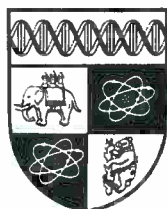


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COMPETITION IN VERTICALLY RELATED MARKETS**

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This paper is circulated for discussion purposes only and its contents
should be considered preliminary.

NEW INSIGHTS ON THE INTERACTIONS BETWEEN REGULATION AND COMPETITION IN VERTICALLY RELATED MARKETS*

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Abstract

The aim of this paper is to consider in some detail the modelling implications of the introduction of regulation in vertically related markets, allowing for non-linear pricing. Laffont and Tirole focus their analysis on socially optimal linear access price regulation under incomplete information, following the Bayesian Nash approach to regulation. By contrast, we leave aside asymmetric information issues, paying particular attention to the problems related to the entrant's behaviour and non-linear pricing. In fact, regarding competitive issues Laffont and Tirole (1990) and (1994) make rather specific assumptions, as competitors are assumed to have an unlimited capacity and they do not really need to undertake any economic decisions. In particular, the price they face is just set equal to the sum of the marginal cost and the access price and they are only allowed to charge linear price schedules. Furthermore, also the authority (as well as the incumbent) makes use only of a linear access pricing policy.

After specifying the main assumptions of the proposed games we show how when the incumbent remains the monopolist of an intermediate good (e.g. a network facility) which is consumed both internally and by any potential competitors, with second degree price discrimination, cream skimming turns out to be the only strategy of competition allowed by the incumbent. We also show how the access charge determined by the incumbent depends, apart from the type of network cost function, on the entrant's cost, the game's structure and the strategy of competition chosen by the entrant. Therefore, in this framework the Baumol-Willig rule is optimal only in a very narrow set of circumstances. Finally, we show how the same results derived for a vertically integrated industry still hold under vertical separation when a) perfect discrimination between downstream producers is not forbidden; and/or b) it is possible to resell access rights.

We believe that these and many other extensions of the analysis are helpful in understanding this intriguing field of study, since they not only have a particular relevance from a theoretical perspective, but also bring considerable practical implications for the policy to apply in many relevant utility industries.

Keywords: Regulation, vertical markets, access pricing, cream skimming, competitive issues.

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1 Introduction

In countries, such as the UK, where previously held assumptions about the extent of network industries are being challenged, experiments have been made in introducing a degree of vertical separation. For example, Mercury (and others) compete with British Telecom to supply telephone calls. But exchange and local loop facilities are, in general, still owned by British Telecom. By these means it is hoped to engineer a reduction in the need of regulation, allowing competition to do some of the work. Thus, the following question arises in theory (and in practice): is such partial competition, at one vertical level alone, beneficial, or can the incumbent maintain monopoly profits? Although there is a huge literature on topics such as access pricing regulation and vertical issues, many such interesting questions remain to be analysed, and even distinguished economists, such as Laffont and Tirole (1993), are still in search of a “general theory of access pricing” (p. 266).

An important supplementary question involves the determination of the range of circumstances in which access pricing regulation can be used to bring about a competitive solution to final goods supply, whilst a monopoly remains at one essential point in the chain of delivery.

Two plausible frameworks in which to examine these questions are provided by Laffont and Tirole (1994) and Vickers (1995). In fact we decided to develop a third alternative. Some of the key dimensions of comparison between the three models are listed in Table 1. As shown in the table, all three models’ aim is to develop a normative theory of access pricing. However, different specifications of the regulator’s objective functions are used. Laffont and Tirole (1994) consider the so called *cost of public funds*, a parameter that affects both consumers’ and producer’s net surplus in the welfare function, in the presence of a regulated monopoly.¹ Vickers (1995), following Baron and Myerson (1982), introduces distributional considerations in a simple but “ad hoc” way, by putting more weight on consumers’ surplus. Here we summarise the two alternative standard definitions of the social welfare function, where the two superscripts λ and ϕ will denote respectively the Laffont and Tirole and the Baron and Myerson approach:

$$[LT] \quad W^\lambda = S(Q) - (1+\lambda)(C+t) - \lambda U(Q)$$

$$[BM] \quad W^\phi = S(Q) + \phi \Pi(Q)$$

where $S(Q)$ denotes the net consumers’ surplus, $(1+\lambda)$ the cost of public funds, C the incumbent’s

¹ Furthermore, they also introduce in the managerial utility function (which has the same weight as profits and consumer surplus) a moral hazard or effort parameter (distinguished from the adverse selection, which has a merely technical nature). However, the introduction of this new problem does not cause any trouble, as both the regulator and the firm’s manager are risk neutral. For a more detailed explanation see also Vagliasindi and Waterson (1995).

