]

A clear virtue of this approach is that the incentive for the incumbent to foreclose disappears at least in the short run, since his profit remains unchanged.[14] Besides the positive effect it brings on its own, it also reduces the need for a heavy-hand regulation of interconnection. Moreover, Willig (1979, p. 146) also stresses that if the entrant is more efficient than the incumbent in providing x or, in other words, if his/her cost of providing x is lower than the incremental cost of the incumbent providing x, then total profits of the incumbent can even increase by supplying access. This

[13] Baumol, Ordover and Willig (1997, p. 150-153) also show that an equivalent measure of the ECPR access price is a^* = *(incremental cost of providing a unit of input to rivals)* + *(incremental opportunity cost)*.

[14] See Laffont and Tirole (1996, p. 238). However, considering the analysis proceeded in Mattos (2001), it is plausible that the fears of the incumbent in the long run, regarding being taken over by the entrant can play a role. In this case, the incentive for foreclosure cannot be assessed only through short-run profit figures. Thus, this kind of rule is not a panacea for avoiding foreclosure behaviour in the market and regulatory oversight over interconnection is still required.

happens because if costs are lower, the entrant is able to charge lower prices, increasing quantity and thus access revenues to the incumbent which more than compensate forgone profits from having business "stolen" from the entrant.

The main alleged benefit of the ECPR is that it sends the right signal to entrants. They will enter if they are really more efficient than the incumbents and the net impact of their entry is welfare enhancing (4 holds).

The access price rule in (7') became known as the Efficient Component Pricing Rule (ECPR) and was popularised by Baumol in several writings.[15, 16] Baumol and Sidak (1994, p. 94) justify the ECPR stressing that economic efficiency requires that prices equal marginal costs, which includes the opportunity costs incurred by the producer. Since, in the current case, there are forgone sales to the final consumer and thus forgone profits when the producer sells to his competitor, these are opportunity costs that must belong to the total accountancy of marginal costs. According to these authors (p. 99), this price rule mimics the welfare results obtained in a perfectly competitive or a perfectly contestable market.[17] The authors (p. 96-97) stress that the ECPR was already used in railroads in the US and in telecommunications in California. The high court in New Zealand had also adopted the rule when deciding an antitrust litigation between two telecom companies.[18] Laffont and Tirole (1996, p. 235-237; 2000, p. 168-169) show that the access price rule

15 That is why the rule is known as the Baumol-Willig rule. Other denominations quoted by Baumol and Sidak (1994, p. 95) are "the imputation requirement", "the principle of competitive equality" and the "parity principle".

16 Hausman (1996, p. 28-35) proposes a similar pricing method that he also calls as the "imputation methodology". The difference is that instead of using opportunity costs to define access prices, it is used to regulate final prices with access pricing being defined by the long-run incremental cost. Thus, what differs is the direction of causation coming from the access price to final prices and not the opposite as in the ECPR.

17 The theory of contestable markets is developed in Baumol, Panzar, and Willig (1982). Laffont and Tirole (1996, p. 230) argue that the contestable market paradigm is not an adequate basis for the ECPR.

18 Tye and Lapuerta (1996, p. 464-485) are the most incisive critics of the ECPR and provide an extensive history of the case of Telecom Corp and Clear Communications in New Zealand where the central issue was the dispute over the correct access pricing rule. While the incumbent Telecom proposed the ECPR as the correct benchmark supported by Willig and Baumol as consultants, Clear Communications defended a cost-based rule.

used by OFTEL in the UK from 1990 to 1997 boils down to the ECPR.

Laffont and Tirole (1994, p. 1695; 1996, p. 242) ask in which situation ECPR satisfies Ramsey optimality requirements as given in the system of equations (2). The authors show that under full symmetry on costs and demand of the two operators in the long distance segment, the ECPR yields the Ramsey result, which reaffirms its positive properties. To see this, note that if we suppose in equations (6) that $\hat{\eta}_1 = \hat{\eta}_2$, and $p_1 = p_2 = a = c_2$, then we get the ECPR as the optimal Ramsey rule.

$$a^* = p_1 - c_1 \qquad (8)^{19}$$

Armstrong, Doyle, and Vickers (1996, p. 135) also derive the ECPR from particular Ramsey formulas, but when final product price is fixed exogenously by regulation.[20] The authors (p. 138-143) also show a more general ECPR formulation, introducing a displacement ratio in the usual formula, besides an extension of the rule to incorporate a Ramsey term. The displacement ratio provides a more sophisticated definition of opportunity costs of the incumbent, allowing for variable coefficient technology, bypass, and service heterogeneity. The ECPR formula provided by the authors (p. 138-139) is:

$$a^* = c_2 = \sigma(p - c_1) \qquad (9)$$

where: c_2 is the direct marginal cost of providing access to the entrant;
c_1 the marginal cost of providing the final service to consumers;
σ the displacement ratio.[21]

The ability of the entrant to replace the input represented by the

[19] Larson and Lehman (1997, p. 76 and 78) provide a more detailed proof of this equivalence, leaving clear the whole (and strong) set of assumptions behind symmetry and also an intuitive explanation: Ramsey optimality requires equal **percentage mark-ups** while the ECPR requires equal **dollar** mark-ups. The two will be equal if there is symmetry.

