Entry Strategy and Regulation of Telecommunications: a Judo Economics Model.

Thierry Pénard*
ENST Bretagne, ICI (FRANCE)

June 28, 2000

Abstract

This paper analyzes the capacity investments of new telecommunications operators and the strategic interactions with the former monopoly (the Public Telecommunications Operator) in recently liberalized markets. A rational strategy for entrants consists in limiting their capacities, which is known as a strategy of *judo economics* (Gelman et Salop [*1983]*). The aim of this paper is to evaluate the efficiency of the regulation in the matter of local access when new operators comply with judo economics. In particular, we compare the capacities and profits of the operators whenever the incumbent is forced or not to separate its competitive activities from its monopoly activities (the local network). We show that separate accounting which is a regulatory device, complex and costly to implement, may have questionable efficiency and is likely to hinder entry into long distance telecommunications markets.

JEL Code : L12, L43, L96

Keywords : Telecommunication, Entry, separate accounting, Judo Economics

1 Introduction

The liberalization process of public utilities (telecommunications, energy, water, transport,...) which started in the early eighties in the United Kingdom and in the USA, is now taking place in all the industrial countries. But, this liberalization is gradually being undertaken with regulatory safeguards, for both political and economic reasons. The public authorities wish to give the former monopolies a transitory period in which to manage the necessary restructuring. At the same time, they are conscious that they must facilitate the entry and the

*Department of Economics, ENST Bretagne, BP 832, 29 285 Brest Cedex, FRANCE. Tel 33 298 001 461. Email : thierry.penard@enst-bretagne.fr

development of new competitors. Indeed, the former monopolies benefit from significant advantages in matters of capacity, financial reserves or goodwill. In some activities and services, their advantage is hardly contestable : this is the case of essential facilities which give access to customers and are costly to duplicate. These facilities, the local loop in the telecommunications market, the distribution network in the electricity and gas, are assumed to be used jointly by the former monopoly and its new competitors. The access conditions to these essential facilities is a crucial issue for the public authorities. On the one hand, restrictive or discriminatory access is likely to hinder the development of competitive networks and services. On the other hand, preferential access at a low cost can reduce the incentives of the former monopoly to invest in its facilities and can lead to a degradation in the quality of the end-users' services. Actually, the former monopoly faces the following dilemma : investing in its essential facilities improves the quality of the services and benefits to its own customers, but it also benefits rival customers and makes entry more attractive. Clearly the monopolies cannot recover all the benefits of their investments. This situation can lead to under-investment in facilities (Economides (1998)). All the above problems are present in the telecommunication sector.

The different experiences of telecommunication liberalization in the eighties and the early nineties exhibited both a degradation in some services provided by the former monopolies (line installation and line repair, mostly in the United Kingdom) and a slow diffusion of competition [1]. For example, ATT held more than 60 % of the long distance market in 1992 (ten years after its dismantling) and the market share of Mercury in the United Kingdom did not exceed 10 % in 1995 (ten years after its entry). Beyond the technical and financial aspects, the weakness of the entrants in the long distance market can be explained by strategic choices, linked to the type of competition. Telecommunications are characterized both by price and capacity competition. Indeed, the first decision taken by a new operator concerns the level of investments in network capacities and this decision is conditional on the capacities of the incumbent operators. It is thus possible that some entrants intentionally and strategically choose to limit their capacity investments in order to avoid a tough reaction of the incumbent operator. This idea was first theorized by Gelman et Salop [1983], in the continuation of Dixit[2] [1980]. Dixit proved that an incumbent firm could always deter the entry of new competitors by investing enough in capacities. Gelman et Salop queried the well-foundedness of such an entry-deterring policy, when the entrant commits to a small capacity: an aggressive reaction by the incumbent can be more costly than a strategy of accommodation. Gelman et Salop gave the name of judo economics to this strategy of capacity limitation: the entrant tries to use its small size to force the incumbent to accommodate

[1] For surveys about the British liberalization of telecommunications, see Armstrong, Cowan et Doyle [1994] and for the American experience see Higgins and Rubin (1995).

[2] We can also mention the contributions of Bulow, Geanakoplos et Klemperer [1985] and Allen [1993].

its entry. As long as the entrant has small capacities, the incumbent has no interest in triggerring a ruinous price war.

This theoretical framework applies well to the liberalization of the telecommunications market. It enables to model the strategic behavior of operators and to evaluate the efficiency of the regulation implemented in many industrial countries. Our study differs from most papers dealing with regulatory efficiency (Laffont et Tirole [1994] , Laffont, Rey, Tirole [1998], Armstrong, Doyle et Vickers [1996]), in stressing both the choices of capacity and the strategic interactions between operators.

In particular, we examine two regulatory instruments. The first instrument is a separate accounting (*unbundling*) between the competitive activities and the monopoly activities of the incumbent operator. Thus, the regulator can require the incumbent to keep separate accounts for each branch. In this case, all the internal transactions between the subsidiaries must be entered into the accounts with transfer prices based on costs. Similarly, common costs must be allocated or affected among the different activities.

The second instrument is control of the incumbent prices. The regulator can monitor the wholesale and retail charges of the dominant operator and force it to notify its tariffs in advance. For example, it can approve or refuse the technical and pricing terms of interconnection provided by the former monopoly. This pricing control limits the discretionary power of the incumbent and prevents it from misusing of its dominant position.

Can regulatory authorities promote competition and protect customer's interests with these two instruments? The main proposition of this paper is that a separate accounting without monitoring of retail prices can be inefficient and less favorable to competition. This paradoxical result can be explained by the fact that the bundled monopoly takes into account the access revenues derived from the long distance traffic of the new operators and consequently has fewer incentives to behave aggressively as long as its competitors have limited capacities. Separate accounting which is complex and costly to implement[3] may have questionable efficiency.