Table 1: A comparison between models of access pricing

	Laffont and Tirole (1994)	Vickers (1995)	Vagliasindi and Waterson (1995)
Focus	Entirely social optimality	Social optimality via price regulation	Private incentives and social optimality
Social welfare function	[LT] $W = S - (1+\lambda)(t+C) - \lambda U$	[BM] $W = S + \phi \Pi$	Both [LT] and [BM]
Downstream market			
Structure	Product differentiation of final goods	Single market	Same final product
Demand function	Basically standard	Standard	High and low demand
Competition	Incumbent plus price taking fringe	Cournot oligopoly (incumbent a player)	Incumbent vs output constrained entrant
Price discrimination			
Industry's side	No	No	Yes (first or second degree)
Consumers' side	No	No	Yes (second degree)
Information structure			
Regulator's side	Adverse selection problem	Adverse selection problem	Full information setting (public firm)
Industry's side	Perfect knowledge of entrants' cost	Perfect knowledge of entrants' cost	Perfect knowledge of the entrant's cost
Consumers' side	Perfect information	Perfect information	Adverse selection problem

cost function, t the net transfer received from the regulator to the firm (following Laffont and Tirole's accounting convention), $U(Q)$ the managerial utility function and $\Pi(Q)$ the incumbent's profit function. According to the first definition social welfare is the sum of consumers' net surplus minus the total cost of the project to the taxpayers minus the rent to the firm times the shadow cost of public funds. In the case of Baron and Myerson social welfare is defined "ad hoc" as a weighted sum of consumers' surplus and producer's surplus with less weight ($\phi < 1$) put on profits.

In this paper we will deal with both specifications, showing how they lead to qualitatively similar results. Furthermore, for clarity of exposition we start from the standard first best analysis [Loeb and Magat (1979)] in which the regulator's objective, i.e. the social welfare function, is defined as the unweighted sum of consumers' and producer's net surplus, abstracting from *distributional considerations* and costs associated with monetary transfers.

The structure of the models, which captures both naturally monopolistic and potentially competitive activities, involves the representation of an upstream monopolist and a downstream sector. The latter is modelled as a price taking fringe in the case of Laffont and Tirole (1994), apart from a brief digression on competitors with "market power", and as a Cournot duopoly (where the incumbent is one of the players) in Vickers (1995). Less extensive deregulation in the downstream market will be considered in this paper, given the presence of a single output constrained entrant, the idea being that competition must begin somewhere. However, particular attention will be devoted to the price discrimination issue (making reference not only to final goods but also to the downstream sector).

Let us finally spend a few words on the information structure of our model. The amount of private information built into the standard models on the regulatory side seems too limited by comparison with the problems actual regulators face. There is no reason why the regulator should be merely uncertain about the level of the cost function, as in Laffont and Tirole (1994) and Vickers (1995), and not about its shape, or the demand condition of the industry. Furthermore, as Vickers (1995) says "It would be nice to examine a model in which the regulator was uncertain about both upstream and downstream cost levels" (p. 4), but as shown in the table none of the models assume that the entrants' costs are private information. Our approach is to ignore the problem of adverse selection on the regulator's side, introducing asymmetric information only between the firm and its consumers. This assumption is quite usual in the case of a public firm which directly maximises social welfare.

Of course, we cannot use the excuse that our model is simply different in order to motivate our analysis. Rather, we feel it has a number of desirable features in relationship to the analysis of certain UK regulatory scenarios. First, comparing with Laffont and Tirole (1994) their model is quite restrictive in terms of the interesting problems of strategic competition which we feel have been evidenced in eg. telecommunications in the UK.² We also believe it is important to allow for different

² Competitors are assumed to have an unlimited capacity and they don't really take any type of economic decisions (there is only a brief digression on competitors with "market power"). In particular, the price they face is just set equal to the sum of the marginal cost and the access price. Furthermore, competitors and also the regulated firm make use only of a linear access price policy. This is also true in the presence of a bypass technology of the monopolised good, where there is a

customer types which are evident in practice and in policy discussions, but not featured in Vickers' model.

