Vertical foreclosure in telecommunications through access prices and interconnection quality*

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RESUMO

É conhecido na literatura de economia da regulação o incentivo que uma empresa verticalmente integrada no setor de telecommunicações proprietária das redes local e de longa distância possui de fechar o mercado para seus concorrentes. Isso ocorreu no mercado de telecomunicações americano, dada a dependência dos novos concorrentes da longa distância (MCI e Sprint) nas redes locais da AT&T para conectar usuários finais. Visando evitar tais problemas, a reforma das telecomunicações no Brasil seguiu a experiência americana no processo antitruste que resultou na quebra da AT&T em 1984, reduzindo a verticalização prévia da estatal TELEBRAS antes da privatização. Apresentamos dois modelos referentes à idéia de fechamento vertical em telecomunicações via preços de acesso e via deterioração da qualidade de interconexão. No Brasil, isso justifica não apenas a quebra vertical da TELEBRAS, mas também a forte regulação de qualidade e custo de interconexão.

Palavras-chave: concorrência, fechamento vertical, telecomunicações, interconexão.

ABSTRACT

It is common sense within the economic regulation literature, that for a vertically integrated company, from the telecommunications sector, which owns local and long distance networks, have incentives to foreclosing other competitors. 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 end users. Aiming to avoid these problems, the telecom reform in Brazil followed the US antitrust experience in the AT&T divestiture of 1984, reducing the previous verticalization of TELEBRAS before privatization. We present two models addressing the idea of vertical foreclosure through access pricing and deterioration of interconnection quality. These models show that the regulation of the quality of interconnection can be more important than access pricing. In Brazil, this justifies not only the vertical break-up of TELEBRAS, but also the strong provisions towards the maintenance of quality and a low cost of interconnection.

Key-words: competition, vertical foreclosure, telecommunications, interconnection.

JEL classification: L12, L22, L42.

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I Introduction

It is common sense within the economic regulation literature, for a vertically integrated company, from the telecommunications sector, which owns local and long distance networks, has to deny interconnecting competitors in the long distance market in its local loop bottleneck. This occurred in the US telecommunications market, given the dependence of new long distance competitors (MCI and Sprint) on the AT&T local networks to connect with end users. AT&T was charged of using its market power to reduce downstream competition, raising rival costs through refusal to deal, high local interconnection charges[1] or even reduction of the quality of access to competitors. Viscusi, Vernon and Harrington (VVH-1995, p. 504-505) summarize 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 specialized 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.*
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> *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"*[2]

1 If the interconnection charge is high enough, it will drive competitors out of the market and the effect is equivalent to a refusal to deal.

2 For a brief history of the AT&T in the US, including the first agreement of the company with the US Department of Justice in 1913 (the Kingsbury Commitment) due to anticompetitive practices, see Noll and Owen (1995, p. 329-333). One of the main duties imposed on the company was interconnection with competitors.

This is not a problem when there is a legal state monopoly in the sector as was the case of Brazil before 1998 (privatization of TELEBRAS, the state owned monopoly of Brazilian telecommunications) and the UK before 1984 (privatization of British Telecom, the state owned monopoly of British telecommunications). Even if there is a state monopoly in the local loop and competition of state and private companies and assuming that state owned companies maximizes social welfare,[3] these problems do not emerge. But when the sector is privatized, it is usually expected that the profit maximizing behavior of the incumbent companies will raise this kind of trouble, undermining one of the main purposes of privatization, the introduction of competition to improve efficiency and welfare. Therefore, it is widely accepted that the success of these targets requires a pro-competitive regulation aiming to avoid anticompetitive behaviour as that described above.

In the UK, these problems appeared after the privatization of British Telecom, given the absence of a policy of vertical break-up as implemented in the antitrust suit in the US[4] and the lack of appropriate action by OFTEL.[5]

Aiming to avoid these problems, the telecom reform in Brazil followed closely the US antitrust experience in the AT&T divestiture of 1984,[6] reducing the previous verticalization of the state-owned company TELEBRAS before privatization. On the other hand, in the UK, the government did not proceed to any restructuring of the state-owned company before privatization.[7] However, there are some important differences between the Brazilian reform and the US antitrust lawsuit. Firstly, the Brazilian government imposed a line of business restrictions on the long distance companies to operate in the local services, which did not occur in the AT&T break-up. In this regard, the BMTR was more stringent than the US antitrust intervention.[8]

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3 This is clearly an extreme and unrealistic assumption.

4 The lack of vertical break-up is also found in the Canadian experience as shown by Crandall and Waverman (1995, p. 67-68).

5 According to Armstrong, Cowan and Vickers (1994, p. 239) the entrant in the telecommunications sector of the UK at that time, Mercury, *"should be protected against anticompetitive behavior by BT, and it is unfortunate that resolution of the question of interconnection was held up for as long as it was... "*

6 This was considered the largest antitrust settlement of all history and started in November, 1974 lasting almost 10 years until implementation.

7 Vickers and Yarrow (1988, p. 237) criticised the UK model in this respect: "*There are several ways in which BT could have been split in order to promote effective competition and regulation before privatisation (or indeed in the future). The operation of local and long distance networks could be separated, perhaps with several local or regional network operators as in the United States. ..... Restructuring of this kind can enhance the effectiveness of competition and regulation by altering incentives and information conditions in such a way that private motives are directed more to social ends.*"

8 This occurred more in practice until the promulgation of the competition Act in 1996, since several State regulators restricted entry in the local service or even long distance service in small areas.

Second, there were seven regional companies divested from AT&T (called Regional Bell Operating Companies or RBOCS) that could only provide long distance service in a very limited area. The Modified Final Judgment in the US, resulted in the break-up of AT&T, divided the country into 160 Local Access and Transport Areas (LATAS).[9] Each RBOC, despite that fact it owned local networks in several LATAS, was only permitted to provide long distance service inside each LATA. In Brazil, the regional companies can provide long distance service in the entire territory. Therefore, in this regard, the US instituted a more radical vertical break-up compared to the BMTR.

Nonetheless, pro-competitive policies were not only undertaken in the phases of restructuring and privatization of TELEBRAS in the BMTR. The auctions of TELEBRAS's companies were carried out with restrictive rules regarding cross-ownership, in order to avoid restablishing horizontal and vertical reconcentration, by mitigating the separation strategy adopted in the TELEBRAS restructuring. It was not allowed for the same shareholder or for a set of shareholders to acquire direct or indirect control or even ownership higher than 20% of the voting capital of: 1) more than one of the four companies of the wire telephone system (three regional companies and Embratel); 2) more than one of the four companies of the wireless telephone system within areas 1 to 6; 3) more than one of the four companies of the wireless telephone system within the areas 7 to 10; 4) any of the eight companies of the wireless telephone system (Group A) which operates in a geographical area where the acquiring company already owns, direct or indirectly, concession for exploring the mobile service from the previous bidding of the mirror company (named Group B). Furthermore, it was forbidden for the new owners to promote mergers among the companies of the four privatized wire telephone companies, also the new owners of the privatized wire telephony could not participate in the competitive biddings in order to become a new entrant wire company. All cross-ownership constraints in the wire segment will last until December 31, 2003 and 2002, respectively, for the privatized wire companies and for new entrants (mirror-companies) which entered before December, 2001. This would complete the transition of the Brazilian telecom sector to a full-blown competition.

The following table summarises the differences among Brazil, US and UK regarding vertical separation of the incumbent company in telecommunications.