[20] Armstrong and Vickers (1998) extend it for the case of unregulated final prices. In this case, the optimal access price can be lower, equal or higher than the marginal cost depending on a trade-off between allocative and productive efficiency. A high access price increases the final price, increasing the dead-weight loss (loss of allocative efficiency). On the other hand, a low access price increases the quantity of a supplier (or a fringe of suppliers) that, by hypothesis, has decreasing returns and thus reduces the productive efficiency.

[21] This last one is defined as the derivative of the incumbent's equilibrium final product demand in respect to the access price divided by the derivative of the equilibrium demand for access in respect to the access price.

local bottleneck by other means, bypassing the incumbent reduces the displacement ratio, which means a shrinkage in the access price given by the ECPR in (13). Furthermore, the greater the service heterogeneity, the lower the incumbent profits forgone with access and the lower the resulting access price. This could be a distinction that would justify a lower access price charged by the local wire companies to mobile carriers than to other local wire companies that provide a service with a higher degree of substitutability with the former. An important characteristic of this redefinition of opportunity cost is that the new optimal access price (disregarding the Ramsey term) is always lower than the one established in the usual formula, since the displacement ratio σ is always between 0 and 1. In other words, the effects of product differentiation, bypass, and technological substitution given in the displacement ratio reduce access price compared to the case where none of these extensions are allowed.[22]

While the introduction of a displacement ratio can be taken only as a refinement of the ECPR principle, Armstrong, Doyle and Vickers (1996, p. 135 and 139) point out the non-optimality of this rule. They show that optimal Ramsey pricing (without a regulated final product price) is higher than that given by the ECPR rule, which challenges the usual view that this rule has a pro-incumbent bias. In this regard, Laffont and Tirole (1994, p. 1695-1696; 1996, p. 242) also show that, assuming brand loyalty and/or cost differential between the two players, the ECPR does not coincide with the Ramsey prescription, and so its welfare properties hold just for very particular cases.

In a less technical statement, Armstrong, Doyle and Vickers (1996, p. 149) argue that, in practice, access prices lower than the ECPR can be desirable to foster a process of "learning by doing" and/or to overcome inefficient entry barriers.[23] Despite these critiques, the authors state that the principle of including the opportunity cost of providing access seems an important ingredient to achieve optimality in the access price rule.

There are other more fundamental critiques to the ECPR. The most important concerns the definition of "competitive neutrality"

[22] Note that this is not a departure from the ECPR rule, but the proper ECPR, relaxing the usual restrictive hypothesis on which it is usually assessed.

[23] See also Larson and Lehman (1997) for two departures from symmetry and the same conclusion that ECPR optimality does not always hold.

generally attributed to the ECPR. The proponents of the ECPR argue that this rule embodies a "weak competitive neutrality property", *i. e.*, the incumbent status confers neither an advantage nor a disadvantage for prospective entrants. Tye and Lapuerta (1996, p. 422) argue that a proper definition of competition neutrality must also require that monopoly rents be dissipated and that efficient competitors be privileged. The authors call this definition as "strong competitive neutrality".

The main problem is that assuming the pre-entry (and presumably monopolistic) price p constant in (7'), the ECPR rule is implicitly throwing out the main prospective gains from competition, that is, a decrease in price. The ECPR would fail this test, since it perpetuates monopoly rents.[24]

Baumol and Sidak (1994, p. 108-109) had already recognized this critique, but replied that ECPR is not the problem, which can be found in the monopoly prices that are allowed by the regulator for the final product price.[25] The problem should be fixed through proper final price regulation and not through access pricing. Indeed, the reduction in the number of goals to be pursued by regulators through the single tool of access pricing is desirable on its own, since it avoids the problem of it becoming, as Laffont and Tirole (1996, p. 248) state, "*jacks of all trades and master of none*" Doane, Sibley and Williams (1999) propose a departure from the ECPR called the "M-ECPR" that incorporates this concern. Price reductions derived from entry are accounted for in (7'), which eliminates the perpetuation of monopoly rents. The difference is that, at the same time, the regulator uses an ancillary tool, by charging the entrant an end-user charge which is transferred to the incumbent in order to satisfy his break-even constraint. According to the authors (p. 322), this rule differs from the conventional ECPR in two aspects. First, this rule incorporates (negatively) the reductions of final prices generated by the introduction of competition. Second, the M-ECPR adds to the ECPR with an end-user charge in order to fund the fixed costs of the

[24] This critique is also raised by Economides and White (1995, p. 570).

