Access Charges and Common Costs with a Dominant Company in Local Telecommunication: A Note[♣]

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Abstract

This paper analyzes optimal access and final service prices with a vertically integrated incumbent company that is a monopoly in the provision of access services, essential for the production of a final service in which it faces competition by competitive fringe companies. Also we analyze four alternative pricing regimes for the access charge and the incumbent final service price, if they are free or regulated, what allows the monitoring of production and allocation efficiency, incumbent incentives, and competitive fringe companies' incentives. Optimal prices depend on the incumbent vis-à-vis competitive fringe companies' efficiency in the final service market, where the optimal access charge stands within incumbent access services direct variable costs and stand alone cost. The analysis of the four alternative price regimes shows that the incumbent can adopt price or output strategies to bypass regulatory constraints, where in some cases a public service obligation should be imposed on the incumbent to avoid the bypass of regulatory constraints.

1. Introduction

In network industries such as telecommunication, gas, electricity, water and sewage services is possible to identify areas where competition is feasible and desirable, while in other areas competition is more difficult do to the natural monopoly characteristics of the industry. In the last two decades in many countries utilities regulation have moved to recognize those areas where competition is feasible, trying to incentive the entry of new agents, while it keeps regulated tariffs in those areas where competition have been less efficient. Within service industries, the telecommunication industry is one of the most dynamic explained by its high growth rates and strong technological innovation, facts that in the last years have shake the structure of the industry.

In this paper we analyze optimal access pricing policies in a one way access charge model when there is an incumbent vertically integrated company that is a monopoly in the production of access services, essential input for the production of the final service, while it face competition by a group of competitive companies in the provision of the final service. Also, we analyze four alternative policy regimes in terms of if the access charge and / or the incumbent final service price are free or regulated. This analysis

allows as monitoring production and allocation efficiency,[1] the incumbent incentives, and competitive fringe companies' incentives.

Because the incumbent company is an upstream monopoly that faces competition in the downstream market, access service is an essential resource needed by downstream competitors to provide a complete telecommunication service without building their own infrastructure. In this situation the incumbent faces strong incentives to spread its upstream monopoly power to other markets, particularly to the downstream market. The access structure that we analyzes resembles today's telecommunication industry and policy challenges confronted by regulatory authorities in many developing countries where the local telephone company provides final users access to long distance telecommunication service providers, internet service providers, and other complementary service providers. In this paper and with a one way access model we address questions as: what are the incumbent company incentives?, or what's the risk that the monopoly power in the access service market spreads to final services markets (local telecommunication, long distance telecommunication, Internet, and other complementary or added value services)?

Telephone networks are characterized by strong scale and scope economies,[2] economies that added with the network externalities that affect the users of the telecommunication service,[3] imply that the incumbent telephone service provider counts with an advantage over new entrants. To neutralize part of the advantage that the incumbent fixed telephone network provider has over new entrants, regulatory policy have made mandatory the network interconnection, what allows the users to contact any other user or services providers independently of the company with which they sign up for the fixed telephone service. Notwithstanding, mandatory network interconnection will be senseless without the appropriate access charges and incumbent final service price.

In general the literature on access pricing has focused on whether access charges encourage inefficient entry to the retail market. This approach, in part developed within the concept of the efficient component pricing rule (ECPR), has been investigated by Willig (1979), Baumol (1983), Baumol and Sidak (1994), Armstrong (2002) and others. Based on regulated final services prices, the ECPR states that the access price should not only cover the incremental cost[4] of the network, but also compensate the incumbent for the value of its lost profits (its "opportunity cost") when it provides access to a competitor who then supplies incumbent's former customers with a perfect substitute. While the ECPR does prevent inefficient entry, it does not correct for any existing allocative inefficiency unless complementary regulation of the retail prices is assumed optimal. The ECPR is not free from criticisms, as for example the fact that it can protect

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[1] Production efficiency refers to produce certain quantity at the minimum possible production cost, and allocation efficiency means that market prices should have a cost orientation where firms obtain no monopoly rents and the quantity produced is socially optimal.

[2] See Cribbet (2000).

[3] See Squire (1973).

[4] See Baumol and Sidak (1994).

incumbent monopoly rents.[5] Since the ECPR is a partial rule, it may be consistent with many regulatory pricing models, including those that are based in costs or those that are based on the use. The ECPR also have been adopted without price regulation in the competitive sectors of the industry,[6] where at first we can notice that there is no guarantee that ECPR will lead to an efficient resource allocation.[7] Complementing previous literature in this field, in this paper we look at optimal access and incumbent final service prices, where also we analyze the incumbent and competitive fringe companies incentives under alternative pricing policy regimes.

In section two we describe the one way telecommunication access model where a company monopolizes the access service that is an essential input for other telecommunication companies to reach final users. In section three we analyze the four pricing regimes in terms of the access charge and the incumbent final service price, free or regulated, what allows the monitoring of production and allocation efficiency, incumbent incentives, and competitive fringe companies' incentives. In section four we look at optimal access charges and incumbent final service price. And finally in section five we give the main conclusions of the paper.

2. The model

The model that we analyze is one with an incumbent or leader firm who is an upstream monopoly that provides access services to downstream competitive fringe companies. The incumbent is a monopoly in the provision of an intermediate service that is essential for the provision of the final service (as can be the termination of a telephone call in the network of the incumbent),[8] where competitive fringe companies contract access services from the incumbent to compete with it in the provision of the final service.

For this model we consider four pricing policy regimes in terms of the incumbent final service price $\overline{P}$ and the access charge P^a that competitive fringe companies pay for the use of the incumbent network. The four pricing policy regimes that we consider are: $\overline{P}$ free and P^a free, $\overline{P}$ free and P^a regulated, $\overline{P}$ regulated and P^a free, and $\overline{P}$ regulated and

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[5] For a critic view of the ECPR see Kahn – Taylor (1994), Economides – White (1995), and the answer by Baumol – Ordover – Willig (1997).

[6] Laffont and Tirole (1996), and Kahn and Taylor (1994).

[7] Ramsey (1927) and Boiteux (1956) are among the first who have analyzed optimal charges looking at the demand characteristics of the service in question.

[8] In general the network access problem happens when a company to provide a full service needs to use the network of other company, whether to originate calls or to finish calls. The model developed here operates indistinctly, and delivers qualitatively equivalent results in both settings. Nevertheless, and in what follows we will be speaking of access as a situation in which a company should finish a telephone call in the network of other company.