Moreover, once we do this it seems reasonable to allow for non-linear pricing (to consumers and to firms in order to get access to the network). However, as the presence of non-linear pricing complicates the structure of the game, introducing incentive compatibility problems, we will slightly simplify the model proposed by Laffont and Tirole, eliminating, for instance, the product differentiation issue, in order to derive clear-cut results and to pay a particular attention to the problems related to the entrant's behaviour and non-linear pricing. Differently from Laffont and Tirole, who focus their analysis exclusively on socially optimal linear access pricing under complete (or incomplete) information, following the *Bayesian Nash* approach to regulation, we start from the unregulated case, examining non-linear pricing. The simplest framework to study is the one in which both the incumbent and his competitors have the same technical requirements for the intermediate good; i.e. there is no need to create new infrastructure or facilities to connect the competitors with the existing network. We will refer to this situation as the "common network case" (following Laffont and Tirole).

Within a model in which we ignore vertical issues it can be shown, as in Vagliasindi (1994), that cream skimming is not always the most profitable strategy for the entrant, except for particular cases. This is no longer true for the common network case. In fact, when the incumbent remains the monopolist of an intermediate good consumed both internally and by any potential competitors cream skimming turns out to be the only strategy of competition allowed by the incumbent.

There are several policy options that need to be analysed in a vertical setting, the most important of which are related to vertical structure and vertical conduct. Referring to the first question a network industry may be vertically integrated or vertically separated. If the incumbent starts off as a vertically integrated firm then a policy of vertical separation involves divestiture. Whether a network industry should be vertically integrated or vertically separated depends on the extent of vertical economies and on the cost of regulation.³

We will therefore also consider vertically separated structures in which the network is owned by an upstream monopolist. We will show that under complete information and in the absence of regulation, the upstream monopolist (if allowed to price discriminate) is able to expropriate all the downstream industry's profits. It is worth noticing how in this simplified setting vertical separation does not introduce major changes in the model proposed in the case of a vertically integrated industry, so that the same results still hold.

When perfect discrimination (i.e. first degree price discrimination) between downstream producers is forbidden (but non-linear pricing is allowed) we are dealing with an incomplete

cream skimming model. Hence, it may be interesting to introduce the possibility of price discrimination. As this pricing strategy is a more general one, always superior to the linear pricing strategy, it is not clear why a firm (and in particular the incumbent) and the regulatory authority should reject it a priori.

³ An intermediate approach may be to allow the incumbent to own the network but to oblige him to keep separate accounts for his network (setting the transfer price paid by his retail organisation equal to the access charge imposed on any potential entrant). This approach allows to combine the benefits of economies of scope with the ban on discrimination by the network.

information setting; however, as long as it is possible to resell access rights, or the access charge can be expressed as a function of the different consumption bundles that characterise each type of customers, nothing changes with respect to the complete information setting.

The previous considerations (true even with an endogenous entry scale) lead us to the conclusion that, under particular circumstances, changes in the vertical structure of a network industry do not matter a great deal. Even in this setting, as under vertical integration, cream skimming turns out to be the only profitable strategy of competition and the upstream incumbent obliges the competitor to act as a surplus taker (keeping the monopoly pricing strategy, as long as he faces a fixed scale of entry).

However, when the access charge cannot be a function of the customers' bundles, the standard result of 'no distortion at the top' no longer holds. In fact, in this case, the constraint imposed on the quantity produced generates a new trade off between rent extraction and profit maximisation for the downstream incumbent, so that a tariff distortion at the top arises.

The structure of this paper is as follows. We will first discuss the structure of the approach chosen to model access pricing and vertical issues, specifying the main assumptions of the proposed games (section 2). The following sections (3 and 4) provide the solution of the game in the absence of regulation and for the case in which the entrant is as efficient as the incumbent. In section 5 we will show how in this setting, even with perfect regulation (in a full information framework) and without product differentiation, the Baumol-Willig rule will not always represent the optimal access pricing policy. We will then discuss the structure of the approach chosen to model vertical separation (section 6) showing how when perfect discrimination between downstream producers is forbidden (and only non-linear pricing is allowed) and/or as long as it is possible to resell access rights the same results still apply. A final section (7) summarises the main results achieved by our analysis.