In section 2, we expose the model of price and capacity competition. In section 3, we compare the entry strategies in the two accounting regimes. In both cases, the weak penetration of the new operator is analyzed as a rational strategy of judo economics. In section 4, we illustrate these results with some simulations. In section 5, we consider the effect of a retail price regulation.

[3]See Bromwich and Hong (1999) for a discussion of the different practical problems that the regulator faces in implementing separate accounting.

2 The model

2.1 The framework

We consider an incumbent operator, called I, which previously had a monopoly over long distance and local communications. With liberalization, it must face the entry of a long distance operator. The entrant, called E, needs to set up its own network by investing in capacities and then needs to interconnect it to the local network of the monopolist if it wants to have access to the users and offer them telecommunications services[4].

The network investments of the entrant will depend on the conditions of access to the local loop. If the monopolist refuses an interconnection with the entrant network or fixes an expensive charge, the profitability of the entrant is not guaranteed and the competition will remain limited. To stimulate entry and competition, most developed countries have opted for regulation of the access conditions. In all these countries, the telecommunications regulator can express its view about the access charges announced by the monopolist. If it judges that these charges are excessive, it can force the monopolist to revise its interconnection price catalog. From the regulator's point of view, the access charges must be linked to the costs of using the local network and can sometimes finance some "universal service" obligations. The higher the access charges, the more likely the monopolist is to fulfill its "universal service" obligations and to guarantee a high level of quality on its local network. Meanwhile, the risk is that it may abuse of its dominant position and attempt to limit entry. The regulator must determine the level of access charge which would incite the incumbent operator to maintain (or improve) the quality of the local network while promoting competition.

The regulator has another regulatory instrument to promote competition : it can constrain the monopolist operator to a separate accounting of all its activities. This *unbundling* prevents it from cross-subsidizing between its monopoly activities and its competitive activities. The long distance subsidiary behaves like an autonomous profit center and is treated like its long distance competitors, for local interconnection : it must pay the same local access charges (non discriminatory access). Conversely, without a separate accounting obligation, the incumbenttelecommunications operator takes into account the interests of its different branches (long distance and local) when fixing its tariffs.

In order to analyze investment strategies, we use a sequential entry game characterized by the three following stages. We consider that the incumbent retail prices are not regulated and rather flexible

- Stage 1 : The public authorities define the regulatory framework, the level of access charge and the accounting regime of the incumbenttelecommu-

[4] A long distance call is composed of a long distance transmission and two local transmissions.

nications operator.

- Stage 2 : The entrant chooses the capacity of its long distance network and announces its prices.
- Stage 3 : The incumbent chooses its long distance prices.

In section 5, we analyze the case where the incumbent retail prices are regulated. If the incumbent operator has not a discretionary power to change its tariff and is forced to reveal its pricing policy before the entrant does, then the leader and the follower are inverted in the *Stackelberg* game.

2.2 The hypothesis

We assume that :

- 1- the demand for long distance communications (measured in minutes of call) is equal to $D(p)$, where p is the price of a minute of long distance communication. The demand function has the following properties $D\prime(p) < 0$ and $D"(p) \leq 0$ (concavity),
- 2 - the unit cost of local and long distance communications is fixed at 0 for the incumbent operator,
- 3 - the unit cost of long distance communications is equal to c with $c \geq 0$ for the entrant. The latter has a competitive disadvantage compared to the incumbent operator[5],
- 4 - the incumbent operator initially has long distance capacities k_I which can satisfy traffic greater than monopolist traffic $q^m = D(p^m)$ with $p^m = argmax\ pD(p)$,
- 5- the interconnection charge is linear. For a call of one minute, the entrant must pay a charge equal to a with $a \geq 0$ to the former monopolist operator[6]. Its complete unit costs is actually $a + c$,

For the sake of convenience, we assume that there is no fixed cost of entry and we focus on a linear tariff (the introduction of binomial or two-part tariffs should not modify the main results of the paper).

[5] This cost differential can be justified by the know-how and the investments that the incumbent operator has accumulated over many years.

[6] If a is negative, the entrant receives an access subsidy.

2.3 The rule for rationing demand

In the long distance market, the entrant is likely not to have enough capacity to satisfy all the traffic, mostly in the first few years. We must define the rule with which it will ration access to its service or select its customers if demand exceeds its capacity. Among the rationing rules proposed in economics theory, the efficient or parallel rule seems to be the most appropriate for the context of telecommunications. When the customers are heterogenous (in their valuation of goods or service), the meaning of the efficient rule is the following : those customers who have the highest valuation, are served first and foremost by the firm having the lowest price. Those who have not been served, buy from the second lowest-price firm. The new telecommunications operators comply with this rule when they keep their services as a priority for those business customers who have the highest willingness-to-pay.

Given the capacities (k_I, k_E) where k_E is the level of the entrant capacities, the demand for the operator i is defined by :

$$\begin{aligned} D_i\left(p_i, p_j\right) &= \begin{cases} D\left(p_i\right) & if \quad p_i < p_j \\ \max\left\{0, D\left(p_i\right) - k_j\right\} & if \quad p_i > p_j \\ \max\left\{\alpha_i D\left(p_i\right), D\left(p_i\right) - k_j\right\} & if \quad p_i = p_j \end{cases} \\ for \quad all \quad i &= I, E \quad and \quad j \neq i \end{aligned} \tag{1}$$

If operator i announces the lowest price, it faces all the demand $D(p_i)$. If it announces the highest price, it faces the demand not satisfied by operator j, this residual demand being null if the latter has capacities superior to $D(p_i)$. Finally, we assume that customers will have a probability α_I of subscribing to operator I and a probability $\alpha_E = 1 - \alpha_I$ to the new operator when both announce the same tariff[7].