P^a regulated. In each case we analyze the incentives of the incumbent and competitive fringe companies in terms of market entry conditions, competition, and market efficiency. Thereafter we solve the optimal tariffs for a benevolent Social Planner who maximizes the summing of consumer plus producer surplus.

The incumbent is a leader in the provision of the final service where he is not a price taker, and confronts a final service residual demand that's given as the final service market demand minus competitive fringe companies' final service supply. Notice that, the leadership character of the incumbent in the final service market is not a synonym of being a dominant company in that market, where this last character is given by the cost advantage in the production of the final service that the incumbent can have respect to the competitive fringe companies as well as on competitive fringe companies access to the incumbent telephone network.

Let $P = a - bQ$ be the final service inverse demand function, where $Q = q_1 + q_2$ with Q as the total demand of the final service, q_1 the quantity produced by the incumbent and q_2 the quantity produced by competitive fringe companies.[9]

Let $CT_1 = c^{1o}\, q_1 + c^{1t}\, (q_1 + q_2) + CF^1$ be the total cost function of the incumbent, where c^{1o} is the cost to originate a call in the incumbent telephone network, c^{1t} is the cost to terminate a call in the incumbent telephone network, and CF^1 is a common cost in which the incumbent incurs to provide the telephone services, that is to originate and to terminate a telephone call.

Let $CT^2 = (c^{2o} + P^a)\, q_2$ be the total cost function of the competitive fringe representative company, where c^{2o} is the cost to originate a call in the competitive fringe company network and P^a is the access charge for terminating a call in the incumbent telephone network. As the competitive companies buy the call termination service from the incumbent at a price P^a, the total cost of the competitive companies depend on the access charge P^a.

Comment 1: The pricing policy by which is determined P^a affects the cost structure of competitive fringe companies.

Given the cost and inverse demand, profits of the incumbent are $\pi^1 = \overline{P}\ q_1 + P^a\, q_2 - c^{1o}\, q_1 - c^{1t}\, (q_1 + q_2) - CF^1$. Profits for the representative company of the competitive fringe are defined as $\pi^2 = P\, q_2 - c^{2o}\, q_1 - P^a\, q_2$, where P is the price that competitive fringe companies charges for the final service. *Ceteris – paribus*, changes in the incumbent access charge affects competitive fringe companies profits, and with it their interest to participate in the industry.

[9] For modelling, we assume that the number of companies that integrate the competitive segment of the industry is not prominent and the only thing that matters is that the companies that conform the competitive segment are price takers. Under this scenario the competitive fringe of the market will be modelled by a representative competitive firm.

3. Price policy regimes

Using the above basic structures we will proceed to analyze market equilibrium for the four alternative pricing policy regimes.

Case 1. $\overline{P}$ and P^a free

When $\overline{P}$ and P^a are freely chosen by the incumbent, competitive fringe companies maximize profits solving

$$\pi^2 = \text{Max}_{q2}\, P\, q_2 - c^{2o}\, q_2 - P^a\, q_2 \qquad (1)$$

Given the incumbent final service price $\overline{P}$ and access charge P^a, we can derive competitive fringe decision rule. If $\overline{P} > c^{2o} + P^a \Rightarrow q_2 = (a - P)/b$, this because competition within competitive fringe companies will decrease the price of the final service until $P = c^{2o} + P^a$, implying that $q_2 = (a - P)/b$. If $\overline{P} = c^{2o} + P^a \Rightarrow q_2 \in [0, (a - \overline{P})/b]$, because the quantity q_2 supplied by competitive fringe companies is undetermined, and is given by $q_2 = (a - \overline{P})/b - q_1$. And if $\overline{P} < c^{2o} + P^a \Rightarrow q_2 = 0$, and competitive fringe companies does not participate in the supply of the final service.

Comment 2: Through P^a the incumbent can influence competitive fringe companies' decision to enter the market for final services. The bigger is P^a, the bigger is the chance that competitive fringe companies are excluded from the market.

Comment 3: The industry efficiency depends on the pricing policy to set P^a.

Knowing competitive fringe decision rule, the incumbent chooses $\overline{P}$ and P^a to solve the following profit maximization problem:

$$\pi^1 = \text{Max}_{\{\overline{P}\,;\,P^a\}}\ (\overline{P} - c^{1o} - c^{1t})((a - \overline{P})/b - q_2) + (P^a - c^{1t})\, q_2 - CF^1 \qquad (2)$$

s.t.

$$q_2 = \begin{cases} 0 & \text{if } \overline{P} < c^{2o} + P^a \\ [0, (a - c^{2o} - P^a)/b] & \text{if } \overline{P} \geq c^{2o} + P^a \end{cases}$$

Problem (2) should be solved analyzing case by case, what depend on the relative efficiency of the incumbent against competitive fringe companies, that is c^{1o} against c^{2o}. Then, in what follows nd for each of the four price policy regime, equilibrium will be analyzed case by case. Here, with $\overline{P}$ and P^a freely chosen, problem (2) leads to two situations depending on if $\overline{P} \gtreqless c^{2o} + P^a$

i.- If $\overline{P} < c^{2o} + P^a \Rightarrow q_2 = 0$, and (2) reduces to

$$\pi^{1'} = \text{Max}_{\{\overline{P},\, P^a\}} (\overline{P} - c^{1o} - c^{1t})(a - \overline{P})/b - CF^1$$

Easily can be obtained that $\overline{P} = (a + c^{1o} + c^{1t})/2$, $q_1 = (a - c^{1o} - c^{1t})/2b$, and incumbent profits

$$\pi^{1'} = (a - c^{1o} - c^{1t})^2 / 4b - CF^1$$

ii.- If $\overline{P} \geq c^{2o} + P^a \Rightarrow q_2 = (a - c^{2o} - P^a)/b$ and $q_1 = 0$, and (2) reduces to

$$\pi^1 = \text{Max}_{\{\overline{P},\, P^a\}} (P^a - c^{1t})\,(a - c^{2o} - P^a)/b - CF^1$$

Easily can be obtained that $P^a = (a - c^{20} + c^{1t})/2$, $\overline{P} = (a + c^{2o} + c^{1t})/2$, and incumbent profits

$$\pi^{1''} = (a - c^{2o} - c^{1t})^2 / 4b - CF^1$$

With i.- and ii.- we have that:

$\pi^{1'} > \pi^{1''}$ if $c^{1o} < c^{2o}, \Rightarrow q_1 > 0, q_2 = 0, P^a > \overline{P} - c^{2o}$

$\pi^{1'} = \pi^{1''}$ if $c^{1o} = c^{2o}, \Rightarrow q_1 \geq 0, q_2 \geq 0, P^a = \overline{P} - c^{2o}$

$\pi^{1'} < \pi^{1''}$ if $c^{1o} > c^{2o}, \Rightarrow q_1 = 0, q_2 > 0, P^a < \overline{P} - c^{2o}$

Further, the herein proposed solutions also requires that $\pi^1 \geq 0$ such that the incumbent can recover his common cost, CF^1.