9 See Noll and Owen (1995, p. 151).

Table 1
International Comparison of Vertical Separation in the Telecommunications Sector

Country	Brazil	US	UK
Vertical Separation of Long and Local Distance Networks of the Incumbent	Yes	Yes	No
Scope of Provision of the Long distance Service	The three regional companies are allowed to make long distance calls inside their respective areas, but not between areas.	The seven RBOCS are only allowed to make long distance calls inside each one of the 160 LATAS in which the country was divided, but not between areas.	None
Temporary Line of Business Constraints	Yes, from the local companies to the long distance and vice-versa.	Yes, but at the federal level. Only from the local companies to the long distance service.	No

In this article we intend to work on the theoretical rationale behind vertical foreclosure through access pricing and deterioration of interconnection quality, which justifies the antitrust policies such as those adopted in the vertical break-up of AT&T in the US and the vertical restructuring of TELEBRAS in Brazil. We provide in the next section, a brief survey of the literature on vertical foreclosure. The third section addresses the definition of vertical foreclosure through access prices and the fourth section, vertical foreclosure through quality deterioration. In both cases, we offer proper definitions of vertical foreclosure. Basically, it is important to isolate, for the net effect of joint ownership of local, access and long distance networks, the incumbent in his behaviour towards the entrant in the long distance market. This occurs when comparing the optimal access pricing and the optimal deterioration of the entrant's quality, settled by the vertically integrated incumbent, compared to an independent access provider, which owns the local loop. Section V concludes.

10 The entry barrier theory is based on the fact that vertical integration may increase the capital requirements for another firm to enter the market. According to Perry (1989, p. 197), this theory was originally conceived with the first body of theoretical work related to the concept of barriers to entry of Bain in 1956: "*Bain argued that vertical integration creates a capital barrier to entry by forcing potential competitors to contemplate entry at two stages of production rather than just one. In addition, he pointed out that vertical merger also eliminates one of the most natural potential entrants into each stage.*" See Posner (1979) as quoted by VVH (1995, p. 160), for the most impacting critique against this theory.

II Brief survey of the literature on vertical foreclosure

There are two main theories behind any antitrust intervention in vertical integrations in the US: i) the entry barriers theory[10] and ii) the "market foreclosure" or "essential-facility" doctrine. The latter one is by far the most important and we concentrate on it. Rey and Tirole (1997, p.1) state the fundamentals of the "market foreclosure" reasoning in the antitrust literature and jurisprudence:

> "*According to the received definition, foreclosure refers to any dominant firm's practice that denies proper access to an essential input it produces to some users of this input, with the intent of extending monopoly power from one segment of the market (the bottleneck segment) to the other (the potentially competitive segment). The excluded firms on the competitive segment are than said to be "squeezed" or to be suffering a secondary line injury. Essentiality means that the dominant firm's product cannot cheaply be duplicated by users who are denied access to it. Examples of essential facilities or bottlenecks to which competition law has been applied include a stadium, a railroad bridge or station, a harbor, a power transmission or a local telecommunications network, and a computer reservation system. The foreclosure or essential facility doctrine states that the owner of an essential facility may have an incentive to monopolize complementary or downstream segments as well. This doctrine was first discussed in the United States in Terminal Railroad Association v. U.S. (1912), in which a set of railroads formed a joint venture owning a key bridge across the Mississipi river and the approaches and terminal in Saint Louis and excluded non-member competitors.*"

In the case of AT&T, the local loop was considered an essential facility given the difficulty of duplication by the competitors, mainly because of its natural monopoly characteristics.

The foreclosure theory was severely criticised by the Chicago school, mainly through the writings of Bork (1978) and Posner (1976),[11] which argued the lack of economic rationality

11 See Comanor (1969) for a full critique of the foreclosure idea as well. The main point for this author was that the degree of market power would not be "*additive at successive stages*" which will become the core of the Chicago critique

for firms to comply with a vertical merger strategy to raise their profits, by foreclosing the market. For these authors, the only explanation for vertical integration would be the generation of efficiencies. Rey and Tirole (1997, p. 7) summarises the Chicago criticism:

> "*The thrust of the Chicago School critique of this doctrine is that there is only one final product market and therefore only one monopoly power to be exploited, and that it is not obvious how the monopolist could further extend its monopoly power.*"

Given the lack of rationality for exclusionary behaviour in the foreclosure approach, these authors defended the intrinsic efficiency aspects of vertical mergers. The force of this criticism resulted in a change of antitrust policy towards vertical mergers in the US, with a less interventionist approach.

In fact, there are many critiques of the foreclosure theory. In a survey made by Ordover, Saloner and Salop (1990, p. 128-129), one of these critiques can be applied to the essential facility case of an integrated company owning a bottleneck, for instance, the telecom local network case.[12] According to these authors, this critique relates to the fact that "*..lost upstream profits*" due to downstream competitor foreclosure "*may exceed the increased downstream profits*" of the integrated firm and thus there would be no reason to foreclose.

The emergence of these critiques was mainly due to the lack of a rigorous analysis of the vertical foreclosure economic rationality. Several authors started to provide more rigorous economic rationales, improving the understanding of possible economic reasoning behind foreclosure,[13] escaping from the naive leverage version of the theory that was used by the US courts until the seventies.

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12 The other criticisms are i) "*The supply of inputs available to rivals is not necessarily reduced.... because the integrated firm also reduces its demand for inputs produced by unintegrated suppliers.... it merely will necessitate a rearrangement in supply relationships*"; ii) "*... remaining suppliers may not have the incentive to raise their input prices*", and, then, the denial of supply by one supplier will not raise rival costs; iii) the likelihood of foreclosed competitors to integrate vertically with remaining suppliers; iv) even if input prices increase, the supplier that integrated would have to be compensated by the forgone potential extra profits obtained by their rivals. This compensation can decrease the profitability of the merger "*possibly to the point that no merger occur*"; v) "*Since the firm that is foreclosed is placed at a disadvantage, it ought itself to participate in the bidding for the scarce upstream resource.*" This last criticism can be used to the case of a single natural monopoly supplier as in the case of telecommunications. The difference with the AT&T case is that the integration happened before the entry of MCI and Sprint in the market.

13 According to Rey and Tirole (1997, p. 4): "*The Chicago school view has had the beneficial effect of forcing industrial economists to reconsider the foreclosure argument and to put it, we believe, on firmer ground.*"

Tirole (1988, p. 193-198) provides a survey of these efforts from the end of the seventies up to the publication of his textbook. One important aspect that emerged is that socially inefficient market foreclosure could be obtained through a myriad of generic strategies aiming to raise rival costs[14] including exclusionary vertical long term contracts[15] rather than only vertical mergers. Concerning the issue of market foreclosure by vertical integration, Tirole (p. 195) states that, with few exceptions, the main failure of the economic literature would be not explain the reason why integrated firms would not sell or buy in the intermediate goods market instead of foreclosing. The two exceptions were published afterwards in Salinger (1988) and Ordover, Saloner and Salop (1990) papers.