[25] Baumol, Ordover and Willig (1997, p. 147 and 159) also recognise that the ECPR, is not a **sufficient** condition to achieve efficiency, although it reaches its main goal of levelling the playing field of competition.

bottleneck owner, in this way satisfying his budget constraint.[26]

Economides and White (1995) make a connected, but even more essential critique to ECPR, by challenging the usefulness of equation (8) as a suitable criterion to define socially desirable entry in the context of previous monopoly prices charged by the incumbent. According to them (p. 560), the ECPR's exclusion of inefficient rivals may be socially harmful, since the presence of even inefficient players in the market can reduce dead-weight losses and thus compensate the increase in the total costs of the industry, in this way enhancing welfare in net terms. A less efficient entrant will increase social welfare when the inefficiency gap is not too high and/or his entry results in a tougher price competition (Bertrand behavior, for instance).[27]

Tye and Lapuerta (1996, p. 451-459) stress that even an equally efficient entrant would not be able to enter under the ECPR rule when there is at least some positive sunk cost, since all his profit will be appropriated by the incumbent through the access pricing rule. We can also add that when sunk costs are substantial, even slightly more efficient entrants will not enter. This happens because they will recoup their sunk costs at a rate given by their productivity differential. If they are only slightly more productive, it will take time to recoup their sunk costs and if their discount rates are large enough, they will not enter. Tye and Lapuerta (1996, p. 446) also stress that the ECPR rule ignores dynamic benefits from competition, which is really not captured in the basic model advanced by Willig. Considering the rapid technological change in

[26] See the authors' paper (p. 324-326) for a full comparison between M-ECPR properties and the approach currently adopted by the FCC of precifying access at other total element long-run incremental cost (TELRIC). Although M-ECPR is superior in several circumstances, the authors recognise that when the entrant is less efficient than the incumbent, the TELRIC allows entry while M-ECPR does not. As we see below by the critique of Economides and White (1995), even unprofitable entry can be desirable, depending on the parameters of the problem. Anyway, Baumol, Ordover and Willig (1997, p. 147), by recognising the validity of the critique, state that the elimination of the dead-weight losses generated by monopoly power should not be addressed with access price rules.

[27] Laffont and Tirole (1996, p. 252) add another potential positive aspect of (even unprofitable) entry: the extra information obtained by the regulator when the entry allows yardstick competition. For a brief survey of yardstick competition and some useful modelling for regulation, see Mattos (2001).

telecommunications, negligence of dynamic features can be taken as a serious criticism.

Laffont and Tirole (1996) are sympathetic to the core of the ECPR idea and assess some interesting departures from the basic ECPR rule. First, they (1996, p. 248-249) argue that when the entrant has some market power and is able to charge a positive mark-up m, it is desirable to discount m from the pure ECPR rule given in (8). The optimal access rule (called the ECPR-M) would be:

$$a^* = p_1 - c_1 - m \qquad (10)$$

At the same time, an excise tax could be charged to the competitor and transferred to the incumbent for the sake of contributing to the access deficit. In this scheme, the departure from ECPR reduces the market power distortion, but raises the access deficit problem. The extra taxation allows the ECPR-M to fulfill this function while recovering the access deficit.[28]

Bypass is another concern of the authors (p. 250-251) that could be handled by avoiding excessive increase in the access price coupled with the use of taxes. However, the authors are not very optimistic with the ancillary use of taxes by regulators, since it is information demanding, besides the risk of extending excessively regulatory powers. Potential tools to deal with inefficient bypass mentioned by the authors are the permission for the incumbents to price discriminate access rates through quantity discounts and the offer of two-part tariffs.

On the other hand, when fixed costs are high in a way that makes a new entry unprofitable, even if socially desirable, and a lump sum subsidy to the entrant is impossible, then a decrease in the access price below the ECPR-M rule given in (10) to subsidize entry can become optimal.

Finally, Tye and Lapuerta (1996) stress the possibility of enlargement of the concept of opportunity cost in the ECPR. They (p. 463) argue, for instance, that when an entrant innovates, the incumbent can argue that he/she would certainly have introduced the new technology afterwards if the entrant had not, claiming to include the efficiency gains of the entrant in the calculus of the opportunity cost. More generally, the authors (p. 498) state that this concept has become very elastic, conferring a high level of subjectivity in the calculus, even including monopoly

[28] Note that despite the similarities with the M-ECPR from Doane, Sibley and Williams (1999) introduced above, the purpose and the result of both rules are quite different.

profits and potential future price increases to the final customer.[29] We don't think that this conclusion can be derived from the statements of the proponents of the ECPR rule. However, this is a risk that the adoption of ECPR cannot be considered free.