The effective sales of operator i are defined as the minimum of its demand $D_i\left(p_i, p_j\right)$ and of its capacities k_i.

In the following section, we determine and compare the capacities chosen by the entrant and the tariffs and market shares of the two operators depending on whether the regulator imposes a separate accounting or not on the monopolist operator.

[7] We can assume that $\alpha_I > 1/2$ because the customers are reluctant to quit the monopolist operator if there is no significant price difference with the new operator (switching costs). If the prices are identical, the incumbent operator will always have a higher market share.

3 Strategies of entry

3.1 Separate accounting

When the monopolist operator is subject to a separate accounting, its long distance subsidiary must pay for access to the local loop, like the new entrant. The access charge is obviously the same for the two long distance carriers.

As the incumbent faces an entrant which is less efficient (the cost advantage or the cost differential is equal to c), it always has the possibility of deterring entry In this case, it just has to fix a price slightly lower than the entrant cost. But this aggressive strategy is not necessarily optimal if the entrant decides to enter on a small scale. This strategy of capacity limitation is called a strategy of judo economics by Gelman and Salop [1983].

To characterize the entrant's optimal capacities, we proceed by backward induction, studying the last stage in the sequential game. The long distance subsidiary of the monopolist must adapt its tariff, given the entrant's capacities and prices. It has two possible strategies :

- an aggressive strategy which consists in announcing a lower price than the entrant's, capturing all the demand,

- a strategy of accommodation which consists in announcing a higher price, leaving the entrant with a part of the demand.

If the entrant has set up capacities k_E and has announced a price p_E, the first strategy yields a profit equal at most to :

$$(p_E - a)\min\{k_I, D(p_E)\} \tag{2}$$

For the second strategy, the profit is defined by :

$$\max_{\{p>p_E\}}(p-a)\,(D(p)-k_E) \qquad if \;\; D(p) > k_E \tag{3}$$

If $D(p_E) \leq k_E$, the incumbent profit is nul. We can eliminate this latter case : it is not a rational strategy for the entrant to fix a tariff p_E such that $D(p_E) \leq k_E$ because it forces the incumbent to behave aggressively and to deter entry.

We denote $\underline{\pi}_I(k_E) = \max_{\{p>p_E\}}(p-a)\,(D(p)-k_E)$. $\underline{\pi}_I(k_E)$ corresponds to the minimum profit that the incumbent operator is always guaranteed to obtain, given the capacities[8] k_E : it cannot obtain a lower profit whatever is the price strategy of the entrant. Let us define p_r the price maximizing $\underline{\pi}_I(k_E)$ where p_r satisfies :

$$(p_r - a)D'(p_r) + D(p_r) - k_E = 0 \tag{4}$$

under the constraint $k_I > D(p_r) - k_E$.

This constraint is always satisfied because by hypothesis $k_I \geq D(p^m)$ where p^m is the monopoly price associated with the demand $D(p)$ and there is no access

[8] $\underline{\pi}_I(k_E)$ is called the minimax profit.

charge. When the demand decreases ($D(p)$ to $D(p)-k_E$) and the cost increases (0 to a), then the monopoly demand is necessarily lower ($D(p_r)-k_E < D(p^m)$).

The long distance subsidiary of the incumbent operator, by announcing price p_r can always obtain at least $\underline{\pi}_I(k_E)$. If the entrant fixes a price lower than p_r, the incumbent's profit is exactly $\underline{\pi}_I(k_E)$ and if E fixes a price higher than p_r then the incumbent obtains a profit equal to $(p_r - a)\min\{k_I, D(p_r)\} > \underline{\pi}_I(k_E)$ So, the long distance subsidiary of the former monopolist can never earn less than $\underline{\pi}_I(k_E)$.

3.1.1 Determination of the entrant price

Given k_E, the long distance subsidiary of the incumbent will not contest entry as long as the entrant price does not exceed the threshold price $\overline{p}(k_E)$ defined by :

$$(\overline{p}(k_E) - a)\min\{k_I, D(\overline{p}(k_E))\} = \underline{\pi}_I(k_E) \tag{5}$$

with $\overline{p}(k_E) < p_r$.

The price $\overline{p}(k_E)$ makes the incumbent operator indifferent to choosing between an aggressive strategy and an accommodation strategy. If the entrant fixes a price higher than $\overline{p}(k_E)$, then the best reaction of the incumbent is to undercut this price in order to rise the number of its customer and its profit. Conversely if the entrant agrees to hold its price below $\overline{p}(k_E)$, the incumbent always prefers to fix the price p_r. We notice that the threshold price $\overline{p}(k_E)$ negatively depends on the incumbent long distance capacities (k_I) and on the entrant capacities, as $\underline{\pi}_I(k_E)$ decreases with k_E.