Comment 4: A company that is leader in a final service market that is potentially competitive and also monopolizes the production of a resource that is essential to produce the final service by competitive fringe companies, will use the most efficient production technology to produce the final service, being own or from the competitive fringe companies who can produce the final service, accomplishing a resource allocation that satisfies production efficiency. However this does not account for the allocation inefficiencies that may result from a deficient production of the final service.

Comment 5: A company that is a monopoly in the provision of an intermediate service and leader in the production of a final service, will maximize monopoly rents using or not the technology that the competitive fringe companies use for the production of the final service. Thus, the incumbent can capture for his own benefit the technology that is available for competitive fringe companies.

From i.- and ii.- we have three cases depending on how compares c^{1o} and c^{2o}.

a.- $c^{2o} + c^{1t} > c^{1o} + c^{1t}$.

Comment 6: When $c^{2o} + c^{1t} > c^{1o} + c^{1t}$ the incumbent monopolizes the production of the final service, and sets P^a high enough to leave competitive fringe companies out of the market, satisfying production efficiency but not allocation efficiency.

Is enough for the incumbent to set $P^a = \overline{P} - c^{1o}$, where $P^a = \textit{rent per unit sold} + c^{1o} + c^{1t} - c^{1o} = \textit{rent per unit sold} + c^{1t}$, what basically correspond to the ECPR ("*Efficient Component Pricing Rule"*) whose two main proponents are Baumol and Willig.

The incumbent can report monopoly rents but leads to an allocation inefficiency that implies a net welfare loss because production is under what is optimal when the price of each service is being set equal to its marginal cost.

b.- $c^{2o} + c^{1t} = c^{1o} + c^{1t}$.

Comment 7: When $c^{2o} + c^{1t} = c^{1o} + c^{1t}$ the incumbent obtain monopoly rents, being or not exclusive in the production of the final service, for that it sets P^a high enough becoming indifferent to provide or not the final service, where a portion or all of the final service is provided by competitive fringe companies, $Q = q_1 + q_2$.

The incumbent sets at the minimum $P^a = \overline{P} - c^{1o}$, where $P^a = \textit{rent per unit sold} + c^{1o} + c^{1t} - c^{1o} = \textit{rent per unit sold} + c^{1t}$, what correspond to the ECPR.

c.- $c^{2o} + c^{1t} < c^{1o} + c^{1t}$. [10]

Comment 8: When $c^{2o} + c^{1t} < c^{1o} + c^{1t}$ the incumbent has monopoly rents by his exclusivity in the production of the intermediate service, where it allows competitive fringe companies to carryout the production of the final service, $Q = q_2$. The incumbent sets P^a high enough to get the highest monopoly rents that it can obtain as if it's the owner of the call origination technology, c^{2o}, that is in hands of the competitive fringe companies.

The leader sets an access charge $P^a = \overline{P} - c^{2o}$, where $P^a = \textit{rent per unit sold} + c^{2o} + c^{1t} - c^{2o} = \textit{rent per unit sold} + c^{1t}$ what correspond to the ECPR, where $\overline{P}$ is the monopoly price that the incumbent will charge for the final service if his costs are $c^{1t} + c^{2o}$.

If the incumbent sets the price of the final service and the access charge freely, it will chose the price of the final service and the access charge to maximize profits taking advantage of his monopoly position in the access to a resource that is essential for other companies to participate in the market for the final service. This will be done independently if the incumbent participates in the provision of the final service or if it maximizes monopoly rents only selling access services, where it reaches through the market competitive fringe companies technology.

The P^a chosen by the incumbent is the ECPR, what allows it to protect his essential facility or access monopoly rents, neutralizing the competition in the final market that competitive fringe companies impose on it. With P^a freely chosen by the incumbent according to the ECPR, the market equilibrium is a monopolist equilibrium, where P^a is set above c^{1t}, spreading through P^a the power that the incumbent has in the access service to the competitive areas of the industry, and that is made with independency of how compares c^{1o} and c^{2o}.

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[10] The results make use of the assumption that the leader company can not buy competitive fringe companies technology, that is, it can not access the same cost function, c^{2o}, that competitive fringe companies have.

The monopolist equilibrium achieved is one where the equilibrium price - quantity basket maximizes the leader monopoly rents, with a bigger price and a smaller supply than what is optimal when social welfare is maximized. If $CF^l > 0$ incumbent profits are settle down by the monopolist price - quantity basket minus CF^l. When the incumbent sets freely P^a as well as $\overline{P}$, it will maximize his access monopoly rents, independently if the incumbent is more or less efficient than the competitive fringe companies, spreading through P^a his market power in the access service market to the final service market.

Case 2. $\overline{P}$ free and P^a regulated

In this case $\overline{P}$ is chosen by the incumbent and P^a is chosen by the regulatory authority, where $P^a = c^{1t}$ or alternatively $P^a = c^{1t}$ + *an adjustment as a function of* CF^l. As in Case 1, representative competitive fringe company solves problem (1), where the incumbent solves problem (2) choosing $\overline{P}$ given P^a.

If $P^a = c^{1t}$, problem (2) reduces to

$$\pi^1 = \text{Max}_{\{\overline{P}\}} \ (\overline{P} - c^{1o} - c^{1t})((a - \overline{P})/b - q_2) - CF^l \qquad (3)$$

s.t.

$$q_2 = \begin{cases} 0 & \text{if } \overline{P} < c^{2o} + P^a \\ [0, (a - c^{2o} - P^a)/b] & \text{if } \overline{P} \geq c^{2o} + P^a \end{cases}$$

Where we have three cases depending on if $\overline{P} \lessgtr c^{2o} + c^{1t}$.

i.- If $\overline{P} < c^{2o} + c^{1t}$, $q_2 = 0$ and $Q = q_1$. Then, $q_1 > 0$ if $\pi^1 > 0$.