4.4_ Global price caps

The third important proposal for regulating access price is done by Laffont and Tirole (1996; 2000; 2000b). According to the authors (p. 243), the imposition of a global price cap can reach the optimal Ramsey formulas if access is treated like a final good, being included in the weighted sum of prices and if the weights used are exogenously determined and proportional to the estimates of quantities. A global price cap with these characteristics can be written in the following way:

$$\bar{q}_0 p_0 + \bar{q}_1 p_1 + \bar{q}_2 a \leq \bar{p} \qquad (11)$$

The main appeal of the rule is its adherence to the Ramsey theoretical precepts and the fact that it does not demand more information than the existing rules not requiring the measurement of marginal costs and demand elasticities. For the authors, the key insight of the global price cap rule is that the inclusion of access prices in the price cap reestablishes the symmetry between access goods and final goods.

The intuition for the optimality properties behind the global price cap, according to Laffont and Tirole (2000, p. 170-171) is that this rule induces the firm to internalize almost perfectly the consumer net surplus in its objective function by setting the weights equal to the forecasted quantities.

Two other advantages of the global price cap are that, according to the authors (1996, p. 245):

i. the incentive to foreclose vertically the rival is eliminated in contrast to the more common rules used by regulators who unevenly reduce artificially access prices in comparison to final good prices, which reduces the access business profitability compared to other lines of business, encouraging foreclosure;[30]
ii. by avoiding the practice of current regulations of providing different incentives for cost reduction or profit enhancement in different product lines, the rule does not encourage cross subsidies.

[29] These authors (p. 425-426) show that the ECPR proponents do not clarify if they are proposing a regulated access price or only showing that leaving market forces operate freely will lead automatically to the most efficient outcome, *i. e.* the ECPR rule and thus there would be no role for state intervention in interconnection pricing. That is why the authors (p. 430-434) state that the ECPR allows for the entrant's efficiency gains being appropriated by the incumbent.

[30] See Laffont and Tirole (2000, p. 175-178, Box 4.8) for a more theoretical based discussion of the incentives for foreclosure in the presence of a global price cap.

Besides showing the optimality properties of the global price cap, the authors (p. 244-246) also show that when the access price is not included in the weighted sum of the cap, noncompetitive segments are being cross-subsidized by the competitive ones.[31] The proof provided by the authors for this statement is not based on a pure global price cap, but relies on a mix of global price cap with ECPR. By making $a = p_1 - c_1$, (11) becomes:

$$\bar{q}_0 p_0 = (\bar{q}_1 + \bar{q}_2) p_1 \leq \bar{p} \qquad (11')$$

On the other hand, a partial price cap rule that does not include the access price is given by the more general formula:

$$w_0 p_0 + w_1 p_1 \leq \bar{p} \qquad (12)$$

The question is what is the relative cost of increasing p_1 in the competitive segment (for instance, long distance) compared to increasing p_0 in the monopolized segment (for instance, local service) under (11') compared to (12)? Under a partial price cap rule like (12), this cost is weighted only by the **incumbent demand** in the competitive segment divided by the **total demand** on the monopolized segment $\frac{q_1}{q_0}$.

In other words, under the partial price cap rule, the numerator is only a part of the whole demand. On the other hand, under a global price cap rule (11'), it is weighted by the **total demand** in the competitive segment also divided by the **total demand** in the monopolized segment, $\frac{q_1 + q_2}{q_0}$, which is the proper unbiased weight between both segments. As there is a **downward bias** of the weight under the partial cap rule, this results in an **upward bias** in the price of the competitive segment p_1 compared to p_0.

Furthermore, the authors state that complementing the global price cap rule with ECPR can bring two important benefits. First, comparing (11) with (11'), it is easy to see that the informational requirements of the second are lower than those of the first. Estimating the aggregate demand in (11') is always easier and less subject to errors than estimating each of its component parts q_1 and q_2. Second, and even more important, mixing a global price cap with the ECPR reduces the likelihood of predatory pricing by the incumbent, who could increase access prices and reduce his/her price in the competitive segment, while satisfying the global price cap constraint.

[31] By "partial price cap" the authors mean a price cap that does not include the whole set of prices, including the access prices.

Predation in this case would occur through two ways, the increase in the rival costs (access prices) and the strengthening of competition by lowering the long distance price of the incumbent.

Introducing the ECPR as a ceiling for the access prices softens the most important critique of the global price cap rule, *i. e.*, the fact that this rule can bring an incentive for the incumbent to predate when this agent proceeds to an intertemporal maximization instead of a single period one. According to Laffont and Tirole (1996, p. 247) it is quite simple to predate if the global price cap is introduced and complementing it with the ECPR, although not preventing it completely, makes predation more costly. On the other hand, the main problem of introducing ECPR in the global price cap rule is that the simplicity of price cap rules is eliminated.[32]

5_ An overview of the literature on "two-way" interconnection

Recently, with technological developments that have been challenging the natural monopoly characteristics of the local network in telecommunications, researchers have started to think about the effects of more than one operator at the bottleneck level. Laffont, Rey and Tirole (1998, p. 5) stress that the literature on interconnection concentrated much effort on the study of better regulatory choices by the regulator in the context of a single bottleneck, but not on the free-market result of symmetric networks competing in the same area and negotiating reciprocal interconnection agreements.