3.1.2 Determination of entrant capacities

Given the price reaction of the incumbent, the entrant can choose its optimal capacities at stage 2. These capacities maximize its profit function:

$$\max_{\{k_E\}} (\overline{p}(k_E) - a - c)k_E \tag{6}$$

The optimal capacities, denoted k_E^* satisfy :

$$(\overline{p}(k_E^*) - a - c) + \frac{\partial \overline{p}(k_E^*)}{\partial k_E} k_E^* = 0 \tag{7}$$

After arrangement :

$$\frac{\overline{p}(k_E^*) - a - c}{\overline{p}(k_E^*)} = -\frac{\partial \overline{p}}{\partial k_E}\frac{k_E^*}{\overline{p}} \tag{8}$$

The entrant chooses the capacities for which the profit margin on long distance communications is equal to the inverse of the price elasticity $\frac{\partial k_E}{\partial \overline{p}}\frac{\overline{p}}{k_E^*}$.

High elasticity means that the entrant must strongly reduce its capacities when it wants to increase its tariffs : this implies that it cannot expect a large profit on its investments.

The entrant optimal capacities k_E^* uniquely define the entrant and incumbent tariffs (respectively $\overline{p}$ et p_r) and their traffic (respectively k_E^* , $D(p_r) - k_E^*$).

Proposition 1 *(judo economics Gelman-Salop [1983]) Under a regime of separate accounting, the capacities chosen by the entrant are always smaller than the monopolist long distance capacities and decrease with access charge and cost disadvantage.*

Proof. Consider the smallest incumbent capacities compatible with hypothesis (4) : $k_I^m = D(p^m)$. From equations (4) and (5), the limit of the entrant price $\overline{p}\,(k_E)$ is p^m when k_E tends to 0. As the entrant price decreases with k_E, then for any $k_E > 0$, we have $\overline{p}\,(k_E) < p^m$. Consequently, we always have $k_I^m < D\left(\overline{p}\,(k_E)\right)$ for any k_E and the entrant price is simply defined by :

$$\overline{p}\,(k_E) = \frac{\pi_I(k_E)}{k_I^m} + a \tag{9}$$

If we derive this price with respect to k_E , we obtain :

$$\frac{\partial \overline{p}}{\partial k_E} = \frac{\partial \underline{\pi}_I(k_E)}{\partial k_E}\frac{1}{k_I^m} = -\frac{(p_r - a)}{k_I^m} \tag{10}$$

Replacing expression (10) in (7), we have :

$$\overline{p}\,(k_E^*) - a - c = (p_r - a)\frac{k_E^*}{k_I^m} \tag{11}$$

As we have $\overline{p} < p_r$ by definition, we can conclude that $\frac{k_E^*}{k_I^m} < 1$. The entrant always chooses capacities lower than the incumbent's. If we consider equation (11), we can notice that the entrant capacities decrease with c (the cost differential). Increasing c reduces the left hand term of (11) and must be counterbalanced by decreasing k_E^*.This result still holds when $k_I > k_I^m$, since $\overline{p}\,(k_E)$ decreases with k_I. An incumbent operator which has large capacities, has more incentives to adopt an aggressive strategy and can easily force the entrant to reduce its tariffs and capacities. ■

The proposition underlines that the entrant has no incentives to invest in capacities that exceed those of the monopolist, for any cost differential (even in the case of symmetric costs for the entrant and the incumbent). The entrant prefers to appear small in order to avoid an aggressive reaction by the incumbent. It uses its small size to force the incumbent to accommodate entry (*Strategy of judo economics*).

The impact of the access charge on entrant capacities is ambiguous. On the one hand, an increase of a raises entrant costs and reduces incentives to invest.

But on the other hand, a higher access charge softens the pricing competition between the two long distance carriers. However, the simulations presented in section 4 show that with a linear demand, the optimal entrant capacities always decrease with the access charge. In a regime of separate accounting, the access charge has a more detrimental effect on the entrant's profits than on the long distance profits of the incumbent operator.

3.2 Bundling

In the case of bundling (no separate accounting), the incumbent operator chooses its price, taking into account all its sources of revenue. Given p_E and k_E, the entrant price and capacities, the incumbent operator can expect the following revenues with a strategy of accommodation : $\underline{\underline{\pi}}_I(k_E) = \max_{\{p>p_E\}} p\left(D(p) - k_E\right)$ for its long distance activities and ak_E for the interconnection charge paid by the entrant.

With an aggressive strategy, it obtains approximately $p_E \min\{k_I, D(p_E)\}$, because it cannot claim any access revenue from the entrant. We denote $\tilde{p}_r$ the price which maximizes the profit $\underline{\underline{\pi}}_I(k_E)$. The incumbent operator will not contest entry as long as the price chosen by the entrant does not exceed the threshold price $\overline{\overline{p}}(k_E)$ defined by :

$$\overline{\overline{p}}(k_E) \min\left\{k_I, D(\overline{\overline{p}}(k_E))\right\} = \underline{\underline{\pi}}_I(k_E) + ak_E \tag{12}$$

with $\overline{\overline{p}}(k_E) < \tilde{p}_r$

This threshold price makes the incumbent operator indifferent to choosing between an aggressive strategy and a strategy of accommodation . As the right hand side in equation (12) decreases with k_E ($\frac{\partial\left(\underline{\underline{\pi}}_I(k_E)+ak_E\right)}{\partial k_E} = -p_r + a < 0$), then the entrant price $\overline{\overline{p}}(k_E)$ depends negatively on its own capacities. As above, the optimal entrant capacities are obtained by solving the following program :

$$\max_{\{k_E\}} (\overline{\overline{p}}(k_E) - a - c)k_E \tag{13}$$

We denote k_E^{**} the optimal entrant capacities :

$$(\overline{\overline{p}}(k_E^{**}) - a - c) + \frac{\partial\overline{\overline{p}}(k_E^{**})}{\partial k_E}(k_E^{**}) = 0 \tag{14}$$

Proposition 2 *: Under the bundling regime, the capacities chosen by the entrant are smaller than the incumbent's long distance capacities.*