With this $\pi^1 = \text{Max}_{\{\overline{P}\}} \ (\overline{P} - c^{1o} - c^{1t})(a - \overline{P})/b - CF^l$, whose solution gives $\pi^1 = (a - c^{1o} - c^{1t})^2 / 4b - CF^l$, where $c^{1o} + c^{1t} \leq \overline{P} < c^{2o} + c^{1t}$, what requires that the incumbent is more efficient than competitive fringe companies in the call origination service, and this is beyond the incumbent monopoly status in the provision of the access service.

However if the incumbent has a common cost CF^l, to recover all his costs is required that $\pi^1 \geq 0$ at the chosen price where $\overline{P} \geq c^{1o} + c^{1t} + CF^l/q_1$, with $c^{1o} + c^{1t} + CF^l/q_1 \leq c^{2o} + c^{1t}$, otherwise competitive fringe companies will enter the market and the incumbent will not recover the common cost.

When $\overline{P} < P^a + c^{2o}$, competitive fringe companies competition is innocuous for the incumbent given the large cost advantage that it has in the call origination service. In this case, there is a range within wich c^{1o} can fluctuate such that the incumbent holds his exclusivity in the production of the final service, even though P^a is regulated in terms of the direct cost c^{1t}. The band within wich c^{1o} can fluctuate has as ceiling the point where $c^{1t} + c^{1o}$ is equal to the monopolist marginal revenue such that the monopolist price for the final service is set equal to $c^{1t} + c^{2o}$. Therefore, as long as $\overline{P} < c^{1t} + c^{2o}$, the achieved

equilibrium is one where the entry threat imposed by competitive fringe companies is irrelevant given the incumbent large cost advantage. In the equilibrium, the incumbent to be financially viable must receive monopoly rents above variable costs, $(c^{1t} + c^{1o})q_1$, that are greater or equal to CF^l. If $\overline{P} < c^{1o} + c^{1t} + CF^l/q_1$ the incumbent incurs in losses.

Comment 9: If the incumbent is dominant in the final service market, measured by a large cost advantage such that monopoly rents achieved in the final service market allows it to recover a common cost CF^l, with $c^{2o} \geq c^{1o} + CF^l/q_1$ and $c^{2o} + c^{1t} > \overline{P} \geq c^{1o} + c^{1t} + CF^l/q_1$, increasing the access charges above c^{1t} is innocuous for the equilibrium in the final service market because the leader does not face any effective competition from competitive fringe companies. The achieved allocation satisfies production but not allocation efficiency.

ii.- If $\overline{P} > c^{2o} + c^{1t}$, $Q = q_2 > 0$, and $q_1 = 0$.

With $q_1 = 0$ and $P^a = c^{1t}$ the incumbent optimization problem reduces to: $\pi^1 = \text{Max}_{\{\overline{P}\}} (c^{1t} - c^{1t})\, q_2 - CF^l$, where $q_2 = (a - c^{2o} - c^{1t})/b$, incumbent access profits are cero, and in the event that $CF^l > 0$ the incumbent will be unable to recover the common cost CF^l. Given the last it may be necessary to increase P^a above c^{1t} to allow the incumbent to recover the common cost CF^l.

If $c^{2o} < c^{1o}$ is efficient from a production perspective that competitive fringe companies satisfy all final service market demand, with the incumbent being specialized in the provision of the intermediate service where it has an advantage.

Choosing P^a, the price quantity basket that brings the largest social welfare is reached with $P^a = c^{1t}$. However, if $P^a = c^{1t}$ and if there is a common cost $CF^l > 0$, it results indispensable to increase the access charge to account for CF^l (defining a new access charge $P^{a'} = c^{1t} + CF^l/Q$)[11], where competitive fringe companies pay for the incumbent common cost CF^l. Notwithstanding the incumbent is less efficient in the call origination service ($c^{1o} > c^{2o}$), it competes with competitive fringe companies to whom it provides access service at a regulated price P^a, being thus unable to exercise monopoly power in the access or call termination services.

Albeit that, incumbent has a large incentive to ask for P^a to be increased from c^{1t} to $P^m - c^{2o}$, the ECPR, where P^m is the monopolist price for the final service when the monopolist equals marginal revenue to cost $c^{1t} + c^{2o}$, and where the incumbent can accede to market power in the access service market and spread this power to the final service market to achieve some monopoly rents.

Comment 10: If $CF^l > 0$ and the incumbent is less efficient in the call origination service, $c^{1o} > c^{2o}$, up to a point that is socially convenient that it specializes in the provision of access services, results necessary to increase access charges above c^{1t} until the incumbent recover all the relevant costs, direct costs $Q \cdot c^{1t}$ plus common cost CF^l.

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[11] In this formula CF^l can not be pass directly to the access charge P^a being paid by competitive fringe companies because an increase in the access charge up to $P^{a'}$ requires to account for an adjustment in the quantity demanded Q.

Despite that, and to achieve monopoly rents, the incumbent faces strong incentives to demand an increase in the access charges above relevant costs, where the incumbent can accede to market power in the access service market and spread it to the final service market.

iii.- If $\overline{P} = c^{2o} + c^{1t}$, $q_1 \geq 0$, $q_2 \geq 0$, and $Q = q_1 + q_2 = (a - c^{1t} - c^{2o}) / b$.