Laffont, Rey and Tirole (1998a and 1998b) and Armstrong (1998) sought to fill this gap, assessing access pricing in an unregulated two-way interconnection setting, deriving important (and very similar) results. Armstrong (1998) introduces the main question: free negotiation on access prices will maximize welfare or regulation is still required?

The same main conclusion emerges in these three articles. Free market interconnection agreements, in a context with two networks with not too different sizes, **can** generate collusion, with final prices different from the social optimum. This means that regulatory oversight on interconnection agreements can remain important, even after breaking the monopolistic characteristics of the local loop.

[32] Other rules that tie final prices in the competitive segment with access price such as $p - a \geq c$ could also be undertaken to avoid predatory pricing incentive.

Laffont, Rey, and Tirole present two papers on two-way telephone interconnection, one of them (1998a) not allowing and the other (1998b) allowing for price discrimination between calls terminating in the subscriber's network and those terminating on the rival's network. One of the main findings is that, since the networks are differentiated, they have at least some market power, which introduces a distortion in final prices. To correct this distortion, the production must be subsidized, justifying regulation of access prices below marginal costs, which outweigh their market power over each other, when there is no common fixed costs across users (but only individual costs of connecting each user).[33]

Proposition 1 of the first paper (p. 10)[34] shows that, when the degree of substitutability and/or the access price between the networks are high enough, there exists no equilibrium for final prices in a model with reciprocal access pricing.[35] On the other hand, when equilibrium exists (substitutability is not too great), the access price becomes an instrument of tacit collusion as shown in their Proposition 2 (p. 11). High access rates, even not affecting the final equilibrium flow of revenues and payments of access if the inflow of calls coming from users in the rival network and the outflows of calls going to users in the rival network are balanced, increase the marginal costs of off-net calls, requiring price increases.

However, high access rates also stimulate the networks to enlarge their market-share to reduce off-net calls that increase access payments. The main way to increase the network market-share is by reducing final prices, which reduces the role of access price as a potential instrument of tacit collusion. On the contrary, the incentive to build market-share dampens collusion incentives.

In the second part of the first paper, the authors address non-reciprocal and non-cooperative access prices in a two-stage game. Contrarily to the reciprocal case, an increase in the degree of substitutability brings ambiguous effects on the access charges. On one hand, the expected impact of increasing access charges on raising rival costs and inducing increases in final prices is of softening competition, which is a good result for the seller of access. On the other hand, this strategic effect is lower as long as

[33] When the authors introduce common fixed costs, the result is ambiguous since the requirement to recover them is added to the problem.

[34] The initial Propositions of the first paper assume a hypothesis of reciprocal access pricing.

[35] This basic conclusion also holds for nonlinear tariffs as shown in their Proposition 7 (p. 21).

the network buyer of access internalises the greater loss of market share under a high substitutability hypothesis. The latter effect can dominate and reduce equilibrium access charges prices under some conditions.

The authors (p. 15-20) also evaluate optimal access pricing by the regulator in the context of unbundling-based entry and facilities-based entry. In the facility-based entry, the authors compare the case where:

i. the regulator mandates the access price and the entrant chooses the optimal coverage of his network; and the case where
ii. interconnection negotiations are fully unconstrained.

For strategic reasons, the entrant, even under a regulated access price, prefers to keep a small coverage, dampening the regulatory target of improving competition between networks. This happens because the authors divide the market in two: one where both networks overlap and another that is captive of the incumbent. Furthermore, the authors assume that the incumbent is obliged not to price discriminate between these two sub-markets. Then, when the part of the market dominated by the incumbent is large, if he/she reduces the price in the overlapping part to obtain market-share, he/she has to reduce the price in the captive market as well. However, the negative effect on profits of the captive market from reducing prices beyond the monopoly level in this sub-market more than offsets the increased market-share in the overlapping market. Thus, the entrant keeps its coverage low to induce the non-discriminating incumbent to avoid price wars and charge high final prices.[36]

In a less regulated environment where an interconnection agreement is not compulsory (but still maintaining the requirement of non-discrimination), the incumbent charges a limit final price aiming to corner the market. This weakens the bargaining position of the entrant, since there is no dead-line to reach an interconnection agreement. So, the incumbent delays the reach of an interconnection agreement as much as possible. The players will agree a large access charge paid by the entrant and a low access charge paid by the incumbent,[37] which tends to weaken the challenge to the incumbent. On the other hand, this situation reverses the

[36] In the words of the authors, the entrant when reducing his coverage and expanding the captive market of the incumbent, transforms him into "*a pacifistic fat cat*".

[37] One of the hypotheses is that there is no need for reciprocity here.

tendency of the entrant to underinvest in coverage and he/she tends to be more aggressive in facility investment,[38] challenging the incumbent position more strongly.