The proof is the same as for proposition 1. The limit of the entrant price $\overline{\overline{p}}\,(k_E)$ is p^m when k_E tends to 0 and for k_I^m,we derive the following relation :

$$\overline{\overline{p}} = \frac{\tilde{p}_r(D(\tilde{p}_r) - k_E) + ak_E}{k_I^m} \tag{15}$$

We have $\frac{\partial \overline{\overline{p}}}{\partial k_E} = -\frac{(\tilde{p}_r - a)}{k_I^m}$ which can be substituted in equation (14) :

$$\overline{\overline{p}} - a - c = (\tilde{p}_r - a)\frac{k_E^{**}}{k_I^m} \tag{16}$$

This equation is equivalent to (11). Using the same reasoning, we can conclude that $k_E^{**} < k_I$ for any $k_I \geq k_I^m$. When the new operator enters with higher costs than the incumbent operator's, it has strong incentives to adopt a judo economics entry strategy. Moreover, we can notice that the entrant capacities always decrease with the cost differential.

Without a separate accounting, the impact of an increasing access charge on entrant capacities is also indeterminate. On the one hand, the cost differential increases with a rise in a because the incumbent operator does not bear any access charge. On the other hand, the traffic of the entrant is source of revenue for the incumbent operator. This argument can reduce the incumbent's aggressiveness and facilitate the installation of larger capacities.

Formally, we define $\pi_E^{**} = (\overline{\overline{p}}(k_E^{**}) - a - c)k_E^{**}$ and $\frac{\partial \pi_E^{**}}{\partial k_E} = \overline{\overline{p}}(k_E^{**}) - a - c + \frac{\partial \overline{\overline{p}}}{\partial k_E} k_E^{**}$.

By applying the theorem of implicit functions, we have :

$$\frac{\partial k_E^{**}}{\partial a} = -\frac{\frac{\partial^2 \pi_E^{**}}{\partial k_E \partial a}}{\frac{\partial^2 \pi_E^{**}}{(\partial k_E)^2}} \tag{17}$$

By hypothesis, $\frac{\partial^2 \pi_E^{**}}{(\partial k_E^{**})^2} < 0$ (the entrant profit function is concave). So the impact of an access charge on the entrant's investments depends on the sign of $\frac{\partial^2 \pi_E^{**}}{\partial k_E \partial a}$. The latter has three distinct terms :

$$\frac{\partial^2 \pi_E^{**}}{\partial k_E \partial a} = -1 + \frac{\partial \overline{\overline{p}}}{\partial a} + \frac{\partial^2 \overline{\overline{p}}}{\partial k_E \partial a} k_E^{**}. \tag{18}$$

For minimal incumbent capacities, as $\frac{\partial \overline{\overline{p}}}{\partial a} = \frac{k_E^{**}}{k_I^m}$ and $\frac{\partial^2 \overline{\overline{p}}}{\partial k_E \partial a} = \frac{1}{k_I^m}$, we have :

$$\frac{\partial^2 \pi_E^{**}}{\partial k_E \partial a} = \frac{-(k_I - 2k_E^{**})}{k_I^m} \tag{19}$$

If the entrant is forced to restrict its investment ($k_E^{**} < \frac{k_I}{2}$), then a rise in the access charge has a negative effect on the entrant capacities. But if the equilibrium entrant capacities are sufficiently large, then higher access charges may soften the incumbent's pricing policy and facilitate entrant investments.

3.3 Comparison of entry strategies in the two accounting regimes

The regime of separate accounting (*unbundling*) which offers the same competitive conditions to entrants and to the long distance subsidiary of the incumbent operator should facilitate entry *a priori*. This argument is generally used by the regulatory authorities in order to justify the separate accounting.

However, we prove that it is not always a valid argument: a regulatory regime without a separate accounting can efficiently encourage competition when the incumbent has no capacity excess.

Firstly, we show that for sufficiently small entrant capacities, the price announced by the entrant is always lower in the regime with separate accounting.

Lemma 3 : *When the incumbent operator has no excess capacities, then* $\overline{\overline{p}}(k_E) > \overline{p}(k_E)$

Proof. Let us define $\pi^m(a) = \max_{\{p\}}(p-a)D(p)$ as the monopolist profit for a unit cost a and $p^m(a)$ as the monopolist price. Assume that the incumbent has no excess capacity. Then $k_I^m = D(p^m(0))$.

According to equations (5) and (12), when k_E is very small, then the entrant price $\overline{p}$ tends to $\frac{\pi^m(a)}{k_I^m} + a$ and $\overline{\overline{p}}$ to $p^m(0)$. When k_E tends to 0, then $\overline{p} > \overline{\overline{p}}$ if :

$$\frac{\pi^m(a)}{k_I^m} + a > p^m(0) \tag{20}$$

or :

$$\frac{\pi^m(a) - \pi^m(0)}{a} > -k_I^m \tag{21}$$

As $\frac{d\ \pi^m(x)}{d\ x} = -D(p^m(x))$ (see the implicit function theorem) and π^m is continuous, then there always exists $b \in [0, a]$ such that $\frac{\pi^m(a)-\pi^m(0)}{a} = -D(p^m(b))$. Since $D(p^m(x)) \leq k_I^m$ for any $x \in [0, a]$ ($p^m(a)$ increases with a), then $\frac{\pi^m(a)-\pi^m(0)}{a} \geq -k_I^m$ and the condition (21) is satisfied. We can conclude that for small entrant capacitiés, $\overline{p}$ is always higher than $\overline{\overline{p}}$. ■

If the entrant capacities are small, the incumbent operator is always less aggressive in a separate accounting regime. Conversely, if the entrant capacities are large, the entrant is likely to fix higher prices when the incumbent is not forced to separate its activities.