2 Modelling approaches to non-linear access pricing

It should be obvious that in general, there are several possible schemes, and correspondingly several games, that can be used to model access pricing and vertical issues. In what follows we examine a sequential model assuming that the interconnection costs are functions of output capacity and of the number of customers to be served, referred as the vertical game, whose structure is summarised below.⁴

Vertical Game

- (0) the authority sets up the regulatory system;
- (1) the incumbent fixes the access pricing strategy $F(K_H, K_L, Q^e)$ in each market, where K_t denotes the number of customers served by the entrant in market t $\{t = H, L\}$ and Q^e represents the total output produced by the entrant;
- (2) the entrant decides her scale of entry in terms of the number of customers $\{K_t\}$ to be served;

⁴ Naturally, we may have different versions of this game, depending on the nature of the network cost function and the pricing strategy chosen by the entrant. We believe that this approach might be particularly appropriate to describe telecommunication industries (where the crucial variable of competition is the number of people to be served) and in particular the case of "British Telecom" and "Mercury", especially if we focus on competition for large users.

- (3) the incumbent chooses his pricing rule $\{T_t, q_t\}$, where $T_t = T(q_t)$ is a fully non-linear tariff (q_t is the quantity purchased by a customer of type t);
- (4) the entrant chooses the strategy of competition and her non-linear tariff $\{T_t^e, q_t^e\}$.

In the following we will consider only two final goods markets. The total output in the final goods' sector can be decomposed in Q^0 , the output of a monopolised good (e.g. local telephone calls), and Q which is the output of a non-monopolised good (e.g. long-distance calls), hereafter denoted also as good 1.

On the **consumers' side**, for simplicity's sake, we restrict the analysis to two types of customers: high and low-demand customers ($t = H, L$).

- (i) each type is present in the same number (denoted by N);
- (ii) as in Laffont and Tirole, for simplicity's sake, we will assume that the monopolised good is sold by the incumbent at the linear price p^0 . We can in fact for instance suppose that both the customers of type L and H make the same phone calls, as they receive the same utility $v(q^0)$ from consuming a unit of the monopolised good. For the non-monopolised good the *gross surplus function* of type t is assumed to be a function of the relative output per unit of customer (q_t) and a taste parameter (θ_t) which captures the willingness to pay for the bundle q_t . To simplify notation consider the following simple functional form, such that for the same quantity, the high-demand utility becomes a fixed multiple (θ) of the low-demand's one, with $\theta > 1$:

$$[1] \quad u_H = \theta u(q_H)$$

$$[2] \quad u_L = u(q_L)$$

with $u'(q_t) > 0$ and $u''(q_t) < 0$.

On the **industry's side** both the incumbent and the entrant are allowed to make use of *fully non-linear tariff*:

$$T_t^j = T^j(q_t) \quad j = i, e$$

where T_t is the amount paid to the firm by the customer of type t .

- (iii) In the absence of entry the incumbent acts as a monopolist in good 1 and is characterised by the following *variable cost* and *revenue functions* in that market:

$$C(Q^1) = c^* Q^1$$

$$R(Q^1) = [T_L + T_H] N$$

where c^* is the incumbent's constant marginal cost and $Q^1 = N (q_L + q_H)$ denotes his total output. We are assuming that the incumbent's fixed costs are already sunk.

- (iv) the competitor has a *fixed limited scale of entry* in terms of number of customers to be served:

$$K = K_L + K_H < N$$

Loosely speaking, she can't preempt either of the two markets. For simplicity's sake, we will keep this assumption in all the stages of the game. We assume that she must pay an access charge F fixed by the incumbent (which can be considered as a cost of entry) which may depend in general both on

the scale of entry K and on the total output Q^e :

$$F(K_L, K_H, Q^e) \geq 0$$

Finally, she has a linear variable cost function:

$$CV^e = m Q^e$$

where m denotes the value of her marginal cost.

Notice how the competitor will enter the non monopolised good market if the usual participation constraint is satisfied:

$$[IR^e] \quad \Pi^e(Q^e) = K_L(T_L^e - m q_L^e) + K_H(T_H^e - m q_H^e) - F(K_L, K_H, Q^e) \geq 0$$

We do not need to specify an incentive compatibility constraint, as we are dealing with a single competitor with complete information.

(v) the production cost of the two final goods also depends on the network subcost function NC . In general the latter may depend on the number of customers to be served ($2N$) and on the total quantity of commodities ($Q^0 + Q$, where $Q = Q^i + Q^e$) which flows through the network:

$$NC(2N, Q^0 + Q) = NC(2N) + c^0 Q^0 + c^1 Q$$

To simplify matters in what follows we will assume, without loss of generality, c^1 equal to zero.