Salinger (1988) shows with three simple assumptions that vertically integrated firms after mergers do not participate in the upstream input market but only supply their downstream associated companies, foreclosing access of other downstream firms. The author defines as an economically meaningful definition of market foreclosure of downstream firms, an increase in the price of the input, which, as we will see, is closer to the first model we are presenting here. Ordover, Saloner and Salop (1990) structure a model where vertical foreclosure can emerge as equilibrium in a successive duopoly setting. The model is a four-stage game where the final equilibrium is obtained through backward induction. The main importance of the paper is that it replies the six main criticisms against foreclosure doctrine.[16] Thus, the main result of their model is that the vertical merger hurts **both** downstream companies. At the same time, **both** upstream firms are benefited and the consumer is unambiguously hurt, given that final price always increases. The full structure of the game results in two downstream firms facing a prisoner dilemma regarding who will be the first to integrate.[17]

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14 See Salop and Scheffman (1983). Salop and Scheffman (1987) extend the basic model of 1983 to other situations, including the one where a dominant integrated firm prefers not to produce their own inputs more efficiently and buy more expensive inputs in the market aiming to raise the rival costs. Anyway, in this case, the vertical integration is not the source of foreclosing behavior. See also Salop and Kratenmark (1993).

15 The most known model of exclusive dealing arrangement that forecloses inefficiently the market comes from Aghion and Bolton (1987), also summarised by Tirole (1988 p. 196-198). The model replies formally the criticisms from Bork (1978) and Posner (1976) that criticized the decision of the courts in the exclusionary contracts of the case United Shoe Machinery Corporation of 1922 on the basis that there was not any incentive for the buyers to feed a monopoly on the other side of the market, signing contracts that exclude competitors. In their model, the capacity to impose fines high enough for the breach of the contract coupled with some degree of uncertainty regarding the entrant efficiency results in long term contracts that ensues a degree of foreclosure greater than the social optimum.

16 The first stage of the game happens when both downstream firms bid to acquire one of the upstream suppliers. In the second stage, input prices are determined. As one of the bidding downstream companies acquires one of the upstream firms, the other downstream firm bids to acquire the remaining supplier in the third stage. Finally, downstream prices are chosen in the fourth stage.

17 The authors summarize this intuition stating that "*the fear of being foreclosed drives each firm to attempt to foreclose the other. As a result, all the rents from foreclosure are dissipated through the bidding and all the profits accrue to the upstream firm(s).*"

Hart and Tirole (1990) built a very rich and complex set of hypotheses under which foreclosure can emerge and antitrust intervention can be welfare enhancing. One of the important features of their model is that they do not restrict their framework to any particular contractual arrangement, which enlarges considerably the application of their model to real world cases. Three variants of the basic model are constructed: a) ex post monopolization is the single variant that results in output contraction; b) scarce needs where downstream firms face capacity constraints and the main reasoning for vertical integration is the need of one of the upstream firms to ensure that downstream firms do purchase their supplies, and do not purchase from the rival's firm; c) scarce supplies where upstream firms face capacity constraints and the main reasoning for vertical merger is the need for one of the downstream firms to ensure that the upstream firm channels their scarce supplies to themselves, instead of to other downstream firms. In the last two cases, foreclosure can emerge as a by-product and not as the main motivation for a merger.

The model of Rey and Tirole (1997) provides a rationale for the foreclosure theory relating this idea to the known Coase model of the "durable good" monopolist.[18] Rey and Tirole (p. 10-17) show that the bottleneck facility owner facing oligopolists in the complementary market may not be able to credibly commit that he will maintain the monopoly result in the contracts with each of these players. This result can be obtained with the bottleneck monopolist offering to each of the oligopolists a "take it or leave it" contract that specifies the quantity supplied and total remuneration. The upstream firm always has an *ex-post* incentive to open secret renegotiations, acting opportunistically against the downstream contractors. Anticipating this result, each downstream oligopolist would not accept the contracts that ensued the monopoly result for the upstream bottleneck. This represents a decrease on the bottleneck monopolist's profit. There are two main ways to deal with this problem: a) an exclusive dealing arrangement with one of the oligopolists or b) merging. In both cases, the bottleneck monopolist refuses to deal with others, foreclosing the market to them. In this case, the temptation for opportunistic behaviour is eliminated. The monopolist bottleneck would then be able to extract all monopolist rents from the complementary market, and then chosen downstream firm will not have to fear about opportunistic behaviour. In this regard, the result is a departure from the conventional wisdom since foreclosure does not aim to **extend** market power from one market to another, but rather to **re-establish** the market power from a situation where the oligopolists in the complementary market fear the opportunistic behaviour from the bottleneck monopolist.

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18 Coase (1972) showed that when the durable good monopolist cannot commit to future prices, the buyers delay purchases in order to benefit from expected lower future prices. This happens because the monopolist himself will be tempted to reduce prices after some level of sales have been achieved, behaving opportunistically with the former buyers. In this regard, the monopolist faces intertemporal competition from himself. Thus, the durable good monopolist is not able to enjoy all his monopoly power that he/she would achieve when he can commit ex-ante to not lowering future prices.

More recently, Kuhn and Vives (1999), by extending and formalizing a conjecture raised by Perry (1989), they link the foreclosure caused by vertical integration and the "excess entry" result from Mankiw and Whinston (1986) arising from the "business stealing effect" In their model, foreclosure brings down the number of players in the market, more in line to the social optimum. So, vertical integration by increasing foreclosure and hurting competitors can increase efficiency and social welfare. The "excess entry result" was also addressed by Vickers (1995) in the context of linkage between a natural monopoly market, with a potentially competitive one. The novelty of his analysis is the introduction of price regulation at the monopolistic level, mainly access regulated prices, considering the information asymmetry of the regulator. This is a crucial departure from the previous literature on foreclosure and applies more closely to the situation of the regulated sectors, including telecommunications.[19]

Laffont and Tirole (2000) show that the incumbent will foreclose through quality deterioration when the regulated access price is settled below its profit maximizing level. So, the incumbent derives more profits by operating through his own subsidiary rather than by supplying the entrant.

The models described above represent the core of the current literature on foreclosure. However, almost all of them (with the exception of Vickers' model) are quite focused on the effects of vertical mergers and not on the plain idea that an already integrated firm, which owns an essential facility, would often have an incentive to foreclose supply to downstream competitors. Next section we introduce the first model to address this simple idea, checking whether the vertically integrated incumbent will use high access prices to foreclose rivals in the downstream (long distance) segment.

III Vertical foreclosure through access pricing

Firstly, we have to define vertical foreclosure in a broader viewpoint, given that full foreclosure is a particular and extreme case of discrimination, in general, of a vertically integrated incumbent against an entrant. We provide two definitions based on the tools used by the access provider to foreclose: the access price and the interconnection quality and cost.

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19 The basic trade-off of the cost and benefits of keeping vertical integration is stressed by the author (p. 4): "*Vertical integration has the disadvantage that the regulator's task is made harder insofar as the monopolist has incentives to raise rivals' costs, but it may have the advantage of offsetting excess entry and hence allowing a more efficient production structure in the competitive industry.*"

The first candidate rule to obtain a proper definition would be the difference between the access price and the marginal access cost. However, since the provision of access is also a business, we can expect that even an independent non-integrated bottleneck supplier will charge access prices greater than the marginal access cost. So, the access price/marginal cost differential does not only capture the incentive of a vertically integrated incumbent to protect its own downstream business, but also incentives to make positive profits in the access business. Thus, we have to pick a definition that eliminates this "access business profit-seeking" effect that will occur regardless of vertical integration. This is made through the following definition:

Definition 1 - ***There is a partial vertical foreclosure through access pricing from the upstream bottleneck segment to a downstream potentially duopolistic segment, when both downstream competitors have the same efficiency, but there is a positive access price differential between the situation where the upstream access provider is a vertically integrated firm and the situation where the access provider is an independent non-integrated monopolist access supplier that is able to price discriminate in his access business and faces the same number of downstream firms from the first situation.***

Since the access price of the independent access provider will contain an access business profit-seeking effect, differently from the marginal access cost, the differential between the access price of the vertically integrated firm and the independent provider will be to isolate for the effect of ownership of the upstream access provider in the access price rule, capturing for the vertical foreclosure incentive. Note that the source of the bias could also stem from an efficiency differential and not from vertical integration. That is why we restrict the comparison to the case of equal efficiency (equal marginal cost).