Lemma 4 *When the incumbent has no excess capacity, then :*

$$0 > \frac{\partial \overline{\overline{p}}}{\partial k_E} > \frac{\partial \overline{p}}{\partial k_E} \tag{22}$$

This lemma comes directly from $\frac{\partial \overline{\overline{p}}}{\partial k_E} = -\frac{\tilde{p}_r - a}{k_I^m}$ and $\frac{\partial \overline{p}}{\partial k_E} = -\frac{p_r - a}{k_I^m}$. As p_r is an increasing function of the unit cost a (see equation (4)) and is equal[9] to $\tilde{p}_r$ for $a = 0$, then $p_r > \tilde{p}$ and $\frac{\partial \overline{\overline{p}}}{\partial k_E} > \frac{\partial \overline{p}}{\partial k_E}$.

In a bundling regime, an increase of the entrant capacities leads to a lower reduction in tariffs. The reason is that in this regime the incumbent operator takes into account the access revenue paid by the entrant. As access revenues increase with entrant capacities, the incumbent operator reacts softer than in a regime of separate accounting.

We can establish the main proposition of this paper concerning the efficiency of separate accounting.

Proposition 5 *There always exists a threshold $\underline{k}_I$, such that for all incumbent long distance capacities $k_I < \underline{k}_I$, the entrant will choose smaller capacities in a regime of separate accounting than in a regime without separate accounting.*

Proof. The entrant capacities with a separate accounting is determined by the following equation :

$$\overline{p}(k_E^*) - a - c + \frac{\partial \overline{p}}{\partial k_E} k_E^* = 0 \tag{23}$$

Let us consider the first order condition of the entrant's profit with no separate accounting, for the capacity k_E^* :

$$\frac{\partial \pi_E}{\partial k_E} = \overline{\overline{p}}(k_E^*) - a - c + \frac{\partial \overline{\overline{p}}}{\partial k_E} k_E^* \tag{24}$$

This is equivalent to :

$$\frac{\partial \pi_E}{\partial k_E} = \overline{\overline{p}}(k_E^*) - \overline{p}(k_E^*) + \frac{\partial \overline{\overline{p}}}{\partial k_E} k_E^* - \frac{\partial \overline{p}}{\partial k_E} k_E^* \tag{25}$$

If the incumbent has no excess capacity, then :

$$\frac{\partial \pi_E}{\partial k_E} = \frac{\tilde{p}_r(D(\tilde{p}_r) - k_E^*) + a k_E^*}{k_I^m} - \frac{(p_r - a)(D(p_r) - k_E^*) + a k_E^*}{k_I^m} \tag{26}$$

$$+ \left(\frac{\tilde{p}_r - a}{k_I^m} - \frac{p_r - a}{k_I^m} \right) k_E^* \tag{27}$$

After arrangement, we obtain :

$$\frac{\partial \pi_E}{\partial k_E} = \frac{\tilde{p}_r(D(\tilde{p}_r) - k_E^*) - (p_r - a)(D(p_r) - k_E^*) + (p_r - \tilde{p}_r) k_E^* - a\,(k_I^m - k_E^*)}{k_I^m} \tag{28}$$

[9] In the regime of no accounting separation, $\tilde{p}_r$ maximizes $p\,(D(p) - k_E)$.

If the access charge is equal to 0, then $p_r = \tilde{p}_r$ and $\frac{\partial \pi_E}{\partial k_E} = 0$. In this case, $k_E^* = k_E^{**}$. The accounting regime has no impact on entrant capacities.

If we derive $\frac{\partial \pi_E}{\partial k_E}$ on a, we obtain :

$$\frac{\partial^2 \pi_E}{\partial k_E \partial a} = \frac{(D(p_r) - k_E^*) - (k_I^m - k_E^*) + 2(p_r - \tilde{p}_r)\frac{\partial k_E^*}{\partial a} + k_E^* \frac{\partial p_r}{\partial a}}{k_I^m}$$

At the proximity of $a = 0$, we find :

$$\left.\frac{\partial^2 \pi_E}{\partial k_E \partial a}\right|_{a=0} = \frac{D(p_r) - k_I^m + k_E^* \frac{\partial p_r}{\partial a}}{k_I^m} > 0$$

since $D(p_r) > k_I^m$ and $\frac{\partial p_r}{\partial a} > 0$.

Consequently, for small access charge and incumbent capacities close to k_I^m, we have :

$$\overline{\overline{p}}(k_E^*) - a - c + \frac{\partial \overline{\overline{p}}}{\partial k_E} k_E^* > 0 \tag{29}$$

From (29), we conclude that the entrant has some incentives to invest in higher capacities in a bundling regime ($k_E^{**} > k_E^*$). ■

Separate accounting which is a complex and costly regulatory tool, may be less favorable for new operators and customers. Without a separate accounting, entrants can be incited to install higher capacities, implying a growth in long distance traffic and a decrease in tariffs which benefits to telecommunication subscribers. In the following section, we present a simulation of entrant capacities for a linear demand.

4 Simulation of entry strategies

In order to illustrate proposition 4, we consider the following linear demand $D(p) = 1 - p$. We assume that the incumbent operator has just the required long distance capacities to carry the monopolistic traffic $k_I = 1/2$ (optimal network size before the liberalization of the long distance market).

From the equations of the previous sections (3.1 et 3.2), we obtain the entrant optimal capacities and the competitive prices and traffic in the two accounting regimes. These capacities depend both on the level of access charge and on the cost differential.