The second paper of Laffont, Rey and Tirole (1998b) allows for the networks to charge their customers different prices for calls terminating on and off the network. There are important similarities to the case without price-discrimination (the first paper). For instance, there will only be equilibrium if the access price is close to the marginal cost and/or if the degree of substitutability between networks is small enough.

Nonetheless, the main point of the second paper is that the nature of competition is substantially affected by the possibility of price discrimination. Network externalities become an issue, since the customers of one network will be better-off as more consumers join their specific network as calls are cheaper within the same network (on-net calls are cheaper compared to off-net calls).[39]

The tendency under price discrimination for high access charges engendering tacit collusion is lower than in the case of no-price discrimination, but can still emerge. High access charges can even trigger beneficial price wars and thus the impact of allowing for price discrimination in terms of the collusion propensity of the market is ambiguous. According to the authors (1998b, p. 40), there are two responses to an increased off-net (access) cost, it raises its off-net price to reflect the cost increase of off-net calls and each network get an incentive to increase his/her market share in order to reduce the cost of serving its customers in off-net calls.

There is no more incentive for the entrant to remain as a low coverage carrier, since there is no prohibition on price discrimination. According to the authors (p. 40) this occurs because in the discrimination case, a full-coverage incumbent can squeeze a small-coverage entrant by insisting on a high access price, which translates into high off-net prices, raising more than proportionally his/her rival costs. The final result can be a *de facto* lack of interconnection. Indeed, the authors show the intuitive result that small scale entry is harder under price discrimination and that the access charges practiced by the incumbent require a minimum coverage of the

[38] In the "animal terminology" of Fudenberg and Tirole (1984), the entrant passes from an almost *puppy-dog* strategy to a *top-dog* strategy. In other words, he has to defend himself more aggressively to be able to survive without government sponsorship.

[39] In the case of non-discrimination, by definition, network externalities are non-existent, assuming that the quality of the call is the same.

entrant for entry to be viable. This suggests that price discrimination can reduce welfare for competition between "unequal" networks.

However, the most important insight of the second article is that banning price discrimination **may** reduce social welfare in the case of "competition between equals" (incumbent and entrant with similar sizes). This challenges the universality of the conventional wisdom of the "non-discriminatory rule of thumb" used by telecom regulators around the world, including Brazil. Despite the fact that price discrimination brings misallocation of resources in the model, since it is not related to differences in costs and/or demand elasticities, the authors (p. 49-50) show that price discrimination tends to alleviate the double marginalization problem of the two-way interconnection when the two networks are poor substitutes and there is a positive mark-up on access. Second, price discrimination tends to intensify competition and lower average final prices for small mark-ups. Given this pattern, the authors (p. 55) conclude that a dominant operator may always defend price discrimination, while the potential entrants have a small coverage, becoming against it, when competitors have entered on a large scale.

The reason is that when the scale of operation of the incumbent and the entrant are not so different (in a mature stage of the industry), the first one prefers the accommodation of a tacit collusion around a single uniform price rather than a fierce price war with the other (now strong) player.

Armstrong (1998) also develops his model based on the likelihood of collusion brought about by unfettered access charge fixing (constrained by a reciprocity condition). Similar to the Laffont, Rey, and Tirole model with enough differentiation between networks, there will be adequate incentives for using access charges as an instrument of collusion. According to the author (p. 554), this occurs because high access charges increase the cost of reducing retail prices unilaterally. Such an action causes the deviating network to have a net outflow of calls to the rival network, which incur costly call termination payments.

In this case, the author captures the change in the type of potential anticompetitive behavior derived from access charge fixing in the case of

asymmetric and symmetric competitors. While in the dominant one way-access (asymmetric) case, the anticompetitive problem was related to a potential exclusionary behavior (foreclosure), in the two way-access (more symmetric) case, the problem is collusion. In one way interconnection, access prices can be used anticompetitively, foreclosing the rival, while in two-way interconnection access prices can become a tool for collusion.

As in the case of Laffont, Rey, and Tirole (without common fixed costs), the welfare maximizing access charge is **below** the marginal cost just to compensate imperfect competition. As the collusive result implies an access charge always **greater** than the marginal cost *c*, this free market access price a_1 is higher than the optimal one a_2 ($a_1 > c > a_2$). Thus, there is scope for a welfare enhancing regulatory intervention in the interconnection market.

If access charges represent a means of price coordination among companies, there is also a case for an active interconnection policy in a typical cartel assessment. Of course this co-ordination will only work when both companies together have sufficient market power and thus the first stage of the two-stage rule proposed by Katz, Rosston and Anspacher (1995) still applies for a previous selection of eligible agreements to be scrutinized by the regulatory authority.