Furthermore, it is important to allow for the independent access provider to price discriminate whenever they wish. We will come back to understanding the motivation behind this hypothesis ahead in this paper. The requirement of the independent supplier facing the same number of downstream firms avoids potential differences associated to a different number of downstream firms, not directly related to the incentives for vertical foreclosure.

Suppose a vertically integrated monopolist incumbent facing an entrant in the downstream market. Assume that the entrant is not able to yet enter the local service (upstream) if they would not enter the long distance service.[20] The inverse demand function and the profit func-

20 We can presume that the marginal cost of the entrant, given that he does not operate in the long distance, is infinite. The role of this assumption is to force the dependence of the entrant in the long distance to the incumbent local network in the short run.

tions of the upstream (*1u*) and downstream (*1d*) segments of the incumbent firm and the entrant firm (*2d*) in the long distance business are given, respectively, by:

$$P(q_1+q_2)=1-q_1-q_2 \tag{1}$$

$$\Pi_{1u}(q_1,q_2)=(a-c)(q_1+q_2) \tag{2}$$

$$\Pi_{1d}(q_1,q_2)=q_1(1-q_1-q_2)-C_1(q_1) \tag{3}$$

$$\Pi_{2d}(q_1,q_2)=q_2(1-q_1-q_2)-C_2(q_2) \tag{4}$$

Variable q_i is the quantity traded by the downstream firm i (i=*1d,2d*). $C_1(q_1)$ and $C_2(q_2)$ are the total costs, respectively, of the incumbent and entrant downstream firms. The parameter a is the access price charged by the upstream incumbent, *1u,* for both downstream firms, *1d* and *2d*. We assume that one unit of access results in one unit of long distance service provided and there are no fixed costs at all. As for the parameter c, it is the marginal cost of the upstream firm providing any input (access) quantity q_i to the downstream firms. The expressions for the total costs of the downstream firms are:

$$C_1(q_1)=aq_1+c_1q_1 \tag{5}$$

$$C_2(q_2)=aq_2+c_2q_2 \tag{6}$$

The parameters c_1 and c_2 are the constant marginal costs of each downstream firm. While these are not general functional forms, their simplicity makes them suitable to get the relevant intuition behind the issue of foreclosure, besides illustrating the point of Chicago criticisms.

As the upstream firm is integrated with the downstream *1d*, their profits must be aggregated. Notice that when we derive the aggregate profit function of the vertically integrated incumbent, the terms including the access price a are cancel out in the sum. This is a revenue to the upstream firm, but an expense to the downstream firm. The profit equation of the vertically integrated and entrant firms are, respectively

$$\Pi_1=q_1(1-q_1-q_2)+aq_2-c(q_1+q_2)-c_1q_1 \tag{7}$$

$$\Pi_2 = q_2(1-q_1-q_2)-(a+c_2)q_2 \tag{8}$$

The oligopolists play a Cournot-Nash game in the downstream market. Given the parameters of this game, the vertically integrated incumbent chooses the optimal value of the access price a, that is charged on the entrant. We assume that the parameters are such that there are only interior solutions. The reaction functions of both companies in the downstream market are given by:

$$\frac{\partial \Pi_1}{\partial q_1} = 1-2q_1-q_2-c-c_1 = 0 \tag{9}$$

and

$$\frac{\partial \Pi_2}{\partial q_2} = 1-2q_2-q_1-c-c_2 = 0 \tag{10}$$

Solving for q_1 and q_2, we get:

$$\begin{aligned} q_1^* &= \frac{1+a-2c_1-2c+c_2}{3} \\ q_2^* &= \frac{1+c-2c_2-2a+c_1}{3} \end{aligned} \tag{11}$$

Replacing (11) in the profit functions and taking the derivative relative to a reaches:

$$\begin{aligned} \frac{\partial \Pi_1}{\partial a} &= \frac{2}{3}\frac{(1+a-2c_1-2c+c_2)}{3}+\frac{(1+c-2c_2-2a+c_1)}{3}-\frac{2(a-c)}{3}=0 \\ a^* &= \frac{1}{2}-\frac{c_1}{10}+\frac{c}{2}-\frac{2c_2}{5} \end{aligned} \tag{12}$$

We have to compare the optimal access price of the vertically integrated firm given in (12) with that from an independent access supplier. There are two possibilities. First, the independent access provider cannot price discriminate and settles the same access price a to both down-

stream companies. Second, the independent access provider is able to price discriminate and settles different access prices to each of the two downstream firms. Note, however, that the vertically integrated firm is implicitly supposed to price discriminate between the access price settled to the entrant (given in (12)) and the access price settled to themselves (c by definition). If we do not allow price discrimination for the independent access provider, the comparison of the access price they settle and the access price of the vertically integrated firm given in (12) can be reflecting this asymmetry. In other words, besides foreclosure, there would be also the price discriminate ability effect, of the vertically integrated firm, which is not possessed by the independent provider. That is why we made explicit the possibility of price discrimination in the definition of foreclosure above. So, a_1 is the access price settled by the upstream firm to the downstream firm 1 and a_2 the access price settled to the downstream firm 2.

Next, we restate (2), (7) and (8) for the case of an independent access supplier in the upstream with two companies in the downstream segment of the market:

$$\Pi_{1u} = (a_1 - c)q_1 + (a_2 - c)q_2 \qquad (2')$$

$$\Pi_1 = q_1(1 - q_1 - q_2) - a_1 q_1 - c_1 q_1 \qquad (7')$$

$$\Pi_2 = q_2(1 - q_1 - q_2) - a_2 q_2 - c_2 q_2 \qquad (8')$$

Differentiating (7′) and (8′), respectively, to q_1 and q_2, and solving the system, we get:

$$q_1 = \frac{1 + a_2 + c_2 - 2a_1 - 2c_1}{3}$$
$$q_2 = \frac{1 + a_1 + c_1 - 2a_2 - 2c_2}{3} \qquad (11')$$

The independent access supplier incorporates (11′) in his problem (2′) and chooses optimally a_1 and a_2.

$$\frac{\partial \Pi_{1U}}{\partial a_1} = \frac{1 + a_2 + c_2 - 2a_1 - 2c_1}{3} - \frac{2}{3}(a_1 - c) + \frac{1}{3}(a_2 - c) = 0$$

$$a_1 = \frac{1+2a_2+c_2-2c_1+c}{4}$$

Given the symmetry of the problem, an analogous equation holds for a_2. Solving for a_1 and a_2, we get:

$$a_1^* = \frac{1-c_1+c}{2}$$
$$a_2^* = \frac{1-c_2+c}{2} \qquad (12')$$

The difference between (12) and (12′) (only a_2^*) is:

$$\frac{c_2-c_1}{10} \qquad (13)$$

So, the vertically integrated firm settles an access price that is greater than the access price picked by an independent provider if and only if he is more efficient than the entrant. Equation (13) results in Proposition 1.