In the presence of entry the incumbent is characterised by the following *cost and revenue functions*:

$$C(Q^i) = c^* Q^i = c^* (N_L q_L + N_H q_H)$$

$$R(Q^i) = N_L T_L + N_H T_H$$

where $N_t = N - K_t$ denote the residual number of customers of type t served by the incumbent, c^* is the incumbent's constant marginal cost and $Q^i = N_L q_L + N_H q_H$ denotes the total output. Notice how we are assuming that the incumbent's fixed cost depends on the total number of customers $2N$. In the next sections we will solve the general game, starting from the simple case of an equally efficient competitor (i.e. $m = c^*$).

3 The incumbent's problem in the presence of an equally efficient competitor

Let us start from the analysis of stage 3, tackling the incumbent's optimisation problem in the **absence of entry** (i.e. when $N = N_L = N_H$). In this case the incumbent acts as a monopolist; that is, he maximises his profit function $\Pi(Q^i)$ with respect to the tariff system $\{T_L, q_L, T_H$ and $q_H\}$ subject to the individual rationality and incentive compatibility constraints:

$$[\textbf{Problem 1}] \quad \max \Pi(Q^i) \equiv p^0 Q^0 + R(Q^i) - NC(2N, Q^0 + Q) - C(Q^i) \quad \text{subject to:}$$

$$[MME] \quad p^0 \leq v'(q^0)$$

$$[IR_L] \quad u(q_L) - T_L \geq 0$$

$$[IR_H] \quad \theta u(q_H) - T_H \geq 0$$

$$[IC_L] \quad u(q_L) - T_L \geq u(q_H) - T_H$$

$$[IC_H] \quad \theta u(q_H) - T_H \geq \theta u(q_L) - T_L$$

The first constraint [MME] simply states the (monopolised) market equilibrium on the consumers' side, imposing the price of the monopolised good to be equal to the marginal utility

enjoyed by its consumption. The two following constraints $[IR_L]$ $[IR_H]$ are the usual participation constraints (with reservation prices equal to zero) for the two types of customers, whereas $[IC_L]$ and $[IC_H]$ specify the incentive compatibility constraints. The upward binding incentive constraint $[IC_L]$ prevents the low-demand type from consuming the high-demand bundle (q_H), while the downward binding incentive constraint $[IC_H]$ prevents the high-demand consumer from mimicking the low-demand customer. As proved for instance by Laffont and Tirole (1993, p. 57-8) the upward binding constraint $[IC_L]$ and the participation constraint $[IR_H]$ are automatically satisfied by the solution of the problem when $[IR_L]$ and $[IC_H]$ are binding. Hence, no surplus is allowed to the L type, whereas the H type enjoys a positive net surplus [given by $(\theta - 1) u(q_L)$].

Making use of consumers' optimality conditions for the non monopolised good, i.e. $p_t = \theta_t u'(q_t)$ we can then write the first order conditions as:⁵

$$\begin{aligned} [q^0] \quad & c^0 = v'(q^0) + v''(q^0) q^0 \\ [q_H] \quad & p_H = \theta u'(q_H) = c^* \\ [q_L] \quad & p_L = u'(q_L) = c^* / (2 - \theta) \end{aligned}$$

The first equation simply states the equality between the marginal cost and the marginal revenue for the monopolised good. The following ones imply that there is **no distortion at the top and the monopoly distortion at the bottom**. In particular, we obtain the optimal relationship between the two marginal prices p_L and p_H (and between q_L and q_H):

$$\begin{aligned} [3] \quad & p_H = (2 - \theta) p_L \\ [4] \quad & \theta u'(q_H) = (2 - \theta) u'(q_L) \end{aligned}$$

The determination of the optimal revenue function in the absence of vertically related markets ($NC=F=0$) involves the solution of the following problem:

$$\begin{aligned} [\textbf{Problem 2}] \quad & \max \Pi(Q^i) \equiv T_L N_L + T_H N_H - c^*(q_L N_L + q_H N_H) \quad \text{subject to:} \\ [IR_L] \quad & T_L = u(q_L) \\ [IC_H] \quad & T_H = \theta u(q_H) - (\theta - 1) u(q_L) \end{aligned}$$

The optimal relationship between the two marginal prices is very easily obtained from the previous one, making use of the optimality conditions which hold for the consumers, i.e. $p_t = \theta_t u'(q_t)$:⁶