Notice that the existence of reciprocal double-marginalization is one of the key points on two-way interconnection. In this regard, we can assess the usefulness of the ECPR rule in the case of two-way interconnection. Indeed, if both companies charge each other access prices that include their respective opportunity costs, there is a reciprocal double marginalization problem and the final result is lower welfare for society. The result can reduce both players profits as well, since ECPR also represents a non-internalization of a negative externality. Thus, it is possible that the pure ECPR rule will result in access prices higher than free negotiation. The important message is that the ECPR does not seem appropriate for a two-way interconnection.

6_ Conclusions

As shown in section 2, the scope of an active interconnection policy can be narrowed when the agents involved in the interconnection agreements (individually or jointly) do not have enough market power to harm competition. Thus, the need for an active interconnection enforcement should not be always taken for granted. When (and if) competition increases enough, the best strategy is to adopt the "two-stage approach" proposed by Katz, Rosston and Anspacher (1995). In this case, note that, even if there is enough market power, a cost/benefit analysis has to be pursued to evaluate whether an active interconnection policy is desirable. Indeed, in some cases, the authority can decide that it is better not to enforce interconnection, since competition over the best standard can be fostered without interconnection enforcement. However, interconnection in a first stage of entry can be a necessary condition for competition to occur later and thus the hypothesis of Mueller (1997) about a trade-off between customization and standardisation must not be exaggerated. On the other hand, given the informational requirements of this kind of policy, the costs of intervention are not negligible and must be considered, at least when deciding the degree of intervention.

The literature on transaction cost theory and foreclosure helps to understand why a detailed ruling on interconnection procedures by the regulatory authority can be desirable. Dominant firms can have incentives to foreclose. There are also high transaction costs involved in any interconnection agreement, mainly due to the incompleteness of the interconnection contract. It is plausible to assume that the incentive for foreclosure by the incumbent will make it more willing to enhance those transaction costs. Therefore, there is often a requirement for the regulatory authority to intervene.

The incentive to foreclose caused (or just enhanced) by a low regulated access price is one of the defenses of the ECPR, since it incorporates the opportunity costs of the bottleneck owner in providing access. However, despite some desirable efficiency properties of the ECPR, there are important critiques. Indeed, ECPR is neither a necessary nor a sufficient condition for optimality. It is not

necessary, since ECPR may not be the unique solution of the Willig's problem. Second, even a solution to Willig's problem will not solve the problem of monopoly rents that are the main concern of the regulator when he/she wishes to introduce competition in telecommunications.

The global cap proposed by Laffont and Tirole (1996) has the great virtue of reconciling the theoretical benchmark of Ramsey regulated prices with practical implementation. The problem is that a by-product of this policy is that predatory pricing can become a profitable strategy. In this regard, Laffont and Tirole (1996) propose that global price caps be supplemented by the ECPR.

Though the main regulatory authorities around the world disregard global price cap and ECPR rules, we think that a mix as proposed by Laffont and Tirole (1996) constitutes a better policy guideline, given the current state of knowledge on interconnection. More precisely, we think that global price caps should be the general rule to regulate prices. On the other hand, some rule to prevent final prices from diverging too far from access prices is required to avoid predatory pricing, and ECPR is a potential candidate.

Finally, the recent studies on two-way interconnection show that foreclosure is not the only concern for policy. Collusive agreements can emerge from market forces when there are few but symmetric networks. As competition in telecommunications evolves, this concern may matter more.

Moreover, another important insight of the Laffont, Rey, and Tirole paper on a two-way interconnection is that allowing price discrimination tends to reduce this incentive for collusion, since the greater flexibility on pricing renders the collusive agreement less stable.

References

ARMSTRONG, M. Telecommunications. In: HELM, D.; JENKINSON, T. (Ed.). *Competition in regulated industries*. [s.l.]: Oxford University Press, 1998.

ARMSTRONG, M. Network interconnection in telecommunications. *The Economic Journal*, n. 108, May 1998.

ARMSTRONG, M.; COWAN, S.; VICKERS, J. *Regulatory reform:* economic analysis and british experience. [s.l.]: The MIT Press, 1994.

ARMSTRONG, M.; DOYLE, C.; VICKERS, J. The access pricing problem: a synthesis. *Journal of Industrial Organization*, v. 44, n. 2, 1996.

ARMSTRONG, M.; VICKERS, J. Regulatory reform in telecommunications in central and eastern europe. *Economics of Transition*, v. 4, n. 2, 1996.

ARMSTRONG, M.; VICKERS, J. The Access pricing problem with deregulation: a note. *The Journal of Industrial Organization*, v. 46, Mar. 1998.

BARON, D.; MYERSON, R. Regulating a monopolist with unknown costs. *Econometrica*, v. 50, n. 4, 1982.

BAUMOL, W.; ORDOVER, J.; WILLIG, R. Parity principle and its critics: a necessary condition for efficiency in the provision of bottleneck services to competitors. *Yale Journal on Regulation*, v. 14, n. 85, 1997.