With $\overline{P} = c^{2o} + c^{1t}$ and because $P^a = c^{1t}$, q_1 and q_2 are undetermined. Notwithstanding, if $c^{1o} \leq c^{2o}$ the incumbent is at least as efficient than the competitive fringe companies, where without loss of generality can be set $q_2 = 0$. If $c^{1o} \leq c^{2o}$, then $\overline{P} - c^{1o} - c^{1t} \geq 0$, and $\pi^1 \gtreqless 0$ will depend on $(\overline{P} - c^{1o} - c^{1t})\, q_1 \gtreqless CF^l$. If $\pi^1 < 0$, and because $P^a = c^{1t}$, the incumbent cannot increase the price of the final service above $c^{1t} + c^{2o}$, then it will not be able to recover the common cost. In this case, the only way for the incumbent to be financially viable is if P^a is increased in $|\pi^1|/Q$, with $Q = q_1 + q_2$, what implies that competitive fringe companies price of the final service increases in $|\pi^1|/Q$ and the incumbent final service price upper bound to recover all his costs also increases in $|\pi^1|/Q$. If $c^{1o} > c^{2o}$ and $P^a = c^{1t}$ the competitive fringe companies are more efficient than the incumbent, what reproduces case ii.- above, where $q_1 = 0$ and $q_2 = (a - c^{2o} - c^{1t}) / b$.

In general, with an access charge $P^a = c^{1t}$ the financial viability of the incumbent depends on the rents that it realizes over the direct costs $(c^{1t} + c^{1o})\, q_1 \gtreqless CF^l$, and if $CF^l > 0$ P^a must be increased to assure that the incumbent recover the common cost.

On other hand, it should be noticed that for the incumbent, and beyond that $P^a = c^{1t}$ or $P^a = c^{1t}$ + *an adjustment to contribute to finance the common cost* CF^l, results of great benefit a strategy in which P^a increases to a value such that competitive fringe companies perceived cost (access charge plus call origination cost) is equal to P^m, or access charge equal to $P^m - c^{2o}$ that correspond to the ECPR, where P^m is the price associated to the monopolist price –quantity basket obtained by setting marginal revenue equal to $c^{1t} + c^{1o}$.

With a chosen tariff for the final service $\overline{P} = P = c^{1t} + c^{2o}$, the incumbent rent above his costs $(c^{1o} + c^{1t})$ is due to his higher efficiency, what is not necessarily as large as the one that it can be achieved in situation when the price of the final service is P^m and the access charges P^a is high enough that suppress the entry threat of the competitive fringe companies. Thus, the incumbent has the incentive to accede to market power in the access service market to spread it to the final service market, and this can be done by asking for access charges to be above the costs to reach with that a monopolist equilibrium.

Comment 11: If P^a is regulated, the incumbent that is vertically integrated, in the provision of an essential facility and the production of the final service, has a ceiling in the market power that it can exert in the final service market being specified by the relative efficiency of competitive fringe companies and the level at which have been set P^a.

Case 3. P^a free and $\overline{P}$ regulated

In this case P^a is a free price and $\overline{P}$ is a price set by the regulatory authority, where $\overline{P} = c^{1t} + c^{1o}$ or alternatively $\overline{P} = c^{1t} + c^{1o}$ + *adjustment as a function of* CF^1. As in the previous cases, competitive fringe companies' problem is given by problem (1). And given competitive fringe companies decision rule, the incumbent chooses access charge P^a, where $\overline{P}$ is given by the regulatory authority, to solve problem (2).

If $\overline{P} = c^{1t} + c^{1o}$, the incumbent profit maximization problem reduces to:

$$\pi^1 = \text{Max}_{\{P^a\}} \ (P^a - c^{1t})\, q_2 - CF^1$$
s.t.

$$q_2 = \begin{cases} 0 & \text{if } \overline{P} < c^{2o} + P^a \\ [0, (a - c^{2o} - P^a)/b] & \text{if } \overline{P} \geq c^{2o} + P^a \end{cases}$$

Because $\overline{P} = c^{1t} + c^{1o}$, and without a public service obligation,[12] the optimal strategy for the incumbent is to set $q_1 = 0$, self excluding from the production of the final service to obtain monopoly rents by charging a monopolist P^a. That is, the incumbent by setting a monopolist price in P^a, according to the ECPR, and by self excluding from the final service market, will aspire to evade the regulatory constrain in $\overline{P}$ and spread his monopoly power in the access service market to the final service market.

But, what happen if at the regulated price $\overline{P}$ the incumbent has a public service obligation?

i.- $c^{2o} + P^a < \overline{P}$, then $q_1 = 0$

If the P^a chosen by the incumbent is one that $c^{2o} + P^a < \overline{P} = c^{1o} + c^{1t}$, happens that competitive fringe companies are more efficient than the incumbent in the call origination service $c^{2o} < c^{1o}$, where the cost advantage is such that the incumbent access charge is $P^a < c^{1t} + (c^{1o} - c^{2o})$, where P^a is set according to the ECPR.

Subtracting from the final service inverse market demand, $P = a - bQ$, the markup required by competitive companies to recover the cost to originating a call (c^{2o}), the incumbent faces an access service derived demand against which it is a monopoly. Because $c^{1o} > c^{2o}$ (where $\overline{P} = c^{1t} + c^{1o}$, $\overline{P} - P^a > c^{2o}$, and $P^a - c^{1t} < c^{1o} - c^{2o}$), for the incumbent is not profitable to participate in the selling of the final service, and is better to take an advantage of the monopoly position in the access service market to make rents. If for the incumbent is optimal to set P^a such that $c^{2o} + P^a = P < \overline{P}$, is because $c^{2o} < c^{1o}$, and with that monopolizes the access service market to achive monopoly rents. In

[12] An obligation on the incumbent by which it is mandated to provide service to any agent that demands it.

this case, the incumbent hand over competitive fringe companies the production of the final service, where bypasses $\overline{P}$ regulation by charging a monopolist P^a, according to the ECPR for a monopoly whose costs are $c^{1t} + c^{2o}$. The financial viability of the incumbent depends on if the access service monopoly rents are $\gtrless CF^1$. In an equilibrium like this is achieved production but not allocation efficiency.

ii.- $c^{2o} + P^a = \overline{P}$, then $q_1 = 0$

If P^a chosen by the incumbent implies $c^{2o} + P^a = \overline{P}$, is because without a public service obligation the incumbent may not be interested to participate in the selling of the final service, and to maximize monopoly rents prefers to take advantage of his monopoly position in the access service market. This situation requires that $c^{1o} \geq c^{2o}$, what is that the incumbent is less efficient than the competitive fringe companies in the final service market.[13] The financial viability of the incumbent depends on his monopoly rents in the access market, if are $\gtrless CF^1$.