Proposition 1: ***Given a downstream duopoly playing a Cournot game with the linear demand function (1) and variable linear cost functions in the downstream*** $((a_1+c_1)q_1$ ***and*** $(a_2+c_2)q_2)$ ***and upstream segments*** $(c(q_1+q_2))$***, there will be no incentive from the incumbent for vertical foreclosure against an entrant through access pricing as defined in Definition 1 resulting from a vertical integration of one of the downstream firms and the upstream firm.***

Proof: *Given the result obtained in (13), is direct if* $c_2=c_1$*, there is no access price differential between the vertically integrated incumbent and the independent access provider. Since definition (1) requires equal costs to check for foreclosure, we conclude that there is no vertical foreclosure through access price.*

This matches the Chicago intuition, but with further insights. What (13) is saying is that when the incumbent is less efficient than the entrant, the former tends to charge a lower access price compared to what would charge an independent access provider. This occurs because when the vertically integrated incumbent is less efficient, he loses twice if they discriminate against the

entrant: Firstly, they do not extract a higher amount of profit from the most efficient player and, secondly, he derives a lower amount of profit through his own (less efficient) downstream subsidiary. On the other hand, the independent access provider loses just once if they discriminate against the most efficient entrant, by not extracting a higher amount of profits from the most efficient player. By the same token, the vertically integrated incumbent earns twice when his downstream subsidiary is more efficient. So, the vertically integrated incumbent is more sensitive to the cost differential than the independent access provider. But this is not a vertical foreclosure strategy as defined in Definition 1. Discrimination occurs when the reduction in the upstream profits by discriminating against the entrant is lower than the gains in the downstream market and this just happen when the entrant is less efficient than the downstream subsidiary of the incumbent.

The Chicago's view is correct by stating that the incumbent earns more in some circumstances by providing access than by foreclosing and thus it is not so obvious that the latter conduct should always be expected. Note, however, that this statement cannot be taken so universal since the model here developed is restricted to specific linear demand and cost functions besides a Cournot hypothesis for oligopolistic interaction. On the other hand, the basic forces in motion may remain the same in other contexts. Non-linear pricing schemes, for instance, imply that the incumbent is more able to extract profits from the rival in the downstream segment. This makes the vertically integrated incumbent even less interested in foreclosure since he has more tools to make profits in the access business than in the case of linear prices. This increases the opportunity costs of denying access to the entrant. If providing cheap access tends to increase quantities, there are at least two interesting extensions. First of all, when there are relevant density economies as usual in telecommunications, marginal costs are decreasing and there are also more profits in the access business that the vertically integrated incumbent can be forgoing by foreclosing his rival. Incorporating consumer network externalities in the demand function can also have the same impact. These are alternatives that can be explored and requires further research.

As we saw in the US experience, regulated prices are not the only single variable to be looked at by the regulator in order to guarantee that a foreclosing behaviour will not harm competition in telecommunications. The quality or the cost of the interconnection to the entrant also matters and can be an alternative channel for foreclosure behaviour. This is what we will be working in the next section.

IV Foreclosure through quality

In this section, we develop a different model using a Hottelling linear city set to show that

quality foreclosure can emerge. Reminds from the brief survey on the literature that Laffont and Tirole (2000) considered that the main thrust to foreclosure by quality is access price regulation. When the vertically integrated incumbent is constrained to settle the access price on a profit maximizing way, their access business will bring less profit from the entrants to themselves and also displaces the potentially more profitable long distance business, where price is free. On the other hand, we show here that foreclosure through quality can emerge regardless of access price regulation.

We assume that the choice of networks can be described through the linear city model of Hotelling.[21] [22] We first present the general model that will be used in this section and later. Next, we study the specific case of foreclosure through the quality of connection.

A basic framework of the linear city model

There is a linear city of size k, by consumers being uniformly distributed along it facing two firms, an incumbent (network 1) and an entrant (network 2), one in each extreme as depicted in Figure 1 below. The closer consumer gets to network 1, the more they prefer 1 relatively to 2. Where k is the maximum horizontal differentiation existent and can be related, as stated by Laffont, Rey and Tirole (1998, p. 2), to different functions offered by each network that appeal differently to different consumers.

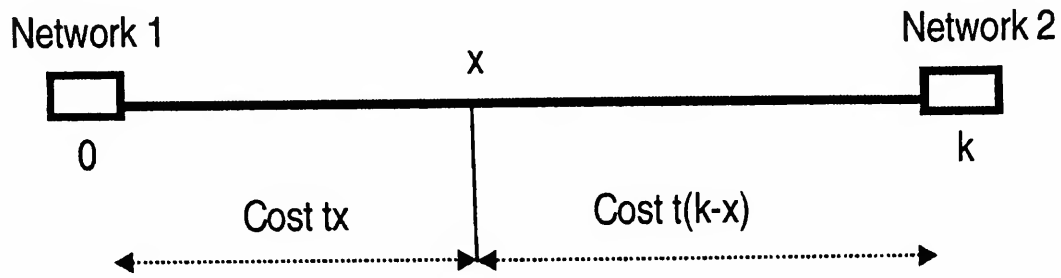
The inverse of the marginal substitution rate between the two networks for any consumer is given by t. In the traditional linear city model, where the variables are explained in terms of geographical distances,[23] this variable is the transportation cost of the consumers per unit of distance. The consumer located at x will have a "transportation cost" (or a utility discount compared to the consumer located at 0), tx, to move from x to network *1* and buy the good (or service). The same consumer will have a transportation cost of $t(k-x)$ to go to network *2*.

21 We assume that all local markets in a given region have exactly the same demand and cost parameters. Then, the results below are valid for the competition between the local incumbent and entrant in every location inside this region.

22 The linear city model proposed here follows closely the steps of Tirole (1988, p. 97-98) and used already in the study of network interconnection by Laffont, Rey and Tirole (1998) and Armstrong (1998).

23 Though the explanation is often made in terms of geographical distances, one of the main purposes of Hotelling in the linear city model was to address the issue of product differentiation. The compatibility of the two kinds of analysis (product differentiation and geographical distances) is stressed by Basu (1993): "*there is a certain analogy between the economics of location and the economics of product brands. This was evident to Hotelling (1929) who observed that the problem of two firms selling a homogeneous good at two different locations on a line could, alternatively, be thought of as two firms choosing to sell cider of two different degrees of sourness from within a continuum of possibilities.*"

Figure 1
Linear City with Two Networks



An important aspect is the distinction between horizontal and vertical differentiation that it is not considered in the standard linear city model as presented by Tirole. While the first concept relates to preference differences between consumers, the second concept represents the element of differentiation common to all consumers.[24]

U_1 and U_2 are taken as the "gross utilities" of the customers of networks *1* and *2* respectively. These gross utilities are defined as the total utility (before deducting the price) obtained by the agent who derives the highest satisfaction than anyone else from consuming in a given network. In the case of networks *1* and *2*, these consumers are located exactly at *0* and *k*, respectively. Note that when we allow for $U_1 \neq U_2$, we are introducing an element that captures vertical differentiation. Thus, the model incorporates both sources of differentiation: horizontal along the linear city and vertical measured by U_1-U_2 in the vertical axes. This variable can include real quality variables as the degree of noise, number of calls falling and likelihood of completing a call, for example. Furthermore, this general variable called "quality" will include brand loyalty and the set of value-added services offered by each local network.