BAUMOL, W.; PANZAR, J.; WILLIG, R. *Contestable markets and the theory of industry structure*. [s.l.]: Harcourt Brace Jovanovich Publishers, 1982.

BAUMOL, W.; SIDAK, G. *Toward competition in local telephony*. AEI studies in telecommunications deregulation. [s.l.]: The MIT Press and the American Enterprise Institute for Public Policy Research, 1994.

BESEN, S.; SALONER, G. The economics of telecommunications standards. In: CRANDALL, R.; FLAMM, K. (Eds.). *Changing the rules:* technological change, international competition and regulation in telecommunications. [s.l.]: Brookings, 1989.

DOANE, M.; SIBLEY; WILLIAMS, M. Having you cake: how to preserve universal services cross subsidies while facilitating competitive entry: reply to baumol. *Yale Journal on Regulation*, 1999.

ECONOMIDES, N.; WHITE, L. *Access and interconnection pricing:* how efficient is the "Efficient Component Pricing rule"? [s.l.]: The Antitrust Bulletin, Fall 1995.

FCC - Report n. 99-33. Commission adopts pricing flexibility and other access charge reforms. at Aug. 5, 1999. <http://www.fcc.gov/Bureaus/Common_Carrier/News_Releases/1999/nrcc9054.html>

FUDENBERG, D.; TIROLE, J. The fat cat effect, the puppy dog ploy and the lean and hungry look. *American Economic Review Papers and Proceedings,* 1984.

HAUSMAN, J. *Proliferation of networks in telecommunications*. Networks, infrastructure and the new task for regulation. [s.l.]: University of Michigan Press, 1996.

KATZ, M.; ROSSTON, G.; ANSPACHER, J. Interconnecting interoperable systems: the reghulator´s perspective. *Information, Infrastructure and Policy*, v. 4, IOS Press, 1995.

KATZ, M.; SHAPIRO, C. Systems competition and network effects. *Journal of Economic Perspectives*, v. 8, n. 2, Spring 1994.

LAFFONT, J. J.; REY, P.; TIROLE, J. Network competition I: overview and nondiscriminatory pricing. *Rand Journal of Economics*, v. 29, 1998a.

LAFFONT, J. J.; REY, P.; TIROLE, J. Network competition II: *Price Discrimination. Rand Journal of Economics*, v. 29, 1998b.

LAFFONT, J. J.; TIROLE, J. *A theory of incentives in regulation and procurement*. Cambridge: MIT Press, 1993.

LAFFONT, J. J.; TIROLE, J.: Access pricing and competition. *European Economic Review*, v. 38, 1994.

LAFFONT, J. J.; TIROLE, J. Creating competition through interconnection: theory and practice. *Journal of Regulatory Economics,* v. 10, 1996.

LAFFONT, J. J.; TIROLE, J. *Competition in telecommunications*. Munich Lectures in Economics. [s.l.]: The MIT Press, 2000.

LAFFONT, J. J.; TIROLE, J. Global price caps and the regulation of access. *Revista de Econometria*, SBE, v. 20, n. 1, Maio 2000b.

LARSON, A.; LEHMAN, D. Essentiality, efficiency and the efficient component pricing rule. *Journal of Regulatory Economics*, v. 12, 1997.

MATTOS, C. C. A. *The brazilian model of telecommunications reform*: a theoretical approach. 2001. Tese (Doutorado) – UNB, 2001.

MITCHELL, B.; VOGELSANG, I. *Telecommunications pricing*: theory and practice. Cambridge: Cambridge University Press, 1991.

MUELLER, M. *Universal service:* competition, interconnection, and monopoly in the making of the american telephone system. AEI studies in telecommunications deregulation. [s.l.]: The MIT Press and The AEI Press, 1997.

NOLL, R.; OWEN, B. *The anticompetitive uses of regulation:* United States v. AT&T (1982). Edited by KWOKA. [s.l.]: The Antitrust Revolution. J. 1995.

SPULBER, D. *Regulation and markets*. [s.l.]: The MIT Press, 1989.

TIROLE, J. The theory of industrial organization. [s.l.]: The MIT Press, 1988.

TYE, W.; LAPUERTA. The economics of pricing network interconnection: theory and application to the market for telecommunications in New Zealand. *Yale Journal on Regulation*, v. 13, 1996.

VICKERS, J. Regulation, competition and the structure of prices In: HELM, D.; JENKINSON, T. (Ed.). *Competition in regulated industries*. Oxford: Oxford University Press, 1998.

VISCUSI, W.; VERNON, J.; HARRINGTON, J. *Economics of regulation and antitrust*. Second Edition. [s.l.]: The MIT Press, 1995.

WILLIG, R. The theory of network access pricing. In: TREBING, H. M. (Ed.). Issues in Public Utility Regulation 109. [S.l. : s.n.], 1979.

Authors' e-mail
cesar.mattos@camara.gov.br