If $\overline{P} = c^{1t} + c^{1o} > c^{1t} + c^{2o}$ and $P^a = c^{1t} + c^{1o} - c^{2o}$, regulated $\overline{P}$ is irrelevant for the incumbent in terms of not affecting his optimal strategy to choose P^a, but according to the ECPR. However, while the incumbent tries to obtain monopoly rents by selling the access service, if the incumbent final service regulated price is such that $\overline{P} = c^{1t} + c^{1o} > c^{1t} + c^{2o}$, that impose an upper limit to the maximum P^a that the incumbent can set to induce the final users to buy the final service from the competitive fringe companies. In this case, and because $c^{1o} \geq c^{2o}$, it happens that the incumbent decision of self excluding from the production of the final service, by setting P^a to persuade the users to buy the final service from the competitive fringe companies, leads to production but not necessarily allocation efficiency.

In the particular case $\overline{P} = c^{1t} + c^{1o} < c^{1t} + c^{2o}$, and when the incumbent has a public service obligation, happens that if $c^{2o} + P^a > \overline{P}$ (where P^a is the monopolist access charge that is obtained by equalizing the marginal revenue of the access service derived demand with c^{1t})[14], the incumbent will be induced to set and access charge $P^{a'} < P^a$, such that $\overline{P} = P = P^{a'} + c^{2o}$, by which the competitive fringe companies are persuade to serve all the final service demand. Here, incumbent access service monopoly rents are restrain by $\overline{P}$. Given $\overline{P}$ regulated, the incumbent attain a price – quantity basket where the rents are smaller than the ones that it can achieve under a non mandatory public service obligation and when its free to maximize access charge monopoly rents, in a sence of the ECPR when there is no regulatory constraint on $\overline{P}$. The attained solution leads to allocation inefficiency that is smaller than the allocation inefficiency that can be

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[13] When $c^{1o} < c^{2o}$ and with a public service obligation, the higher P^a that the leader company can price has as ceiling c^{1t}, and given that $\overline{P}$ is regulated, the competitive fringe companies can not offer a price for the final service lower than the one offered by the leader company.

[14] Access service derived demand obtained by subtracting from the final service inverse market demand, $P = a - bQ$, the markup required by competitive companies to recover the cost to originating a call (c^{2o}), derived demand against which the incumbent is a monopoly.

reached in a case where the incumbent is also free to choose the final service price. Also, in a case like this we can observe production inefficiencies.

Even thought $c^{1o} \lessgtr c^{2o}$, the incumbent faces the problem that with the regulated $\overline{P}$ it can not recover total costs if the price – quantity basket induced by the mandatory public service obligation is one where access service monopoly rent are < CF^l.

If the incumbent can self exclude from providing the final service at the regulated price $\overline{P}$, it will look to achieve monopoly rents in the access service market by not participating in the market for the final service, and this can happen even though the incumbent is more efficient than the competitive fringe companies ($c^{1o} < c^{2o}$). The incumbent self excludes from the production of the final service, service where he obtain no rents $\overline{P} = c^{1o} + c^{1t}$, if it can induce the users to buy the final service from competitive fringe companies, companies at which he charges a monopolist access charge to accomplish positive rents. The financial viability of the incumbent is given by if access monopoly rent $\lessgtr CF^l$.

When the incumbent faces $\overline{P} < P = P^a + c^{2o}$, and if there is no mandatory public service obligation, for the incumbent will be optimum $q_1 = 0$. Without a public service obligation the price – quantity basket that maximizes the incumbent monopoly rents induce allocation inefficiencies and if $c^{1o} < c^{2o}$ also can induce production inefficiency. The last because production is carried using a more inefficient technology than the one that the incumbent has, as a consequence of the incumbent interest to bypass the regulatory constraint on $\overline{P}$, and to exploit in that manner access monopoly rents that leads to the entrance of more inefficient operators into the market.

Comment 12: When $c^{1o} < c^{2o}$, P^a is freely choosen by the incumbent, and $\overline{P}$ is set by the regulatory authority, where $\overline{P} = c^{1t} + c^{1o}$ or alternatively $\overline{P} = c^{1t} + c^{1o}$ + *adjustment as a function of* CF^l, with out a public service obligation the incumbent can self exclude from the final service market to exploit his monopoly position in the access service market. This allows the incumbent to expand the monopoly that it has in the access service market to the final service market, leading to production and allocation inefficiencies.

Case 4. P^a and $\overline{P}$ regulated

$\overline{P} = P^a + c^{1o}$ and $P^a = c^{1t}$

i.- If $c^{2o} > c^{1o}$ the incumbent has a cost advantage respect to competitive fringe companies in the production of the final service, where social welfare (first best) is maximized with a price – quantity basket where the incumbent carries all the production of the final service, $Q = q_1 > 0$ and $q_2 = 0$. However, if $CF^l > 0$, $\pi^1 = -CF^l < 0$. Also, when $c^{2o} > c^{1o} + CF^l/q_1$ the incumbent is dominant, and setting prices as $\overline{P} = P^a + c^{1o} + CF^l/q_1$ and $P^a = c^{1t}$ leads to a second best social optimum where $Q = q_1 > 0$, $q_2 = 0$ and $\pi^1 = 0$.

Comment 13: If $c^{2o} > c^{1o} + CF^{l}/q_1$, tariffs $\overline{P} = P^{a} + c^{1o} + CF^{l}/q_1$ and $P^{a} = c^{1t}$ leads to a resource allocation where costs are minimized and the incumbent recovers all his costs.

When $P = c^{2o} + P^{a} = \overline{P} = c^{1t} + c^{1o} + CF^{l}/q_1$ and $P^{a} = c^{1t}$, in the margin competitive fringe companies are indifferent to enter the market, so that $q_2 = 0$ and $Q = q_1 > 0$, and $\pi^{1} = 0$.

If $P = c^{2o} + P^{a} < \overline{P} = c^{1t} + c^{1o} + CF^{l}/q_1$, and $P^{a} = c^{1t}$, competitive fringe companies fulfill all market demand and the incumbent is excluded from producing the final service, $q_1 = 0$ and $Q = q_2 > 0$. But if $CF^{l} > 0$, $\pi^{1} = - CF^{l}$. Thus to avoid $\pi^{1} < 0$, $\overline{P}$ as well as P^{a} may increase in CF^{l}/Q, leading to a second best solution where $q_2 = 0$, $Q = q_1 > 0$, and $\pi^{1} = 0$.