P_1 and P_2 are the prices charged by each local network for the average call charge.[25] The surplus of the consumer located at x will be given by the gross utility, the price and the transportation cost:

$$U_1 - p_1 - tx$$

24 For more detail on vertical differentiation, see Tirole (1988, p. 96-99).

25 For the sake of avoiding non-linear prices, we assume that line installation and and the maintenance charges are zero. Alternatively, we could also assume as is standard in this type of model that each consumer just buy one unit of the service.

if he buys at network 1

$$U_2 - p_2 - t(k - x) \tag{14}$$

if he buys at network 2

and

0 if he does not buy at all.

If the difference between the prices charged by the two networks does not exceed the transportation cost plus the vertical differentiation,[26] there will be a consumer x_1 located between *0* and *k*, which would be just indifferent between the two networks. x_1 is given by:

$$U_1 - p_1 - tx_1 = U_2 - p_2 - t(k - x_1)$$

$$x_1(p_1, p_2) = \frac{(p_2 - p_1 + tk + U_1 - U_2)}{2t} \tag{15}$$

$$k - x_1(p_1, p_2) = x_2(p_1, p_2) = \frac{(p_1 - p_2 + tk + U_2 - U_1)}{2t} \tag{16}$$

It will be useful to take ahead quantity when firm 1 is a local monopolist.

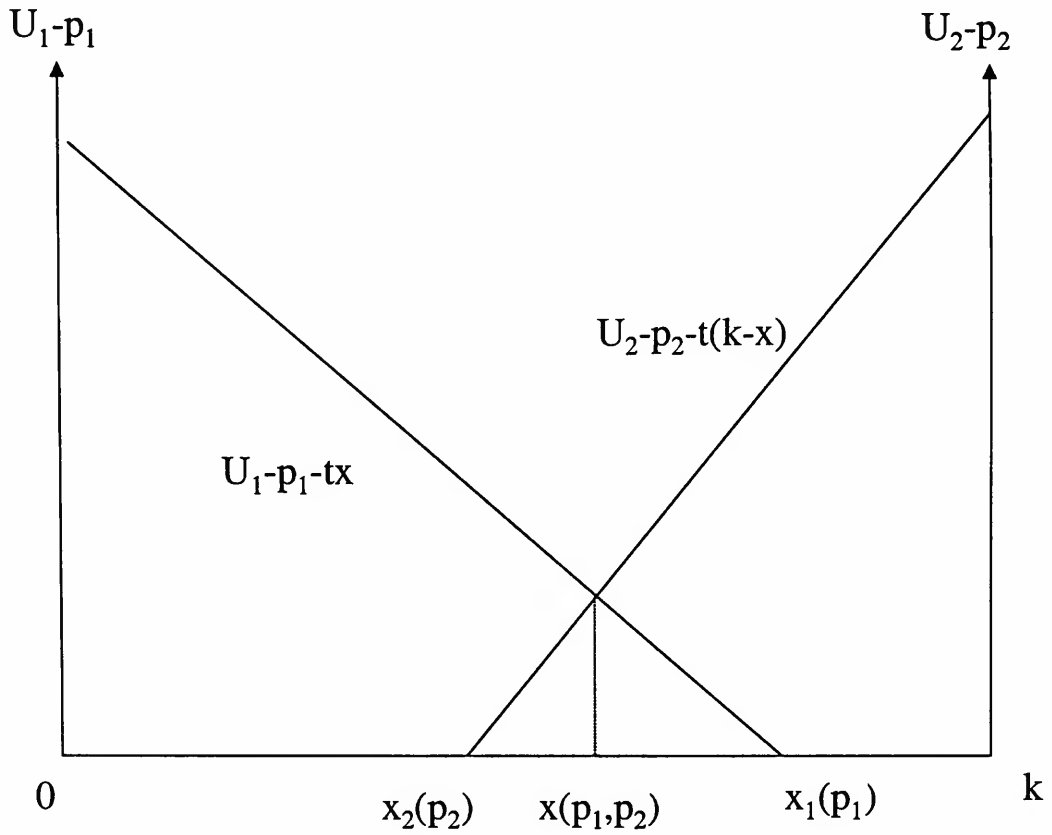
$$U_1 - p_1 - tx_{1m} = 0$$

$$x_{1m} = \frac{U_1 - p_1}{t} \tag{15'}$$

Figure 2 shows the equilibrium given in (16):

26 *p2 - p1 < tk + U1 U2*. Otherwise, there is the case of local monopolies also found in the basic reference of Tirole (1988).

Figure 2
The Linear City Model of Hotelling



Assume that networks 1 and 2 have, respectively, marginal costs c_1 and c_2. The profit expression for networks 1 and 2 are, respectively:

$$\Pi_1 = \frac{(p_2 - p_1 + tk + U_1 - U_2)}{2t} * (p_1 - c_1)$$
$$\Pi_2 = \frac{(p_1 - p_2 + tk + U_2 - U_1)}{2t} * (p_2 - c_2) \qquad (17)$$

Differentiating Π_1 and Π_2 to, respectively, p_1 *and* p_2, and solving the system, we find the optimal prices for networks *1* and *2*.

$$p_1^* = tk + \frac{U_1 - U_2}{3} + \frac{2c_1 + c_2}{3}$$

$$p_2^* = tk + \frac{U_2 - U_1}{3} + \frac{2c_2 + c_1}{3} \qquad (18)$$

Replacing (18) in (16), we get:

$$x_1^* = \frac{k}{2} + \frac{U_1 - U_2}{6t} + \frac{c_2 - c_1}{6t}$$
$$x_2^* = \frac{k}{2} + \frac{U_2 - U_1}{6t} + \frac{c_1 - c_2}{6t} \qquad (19)^{27}$$

The same rationale applies to the case of firms 1 and 2 being local monopolists:

$$p_{1m} = \frac{U_1 + c_1}{2}$$
$$p_{2m} = \frac{U_2 + c_2}{2} \qquad (20)$$

We derive expressions for profits, using the equilibrium prices and quantities given in (18) and (19):

$$\Pi_1^* = (tk + \frac{U_1 - U_2 + c_2 - c_1}{3})(\frac{k}{2} + \frac{U_1 - U_2 + c_1 - c_2}{6t})$$
$$\Pi_2^* = (tk + \frac{U_2 - U_1 + c_1 - c_2}{3})(\frac{k}{2} + \frac{U_2 - U_1 + c_2 - c_1}{6t}) \qquad (21)$$

---

27 Networks 1 and 2 market shares, s_1 and s_2 are

$$s_1 = \frac{x_1}{x_1 + x_2} = \frac{1}{2} + \frac{U_1 - U_2 + c_2 - c_1}{6tk}$$
$$s_2 = \frac{x_2}{x_1 + x_2} = \frac{1}{2} + \frac{U_2 - U_1 + c_1 - c_2}{6tk}$$

Notice that for the special case where $U_1 = U_2$ and $c_1 = c_2$, $s_1 = s_2 = 1/2$. However, we have assumed before that $U_1 - U_2 \geq 0$, given the brand loyalty contemplated by network *1* which is an exogenous first mover advantage. We also assume a second potential source of first mover advantage coming from a marginal cost differential derived from the low experience of the entrant, $c_{1t} \leq c_{2t}$. In this case, we have that $s1 \geq s2$.

Observe that all variables have the expected signs. The higher the vertical differentiation (U_1-U_2 larger) is, the higher the profits of network *1* and the lower the profits of network *2* would be. The marginal costs for each firm enters negatively in the firm's own profits and positively in the other. The effects of t and k are ambiguous.