In a regulatory regime of separate accounting, the price equilibrium is defined by $(\tilde{p}_E, \tilde{p}_I)$ **with** $\tilde{p}_E = \frac{(1-a-\tilde{k}_E)^2}{2} + a$ **and** $\tilde{p}_I = \frac{1+a-\tilde{k}_E}{2}$ **where** $\tilde{p}_E < \tilde{p}_I$ **and the traffic equilibrium by** $(\tilde{q}_E, \tilde{q}_I)$ **with** $\tilde{q}_E = \tilde{k}_E$ **and** $\tilde{q}_I = \frac{1-a-\tilde{k}_E}{2}$ **where** $\tilde{q}_E < \tilde{q}_I$ **and** $\tilde{k}_E = \frac{2(1-a)-\sqrt{(1-a)^2+6c}}{3}$.

The entrant's capacities in the long distance market clearly decrease with cost differential and access charge. The interconnection charge has an *entry deterring effect.* The entrant always selects lower capacities than the incumbent, whatever the cost disadvantage : its capacities are at most equal to 1/3 (optimal capacities for a=0 and c=0)[10].

In a regulatory regime without a separate accounting, if the access charge[11] is below $\frac{1+\sqrt{1+32c}}{16}$**, the price equilibrium is defined by** $(\hat{p}_E, \hat{p}_I)$ **with** $\hat{p}_E = \frac{(1-\hat{k}_E)^2}{2} + 2a\hat{k}_E$ **and** $\hat{p}_I = \frac{1-\hat{k}_E}{2}$ **where** $\hat{p}_E < \hat{p}_I$ **and the equilibrium traffic by** $(\hat{q}_E, \hat{q}_I)$ **with** $\hat{q}_E = \hat{k}_E$ **and** $\hat{q}_I = \frac{1-\hat{k}_E}{2}$ **where** $\widehat{\mathbf{k}}_E = \frac{2(1-2a)-\sqrt{(1-4a)^2-2a+6c}}{3}$.

In a regime without a separate accounting, entrant capacities decrease with the cost differential. But the access charge has a more ambiguous effect. More specifically, for a small cost differential $c < 3/32$, entrant capacities increase with the access charge (as long as a is lower than $\frac{1+\sqrt{1+32c}}{16}$), whereas for $c > 3/32$, we have the inverse relation. Two effects are present: a rising access charge strengthens the competitive advantage of the incumbent operator and increases its rent on its interconnection activities. When the cost differential with the entrant is small, the second effect is dominant and the incumbent operator lets the entrant install large capacities. Meanwhile, the judo economics principle holds since the entrant never chooses capacities greater than 1/2 (the highest capacities are obtained for $a = 1/8$ and $c = 0$).

We compare entrant capacities and the incumbent's profit in the two regulatory regimes. Figures 1 and 2 represent entrant capacities with respect to access charges, given the cost differentials.

We can notice that entrant capacities are always higher in the case of no separate accounting whatever is the level of the access charge and the cost advantage. However, figure 1 shows that entrant capacities increase with access charge for the bundling regime: if the two operators have symmetric costs on the long distance services, the incumbent operator is more interested in the revenues from local access.

We can also represent the incumbent's profits in the two regulatory regimes (figure 3). Logically, we observe a lower profit in the bundling regime. When

[10] The entrant gives up investing in capacities ($k_E = 0$) if $a > 1 - \sqrt{2c} = \underline{a}$. We can interprate $\underline{a}$ as the threshold access charge below which the new operator is deterred to enter. If we restrict the upper bound of a and c with reasonnable values (a and c lower than 1/4), then the entry is always profitable. However, if we introduce some fix costs of entry, the threshold $\underline{a}$ could diminish.

[11] In the case of $a > \frac{1+\sqrt{1+32c}}{16}$, the entrant and the incumbent operator fix the same prices and the incumbent has a smaller market share. It accepts to loose its dominant position on the long distance market in order to exploit its rent on the local access market.

Figure 1: Entrant capacities in the regime of separate accounting - dashed line- and the bundling regime (without a separate accounting) - solid line - for a cost advantage c=0.

the long distance subsidiary decides its tariffs by itself, it behaves tougher or more agressively towards the entrant. Conversely, bundliing puts the incumbent operator in the position of a “puppy dog“ in the terminology of Fudenberg et Tirole [1984]. It may be in the interest of the incumbent operator to separate its long distance activities from its local activities deliberately, even if this is not imposed by the regulator: organizing the operator’s differents entities into separate profit center can facilitate a tougher price policy towards entrants[12].

5 Retail Price Regulation

The regulator can decide to monitor the retail prices of the former monopoly to avoid predatory or squeezing strategies. Indeed, the regulator can force it to reveal or notify its pricing policy in advance. Then the tariffs are examined and are approved only if they can be contested by the new entrants. For example, charges for long distance call cannot be fixed below the interconnection charges supported by the new operators to provide such a service. Now the sequential

[12] However, the autonomy of each subsidiary must be real and credible. Otherwise the entrants will not be incited to restrain their capacities.

Figure 2: Entrant capacities in the regime of separate accounting - dashed line- and the bundling regime (without a separate accounting) - solid line - for a cost advantage c=0.2.

game is as follows. In the first stage, the public authorities define the regulatory framework. Then, the entrant chooses the capacities of its long distance network. In the third stage, the incumbent operator notifies its long distance prices and finally, the entrant fixes its prices.