Comment 14: If $c^{2o} > c^{1o}$ and $c^{2o} \leq c^{1o} + CF^{l}/q_1$, tariffs $\overline{P} = P^{a} + c^{1o} + CF^{l}/q_1$ and $P^{a} = c^{1t}$ leads to a resource allocation in which the incumbent does not recover all his cost and competitive fringe companies fulfills market demand.

ii.- If $c^{2o} = c^{1o}$, competitive fringe companies are in the same situation with the incumbent in the production of the final service. The incumbent with competitive fringe companies satisfy all the market demand, $q_1 + q_2 = Q$, $q_1 \geq 0$ and $q_2 \geq 0$, and $\pi^{1} = - CF^{l}$. Because $\pi^{1} = - CF^{l} < 0$, to have that the incumbent can recover all his costs, an alternative is to set $\overline{P} = c^{1t} + c^{1o} + CF^{l}/Q$ and $P^{a} = c^{1t} + CF^{l}/Q$, where with independence of q_1 and q_2, in a second best solution the incumbent and competitive fringe companies will be able to compete, and asking the same price for the final service.

iii.- If $c^{2o} < c^{1o}$, competitive fringe companies have an advantage in the production of the final service, where the incumbent is less efficient. With $P = c^{2o} + P^{a}$ and $\overline{P} = c^{1t} + c^{1o}$, the incumbent can not compete with competitive fringe companies, so $q_1 = 0$, $Q = q_2 > 0$, and $\pi^{1} = - CF^{l}$. Because $\pi^{1} = - CF^{l} < 0$, is needed that P^{a} and $\overline{P}$ contribute to finance CF^{l}, where a solution is to increase P^{a} and $\overline{P}$ in CF^{l}/Q. As in previous cases, the incumbent faces strong incentives to spread his market power in the access market to the final service market, what can be done if it artificially ask for an increase in the access charge in a way that the competitive fringe companies perceived cost (originating cost plus access charge) correspond to the incumbent monopolist final service price P^{m}.

Comment 15: If $c^{2o} \leq c^{1o}$, tariffs $\overline{P} = P^{a} + c^{1o} + CF^{l}/q_1$ and $P^{a} = c^{1t}$ leads to a resource allocation in which the incumbent does not recover all his cost and competitive fringe companies fulfills market demand.

4. Optimal Tariffs. P^{a} and $\overline{P}$ regulated

Following Cases 1 to 4 in this section we summarize the general criteria's to set efficient prices for final and intermediate services, with and with out a common cost. The social optimal solution in terms of tariffs $\overline{P}$, P^{a}, and the quantity of the final service provided by competitive fringe companies, is obtained by maximizing the

consumer plus the producer surplus under a nonnegative profits constraint for the incumbent and competitive fringe companies. In this case, a floor for minimum P^a for the incumbent telephone network is $P^a = c^{1t}$, where this correspond to the *incremental cost* or direct cost faced by the incumbent, and a ceiling or maximum P^a for the incumbent telephone network is given by $P^a = c^{1t} + CF^1/Q$, that basically correspond to the *stand alone cost*, cost that competitive fringe companies eventually face if they decide to invest in infrastructure providing for their selves the call termination service, and bypassing the bottleneck that backup the incumbent monopoly in the access service.[15]

Without a common cost, economic efficiency lead to set tariffs equal to services marginal costs. In this sense, $\overline{P} = c^{1o} + c^{1t}$ and $P^a = c^{1t}$. Under these prices, competitive fringe companies will set a tariff for the final service $P = c^{2o} + c^{1t}$. Thus, if $c^{1o} \leq c^{2o}$, the incumbent is more efficient as a vertically integrated company in the production of the final service than competitive fringe companies. Hence, competitive fringe companies will not be able to compete with the incumbent when the prices are $\overline{P} = c^{1o} + c^{1t}$ and $P^a = c^{1t}$, where $\overline{P} \leq P = c^{2o} + c^{1t}$. If $c^{1o} > c^{2o}$, the incumbent is less efficient as a vertically integrated company in the production of the final service than the competitive fringe companies that use incumbent call termination service, and competitive fringe companies will be able to request a smaller price for the final service than the incumbent, serving with that all market demand, where $P = c^{2o} + c^{1t} < \overline{P} = c^{1o} + c^{1t}$, and $P^a = c^{1t}$.

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[15] The last assumes that competitive fringe companies by supplying their selves the call termination service, face a direct cost c^{1t} and a common cost CF^1. Obviously, if the competitive fringe companies can build and use a similar and cheaper infrastructure, they will have an advantage over the leader company in the call termination service. However, and given the sunk cost character of the leader company infrastructure investment, the decision to use or not his infrastructure only depends on having a tariff that recovers the direct costs, where is the decision to invest in new infrastructure the one that depends on if the tariff allows the recovery of operation and maintenance costs as well new infrastructure investment costs. Respect to the last, "stranded costs" come out as investments made in the past that become obsolete against more efficient new technologies, new technologies that accounting for all their costs (investment cost plus operation and maintenance costs) have smaller costs than the direct cost of the technology that was adopted in the past. Because of that, historical investments become obsolete at their marginal or variable cost level, even without accounting for infrastructure sunk costs. Thus, in an environment that is exposed to a fast technical change, frequently, the operators can not set a price for each of their products to recover all their historical costs, and that is because they should respond to market prices, prices that under the new technologies may well be below the costs that in the past was incurred for the provision of the service.

Comment 16: Without a common cost, economic efficiency indicates to set tariffs equal to the direct cost of the service, $\overline{P} = c^{1o} + c^{1t}$ and $P^a = c^{1t}$, under what it will be induced the entry of efficient companies in the market.