Following the same rationale, the profit function of the monopolist is:

$$\Pi_{1m} = \frac{(U_1 - c_1)^2}{4t}$$
$$\Pi_{2m} = \frac{(U_2 - c_2)^2}{4t} \qquad (22)$$

Quality and costs of interconnection and foreclosure

Next, we concentrate on the problem where a long distance entrant enters a market dominated by a vertically integrated incumbent that owns the local bottleneck and the long distance company. Assuming the model depicted above, that network 1 is the long distance network of this vertically integrated incumbent. Also, assuming that network 2 is the long distance network owned by an entrant not integrated in the local bottleneck.

Here, we assume that the access price is regulated on an *ad-hoc* basis. The rule is very simple with the regulator setting a fixed mark-up d on the marginal access cost c. On the other hand, we also assume that the regulator is not able to monitor or does not care about the regulation of the quality of interconnection and/or the cost of interconnection[28]. At the same time, we assume that the vertically integrated supplier of access provides access to himself and to the rival at the same access cost c, regardless of the quality of the interconnection. The maximum levels of interconnection quality that can be provided to both long distance companies are U_{1M} and U_{2M}.

We assume that the incumbent can reduce costlessly (not increase) the interconnection quality of himself and of his downstream rival to less than U_{1M} and U_{2M}, decreasing U_i until any

28 Most of the time, we will work on interconnection quality. It will be clear ahead, however, that the assessment of the cost of interconnection is basically the same and thus all conclusions can be extended.

non-negative value. Moreover, the incumbent can provide interconnection to the rival in such a way that the latter cost will increase. So, we suppose that the vertically integrated incumbent can costlessly increase (but not decrease) the long distance cost of the entrant. So, we define c_{2m} and c_{1m} as the minimum levels of long distance cost that can be achieved by, respectively, the entrant and the incumbent without any interference of the incumbent.

Additionaly, the vertically integrated incumbent is able to reduce the quality and increase the long distance cost of the entrant costlessly through their interconnection relationships. The question in this section is to assess what would be the incentives behind this potential predatory incumbent´s behaviour.

Here, we provide a different definition for partial vertical foreclosure through quality compared to the definition based on access pricing.

Definition 2. ***There will be partial vertical foreclosure through quality made by a vertically integrated incumbent against a downstream entrant in a linear city model like the one described in figure 2, when, having both the same maximum gross quality*** U_{iM} ***and the same minimum interconnection costs*** c_{im}***, with access prices being regulated as in equation (23) below, the former has an incentive to reduce the quality of the latter in the downstream potentially duopolistic segment, while curves*** $U_1 - p_1 - tx$ ***and*** $U_2 - p_2 - t(k - x)$ ***are crossing above the horizontal line and an independent access provider would not have this incentive.***

The total marginal cost of the incumbent for providing long distance service, which we call c_{1l}, can be disentangled into two components, the long distance marginal cost, c_1 and the cost of access c. The total marginal cost of the entrant, called c_{2l}, also has two components, the long distance marginal cost, c_2 and the access price a. The regulator sets the access price a summing the marginal cost of access c to a fixed mark-up δ. Then,

$$\begin{aligned} c_{1l} &= c + c_1 \\ c_{2l} &= c + \delta + c_2 \end{aligned} \tag{23}$$

Changing (17) appropriately, the entrant and incumbent´s profit functions in the long distance service are given, respectively, by:

$$\Pi_1 = \frac{(p_2 - p_1 + tk + U_{1M} - U_{2M})}{2t} * (p_1 - c - c_{1m})$$

$$+ \frac{(p_1 - p_2 + tk + U_{2M} - U_{1M})}{2t} * (c + \delta - c) \qquad (24)$$

$$\Pi_2 = \frac{(p_1 - p_2 + tk + U_{2M} - U_{1M})}{2t} * (p_2 - c - c_{2m} - \delta)$$

The second term in the first profit equation of (24), accounts for the profit derived from the access business of the incumbent to the entrant. We assume that the vertically integrated incumbent will first decide if he reduces the quality of the entrant and/or increase the cost of the entrant through c_{2m} and then chooses simultaneously with the entrant the optimal price to be charged. So, the incumbent first decides for the equilibrium price and only then chooses if he reduces the quality or increases the entrant's cost. Differentiating the profit functions in (24), in respect to prices at U_{1M}, U_{2M}, c_{1m} and c_{2m}, we find the equilibrium prices for the two companies:

$$p_1^* = tk + \frac{U_{1M} - U_{2M} + 2c_{1m} + c_{2m}}{3} + c + \delta$$

$$p_2^* = tk + \frac{U_{2M} - U_{1M} + 2c_{2m} + c_{1m}}{3} + c + \delta \qquad (25)$$

The reader can check that replacing (25) in (16) we find the same value for x_1^* and x_2^* from (20). Next, we present the profit functions of the incumbent and of the entrant after accounting for these changes. We find that,

$$\Pi_1 = (tk + \frac{U_{1M} - U_{2M|} + c_{2m} - c_{1m}}{3}) * (\frac{k}{2} + \frac{U_{1M} - U_{2M} + c_{2m} - c_{1m}}{6t}) + k\delta$$

$$\Pi_2 = (tk + \frac{U_{2M} - U_{1M} + c_{1m} - c_{2m}}{3}) * (\frac{k}{2} + \frac{U_{2M} - U_{1M} + c_{1m} - c_{2m}}{6t}) \qquad (26)$$

Now, we can address the conditions under which the incumbent would wish to reduce the entrant's quality in the downstream market, since we assumed that the regulator is not able to

monitor or does not care for quality and neither for the cost of interconnection. Taking the derivative of the incumbent profit function in respect to the quality of the call from the entrant, we have:

$$\frac{\partial \Pi_1}{\partial U_2} = -\frac{1}{3} * (\frac{k}{2} + \frac{U_{1M} - U_{2M} + c_{2m} - c_{1m}}{6t}) - \frac{1}{6t}(tk + \frac{U_{1M} - U_{2M} + c_{2m} - c_{1m}}{3}) \quad (27)$$

Given definition 2, we know that at $U_{1M}=U_{2M}$ and $c_{2m}=c_{1m}$, (27) is always non-positive. In other words, the incumbent has incentives to reduce the entrant interconnection quality if the regulator does not monitor or does not care about the **quality** of interconnection from U_{2M} downwards. Moreover, note that the lower the U_2, the more negative will be (27). This means that the incentive to reduce U_2 even further is stronger for some range where $U_2 < U_{2M}$. Furthermore, we have

$$\frac{\partial \Pi_1}{\partial c_2} = -\frac{\partial \Pi_1}{\partial U_2} = \frac{1}{3} * (\frac{k}{2} + \frac{U_{1M} - U_{2M} + c_{2m} - c_{1m}}{6t}) + \frac{1}{6t}(tk + \frac{U_{1M} - U_{2M} + c_{2m} - c_{1m}}{3}) \quad (28)$$

As (28) is just as (27), but with the opposite signal, the same result holds. In other words, the incumbent has incentives to increase the entrant's **cost** c_2 if the regulator is not able to monitor interconnection quality and costs and/or does not care about it.