If the incumbent has announced a price p_I, the entrant has the choice between undercutting this price $(p_I - \varepsilon)$ or announcing a higher price which maximises its profit on the residual demand $(D(p) - k_I)$. Given hypothesis 4 (incumbent capacities are higher than k_I^m), the first strategy is always more profitable than the latter.

Indeed, in the regime of separate accounting, the incumbent and entrant prices are given by p_r and $p_r - \varepsilon$ respectively where p_r is defined by (4). The regulation of the incumbent price allows the entrant to increase its price ($p_r - \varepsilon$ instead of $\overline{p}$).

Given these prices , the entrant can choose its optimal capacities by maximizing its profit function:

$$\max_{\{k_E\}} (p_r\,(k_E) - \varepsilon - a - c)k_E \tag{30}$$

Figure 3: The incumbent operator's profits with separate accounting (dashed line) and without a separate accounting (solid line) for a cost advantage c=0.

The optimal capacities, denoted k_E^* satisfy:

$$p_r\left(k_E^*\right) - \varepsilon - a - c + \frac{\partial p_r\left(k_E^*\right)}{\partial k_E} k_E^* = 0 \tag{31}$$

Similarly, in the case of no separate accounting, the incumbent and entrant prices are $\tilde{p}_r$ and $\tilde{p}_r - \varepsilon$. The entrant capacities are obtained by solving the following program:

$$\max_{\{k_E\}} (\tilde{p}_r(k_E) - \varepsilon - a - c)k_E \tag{32}$$

We denote k_E^{**} the optimal entrant capacities:

$$\tilde{p}_r(k_E^{**}) - \varepsilon - a - c + \frac{\partial \tilde{p}_r(k_E^{**})}{\partial k_E} k_E^{**} = 0 \tag{33}$$

As $p_r > \tilde{p}_r$, the incumbent operator is always less aggressive in the separate accounting regime. Moreover, the impact of entrant capacities on the prices is such that $0 > \frac{\partial p_r}{\partial k_E} \geq \frac{\partial \tilde{p}_r}{\partial k_E}$ (since the access charge a limits the impact of k_E on the incumbent price p_r). These results allow the entrant capacities to be compared.

Proposition 6 *For any incumbent capacities, we have* $k_E^{**} > k_E^*$.

If the incumbent is forced to notify its retail prices, then the regulator also needs to impose a separate accounting. In this sense, the efficiency of a separate accounting is restored when the retail prices of the incumbent telecommunication operator are regulated or at most notified in advance. Moreover, a separate accounting is less questionable when the incumbent has important capacities in the competitive market.

6 Conclusion

In this paper, we have underlined that in recently liberalized markets, it could be in the interest of the new telephone operators to aim at modest ambitions for the first few years and to limit their capacity investments. Given such a strategy of judo economics, we have evaluated the efficiency of the regulation of local access. In particular, we have proved that the separate accounting of the incumbent telecommunications operator is not always favorable to competition. It could even be in the interest of the incumbent operator to adopt such a separation in order to increase its profits and hinder new operators. However, this result must be qualified because other reasons can lead entrants to invest heavily in the first years of their activities. For example, electricity or railway companies might possess telecommunication carrier infrastructures that can be used by new operators. Consequently, an entrant has the possibility of reaching large capacities in a very short period. Moreover, the first entrants can anticipate the entry of new operators in the future and overinvest for strategic reasons to deter these entries. All these arguments enable us to explain the possibility of one significant size entrant into recently liberalized telecommunication markets.

7 Bibliography

Allen, B., 1993. Capacity Precommitment as an Entry Barrier for Price-Setting, International Journal of Industrial Organization 11, 63-72.

Armstrong, M., Doyle, C., Vickers, J., 1996. The Access Pricing Problem: a Synthesis, Journal of Industrial Economics 44, 131-150.

Armstrong, M., Cowan, S., Vickers, J., 1994. Regulatory Reform - Economic Analysis and British Experience, (MIT Press, Cambridge).

Bromwich, M., Hong, C., 1999. Costs and Regulation in the UK Telecommunications Industry, (Working Paper, London School of Economics).

Bulow, J., Geanakoplos, J., Klemperer, P., 1985. Multimarket Oligopoly:

Strategic Substitutes and Complements, Journal of Political Economy 93, 488-511.

Dixit, A., 1980. The Role of Investment in Entry-Deterrence, Economic Journal 90, 451-467.

Economides, N., 1998. Raising Rivals'Costs in Complementary Goods Markets: LECs Entering into Long Distance and Microsoft Bundling Internet Explorer", (Working Paper).

Fudenberg, D., Tirole, J., 1984. The Fat-Cat Effect, the Puppy-Dog Ploy and the Lean and Hungry Look, American Economic Review 74, 361-366.

Gelman, J.R., Salop, S.C., 1983. Judo Economics: Capacity Limitation and Coupon Competition, Bell Journal of Economics 14, 315-325.

Higgins, R., Rubin, P., 1995. Deregulating Telecommunications, (Wiley Series in Managerial Economics, John Wiley & Sons).

Kreps, D., Scheinkman, J., 1983. Quantity Precommitment and Bertrand Competition Yield Cournot Outcome, Bell Journal of Economics 14, 326-337.

Laffont, J.J., Tirole, J., 1994. Access Pricing and Competition, European Economic Review 38, 1673-1710.

Laffont, J.J., Rey, P., Tirole, J., 1998. Network Competition I: Overview and Nondiscriminatory Price, Rand Journal of Economics *29, 1-37.*

Laffont, J.J., Rey, P., Tirole, J., 1998. Network Competition II: Price Discrimination, Rand Journal of Economics 29, *38-56.*