When the incumbent faces a common cost $CF^l > 0$ in the provision of the final and the access services, to recover all the costs is not sufficient for the incumbent to have tariffs being set equal to the direct cost of the services in question, $\overline{P} = c^{1o} + c^{1t}$ and $P^a = c^{1t}$. In this case, becomes necessary to increase at least one of these two tariffs to guarantee that the incumbent can recover total costs. In general, there is no unique policy rule to set tariffs; instead each particular cost structure should be analyzed to see the specific form that the conditions for economic efficiency take.

i.- If $c^{1o} < c^{2o}$ and $c^{1o} + CF^l/Q < c^{2o}$, the incumbent is dominant or very efficient in the production of the final service, so the solution $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$ and $P^a = c^{1t}$ is socially optimal. In this case, and given the cost advantage of the incumbent ($c^{1o} + CF^l/Q < c^{2o}$) respect to potential competitors, an access charge equal to the direct cost of the service $P^a = c^{1t}$ is sufficient to have that the incumbent can recover all his costs. In the particular case considered here, competitive companies do not participate in the production of the final service given the incumbent large cost advantage in the final service.

ii.- If $c^{1o} < c^{2o}$ and $c^{1o} + CF^l/Q \geq c^{2o}$, the incumbent is weak dominant in the final service market. Then an increase in $\overline{P}$ to account for the common cost CF^l without increasing P^a, where $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$ and $P^a = c^{1t}$, will lead to the entry of inefficient companies into the market. Under this circumstances, what is socially optimal is to increase $\overline{P}$ in CF^l/Q, $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$, and simultaneously increase P^a above the direct cost c^{1t} in an amount $c^{1o} + CF^l/Q - c^{2o}$, what corresponds to the opportunity cost of the incumbent to provide access service to competitive fringe companies. In that sense, is obtained that $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$ and $P^a = c^{1t} + c^{1o} + CF^l/Q - c^{2o}$, where the access charge is adjusted according to the Baumol and Willig ECPR. With access charges being set in this manner, competitive fringe companies are able to supply the final service at a price $P = c^{2o} + P^a$, that comes to $P = c^{2o} + c^{1t} + c^{1o} + CF^l/Q - c^{2o} = c^{1o} + c^{1t} + CF^l/Q = \overline{P}$.

iii.- If $c^{1o} = c^{2o}$, the incumbent does not have a cost advantage in the call origination service, where the optimal tariffs for the incumbent to recover all his costs are $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$ and $P^a = c^{1t} + c^{1o} + CF^l/Q - c^{2o}$, where P^a is adjusted according to the ECPR, that in this particular case gives $P^a = c^{1t} + CF^l/Q$, or the "Stand Alone Cost".

iv.- If $c^{1o} > c^{2o}$, competitive fringe companies have a cost advantage in the call originating service, when $\overline{P} = c^{1o} + c^{1t}$ and $P^a = c^{1t}$ is incentive an efficient entry of operators in the market. Not withstanding, the incumbent is not financially viable because it is not recovering his total costs, what makes convenient to set tariffs $\overline{P} = c^{1o} + c^{1t} + CF^l/Q$ and $P^a = c^{1t} + CF^l/Q$, guaranteeing the entry of efficient operators in the market and that the incumbent can recover all his costs. In this case P^a is set according to a "Stand Alone Cost" rule. On the other hand, and in this particular case, if instead of setting P^a according to a "Stand Alone Cost" rule, it is adjusted according to a ECPR, $P^{a'} = c^{1t} + c^{1o} + CF^l/Q - c^{2o} > c^{1t} + CF^l/Q$, the incumbent may achieve abnormal access

profits and with that can discourage the entry of efficient operators into de market. That because the final price of competitive fringe companies should have be given by $P = c^{2o} + P^a = c^{2o} + c^{1t} + c^{1o} + CF^l/Q - c^{2o}$ that gives $P = c^{1t} + c^{1o} + CF^l/Q$, with what competitive fringe companies will perceive equivalent costs than the incumbent, even though competitive fringe companies are more efficient than the incumbent. In this case, the use of the ECPR disincentive an efficient entry into the market.

The calculated optimal tariffs induce the entry of efficient operators into the market taking a provision for the incumbent to recover al his operation, maintenance and infrastructure investment costs. There is no unique rule to set the incumbent optimal tariffs, and it will depend on if the incumbent is or is not more efficient than the competitive fringe companies in the call origination service.

The following table resumes the most important results of second best tariffs for the incumbent under the different cost structures considered, whether the incumbent is or is not more efficient in the final service market.

Second Best Optimal Tariffs for Final and Intermediate Service				
Case		Incumbent final service tariff $\overline{P}$	Access charge for incumbent network P^a	Comment
Incumbent is dominant in the final service market	$c^{1o} < c^{2o}$ $c^{1o} + CF^l/Q < c^{2o}$	$c^{1o} + c^{1t} + CF^l/Q$	c^{1t}	P^a calculated at direct costs
Incumbent is weak dominant in the final service market	$c^{1o} < c^{2o}$ $c^{1o} + CF^l/Q \geq c^{2o}$	$c^{1o} + c^{1t} + CF^l/Q$	$c^{1t} + c^{1o} + CF^l/Q - c^{2o}$	P^a calculated according to the ECPR to exclude inefficient or less efficient operator in the market
Incumbent is not dominant in the final service market	$c^{1o} = c^{2o}$	$c^{1o} + c^{1t} + CF^l/Q$	$c^{1t} + c^{1o} + CF^l/Q - c^{2o}$ = $c^{1t} + CF^l/Q$	P^a calculated according to Stand Alone Cost or ECPR
Incumbent is not dominant in the final service market	$c^{1o} > c^{2o}$	$c^{1o} + c^{1t} + CF^l/Q$	$c^{1t} + CF^l/Q$	P^a calculated according to Stand Alone Cost

Comment 17: When the incumbent, that is vertically integrated, faces a common cost in the production of the access and final services, the rules to set optimal second best tariffs for the access and final services will depend on whether the incumbent is or not a dominant company in the final service market, understanding by that the cost advantage that the incumbent has respect to competitive fringe companies.

5. Conclusion

In this paper we have analyzed optimal access and final service prices for a vertically integrated incumbent company that is a monopoly in the provision of access services essential for the production of a final service, where it faces competition by competitive fringe companies. We analyze four alternative pricing regimes for the access charge and the incumbent final service price, in terms if they are free or regulated.

We find that optimal prices depend on the incumbent vis-à-vis competitive fringe companies' efficiency in the final service market, where the optimal access charge stands within incumbent access services direct variable or marginal costs and the stand alone cost. The analysis of the four alternative price regimes shows that the incumbent can adopt price or output strategies to bypass regulatory constraints, where in some circunstances a public service obligation should be imposed on the incumbent to avoid the bypass of regulatory constraints. Depending on the price policy regime, production and allocation inefficiencies can emerge, where the incumbent incentives to bypass regulatory constraints depend on the particular price policy regime.

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