And then, independent from the profitability of the access business granted by the regulator through δ, the negative impact of U_2 on Π_1 remains So, in this model, the decrease in the downstream profits of the vertically integrated incumbent generated by a strategy of non-vertical foreclosure compensates greatly the increase in the upstream profits stemming from an increase in the access profits derived from an increase in the competitor's quality. This occurs because the incentive to foreclose does not depend on the regulated access price $c+\delta$. The term on the access price mark up δ cancel out in the derivative of the incumbent profit regarding U_2. Formally,

$$\frac{\partial^2 \Pi_1}{\partial U_2 \partial \delta} = \frac{\partial^2 \Pi_1}{\partial c_2 \partial \delta} = 0$$

This happens because the incumbent adds this whole value in its own price as shown in (25) and, then, one unit of the incumbent quantity is always more valuable rather than one unit of the entrant quantity in the access business of the incumbent.

Furthermore, observe that there is not an incentive for droping the quality of the entrant down to zero. This occurs because the profit function given in (26) above holds only while the two curves in Figure 2 crosses each other. After $x_1(p_1)$, the incumbent and the entrant become local monopolists and the preference of the former is to supply access for the entrant in the local monopoly of this player, by obtaining some profit from it. Given (16'), the incumbent will be willing to leave the following market for the entrant:

$$x_{2ml} = k - (\frac{U_{1M} - c_{1m}}{2t}) \tag{29}$$

Since the entrant will also become a local monopolist after $x_1(p_1)$, from (16'), his optimal quantity will be:

$$x_{2m}* = \frac{U_2* - c_{2m}}{2t} \tag{30}$$

In the equilibrium of the vertically integrated incumbent that is able to change costlessly U_{2M} downwards, equations (29) and (30) must match. So, we are able to define the entrant's quality level until when the incumbent has an incentive to reduce the entrant's quality:

$$\begin{aligned} \frac{U_2* - c_{2m}}{2t} &= k + \frac{c_{1m} - U_{1M}}{2t} \\ U_2* &= 2kt + c_{1m} + c_{2m} - U_{1M} \end{aligned} \tag{31}$$

Every term of (31) respond to a basic intuition. The greater is the level of demand k, there more space in the market there will be, and also the need to foreclose through decreasing the rival quality would be minor. A large inverse marginal rate of substitution t means that both networks are not so interchangeable and thus, the lower will be the requirement to foreclose the rival. The higher is the cost, the larger prices will be and more will the network concentrate in their respective regions. This also reduces the requirement for foreclosure. The opposite holds with U_{1M}. The greater U_{1M} gets, the larger the space of the linear city the incumbent may occupy. In the limit, when the $U_{1M} - p_1 - tx$ curve does not cross the horizontal axis of the linear city, then we say that there is an incentive for full foreclosure of the entrant, reducing the quality of the entrant down to zero. Anyway, we assume that k is high enough such as that:

$$U_2* = 2kt + c_{1m} + c_{2m} - U_{1M} > 0 \tag{32}$$

Using (32), the final profits of the incumbent and entrant after quality adjustments are:

$$\Pi_{1m} = \frac{(U_{1M} - c - c_{1m})^2}{4t} + \delta \frac{(2kt + c_{1m} - U_{1M})}{2t}$$

$$\Pi_{2m} = \frac{(2kt + c_{1m} - c - \delta - U_{1M})^2}{4t} \qquad (33)$$

To simplify the analysis, we assume that it is always better to be the incumbent providing access rather than the entrant with the following hypothesis:

$$\frac{(U_{iM} - c - c_{im})^2}{4t} + \delta \frac{(2kt + c_{im} - U_{iM})}{2t} \geq \frac{(2kt + c_{im} - c - \delta - U_{iM})^2}{4t} \qquad (33')$$

Next, we check what are the incentives of an independent access provider regarding the quality of both companies. The access provider considers the equilibrium quantities as in (20). His profit would be:

$$\Pi_{ind} = \delta k \qquad (34)$$

So, from (34), we have that $\frac{\partial \Pi_{ind}}{\partial U_1} = \frac{\partial \Pi_{ind}}{\partial U_2} = 0$ and there is no incentive to reduce the quality of any player, contrarily to the vertically integrated access provider incumbent. Now, we can derive the main proposition of this section

Proposition 2. ***Assumes that the linear city model depicted in figure 2 represents a duopoly telecom long distance competition. Then, the vertically integrated incumbent will always have an incentive to foreclose partially the downstream entrant through quality, according to definition 2. These incentives are larger, the lower k, t, c_{1m} and c_{2m} and the larger U_{1M}.***

Proof: *By definition 2, we make $c_{1m}=c_{2m}$ and $U_{2M}=U_{1M}$. Clearly, the signal of (28) is always negative. Adding expression (34) to the analysis, we check that the independent access provider does not have any incentive to foreclose since* $\frac{\partial \Pi_{ind}}{\partial U_1} = \frac{\partial \Pi_{ind}}{\partial U_2} = 0$. *So,*

given definition 2, the existence of an incentive for partial foreclosure is proved. The sign of the variables influencing quality foreclosure come directly from (32).

The incentives to reduce quality (but not to foreclose according to definition 2) will be even enhanced if there is a first-mover advantage in the sense that $U_{1M} \geq U_{2M}$ and $c_{2m} \geq c_{1m}$. The first inequality can be caused, for instance, by any positive degree of brand loyalty of the customers to the incumbent. The second inequality can be caused by a higher degree of efficiency of the incumbent due to the longer time they are already supplying service in the market.

V Conclusions

We saw that regulation of access price can be neither necessary nor sufficient to avoid foreclosure behaviour by the incumbent over the entrant, justifying an emphasis on a heavy-hand regulation on interconnection quality.

In the US and the UK, there was a growing concern for interconnection quality regulation, given the problems quoted in the introduction of this article. That was also the case of Brazil. The General Ruling Toward Interconnection issued by ANATEL provides in more detail the regulatory provisions of interconnection in Brazil. There are specific provisions against anticompetitive practices within the interconnection agreements, including inefficient operation and deliberate postponement of negotiations. Duties regarding directly the issue of interconnection quality, includes the choice of an adequate point in the network, common planning and supply of information about technical changes and eventual interruptions of the service among the interconnected providers, minimum technical requirements related to interfaces, alternative routes in case of failure of the interconnection points, minimum operational availability of the interconnection points about 99,8% of the time and, finally, targets regarding the construction of a minimum number of interconnection points until the end of 2000 to the regional privatized companies and EMBRATEL. Finally, access providers are obliged to make relevant information available. Based on the issues discussed theoretically in this text, we consider that the direction of this intervention conceived in the Brazilian Model of Telecommunications Reform, which was based on the experience of other countries, is very positive.

Although the model of section III shows how foreclosure through access pricing may not occur as defended by Chicago critiques, it is not general enough to conclude that there would be no anticompetitive concern of a vertically integrated firm in this case. Other features like the fear of having the local market taken over after entering the long distance market has also to be considered. Moreover, it does not mean that the regulation of access prices is meaningless. Certainly, even the independent access provider, given his monopolist position, has had his price

regulated and so does the vertically integrated incumbent. We think that the main conclusion is: i) there are, like the Chicago critique, circumstances where there won't be any difference between the behaviour of the independent access provider and the vertically integrated incumbent. This occurs because the increase in the profit of the upstream subsidiary by providing access will compensate fully the fall in the profits of the downstream subsidiary and thus there will be no reason to discriminate an entrant; ii) interconnection quality regulation can be an issue even more important than access price regulation.

The two models above did not attempt to proceed to a welfare analysis of vertical foreclosure. Therefore, we restricted the analysis to the existence of incentives from a vertically integrated incumbent to foreclose, but not what would be the impact over social welfare. In this case, fixed costs would gain a prominent role in the models, but this will be a topic for future research.

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