⁵ Once we substitute all the functional forms of the revenue and cost functions, as previously defined, **[Problem 1]** becomes:

$$\begin{aligned} \max \Pi(Q^i) \equiv & 2Np^0q^0 + N(T_L + T_H) - NC(2N) - c^0(2Nq^0) - c^*Q^i \quad \text{subject to:} \\ [MME] \quad & p^0 = v'(q^0) \\ [IR_L] \quad & T_L = u(q_L) \\ [IC_H] \quad & T_H = \theta u(q_H) - (\theta - 1) u(q_L) \end{aligned}$$

This problem can be easily solved only with respect to q^0 , q_L and q_H , once we substitute the three binding constraints into the objective function:

$$\max \Pi(Q^i) \equiv 2Nv'(q^0)q^0 + N(2 - \theta)u(q_L) + N\theta u(q_H) - NC(2N) - c^0(2Nq^0) - c^*N(q_L + q_H).$$

⁶ **[Problem 2]** can be solved only with respect to q_L and q_H , once we substitute the two binding constraint $[IR_L]$ and $[IC_H]$ into the objective function:

$$[a] \quad p_H = \theta u'(q_H) = [1 - (\theta - 1) N_H/N_L] u'(q_L) = [1 - (\theta - 1) N_H/N_L] p_L = c^*$$

Notice how, in the absence of vertically related markets q_L and T_L are decreasing functions of the ratio N_H/N_L where as $T_H = \theta u(q_H) - (\theta - 1) u(q_L)$ is an increasing function of the ratio N_H/N_L . However, introducing vertical markets, the non-linear tariffs are independent of the scale of entry, that is of the ratio N_H/N_L , as is evident from equation [3]. Also the simplified optimal monopoly relationship between the two marginal prices holds independently of the value of the ratio N_H/N_L .

In order to clarify the exposition of the model, let us focus, as we have already mentioned, on the case of an equally efficient competitor (i.e. m is equal to c^*) and solve the game in the absence of regulation, that is ignoring stage (0). In particular, we will tackle the question on how the incumbent's profits vary, depending on the competitor's entry decision. In this case, if the competitor acts as a tariff taker [i.e. she takes as given the tariffs T_t determined by the incumbent in stage (3)] she will maximise her gross profits (abstracting from the access charges). That is, as will be shown later, a surplus taker competitor and a tariff taker competitor will end up proposing the same tariffs. Hence, for simplicity's sake we will consider only the case of a tariff taker competitor and demonstrate the following proposition.

Proposition 1

When an equally efficient competitor may enter the market of good 1 it is optimal for the incumbent to set the per customer access charge equal to the monopoly variable profits; that is, $T_H - c^*q_H$ and to maintain the previous monopoly pricing strategy, independently of the scale of entry K . In other words, the incumbent is indifferent between facing a duopoly or a monopoly situation in the market of good 1.

In what follows we will provide just a sketch of the proof of Proposition 1, as what matters at this stage is to develop the crucial reasoning relevant in the solution of the game.

Since in the absence of regulation the incumbent can fix at his discretion the level of the access charge, his profit can never be reduced in the presence of entry (as he can always deter entry by setting a very high access price). Furthermore, as the incumbent knows the competitor's marginal cost he can extract all the entrant's profit, simply by setting the per customer access charge equal to the entrant's per capita gross profits; that is, $T_H^e - c^*q_H^e$. Notice how we are considering a simplified framework (i.e. in the absence of inframarginal effects, or alternatively assuming a small scale of entry) the entrant will cream skim, since her variable profits in this case are strictly greater than the ones she had serving low-demand customers. A lower access charge would not be levied, since in this case the incumbent would be worse off, getting lower profits. Therefore, assuming the presence of a tariff taker competitor, stage (3) is automatically solved, given the incumbent's choice of T_H .

In particular, if the per customer access charge is set equal to the gross profits of a tariff taker competitor, the incumbent will expropriate all the entrant's profits. In this case, we can write the access pricing condition [AP]:

$$[AP] \quad F(K_H) / K_H = T_H - c^*q_H$$

$$\max \Pi(Q^i) \equiv [N_L - N_H(\theta - 1)] u(q_L) + N_H \theta u(q_H) - c^*(q_L N_L + q_H N_H).$$

In order to deal with stage (3) we may write down the incumbent's maximisation problem, in presence of entry, subject to the access pricing condition:

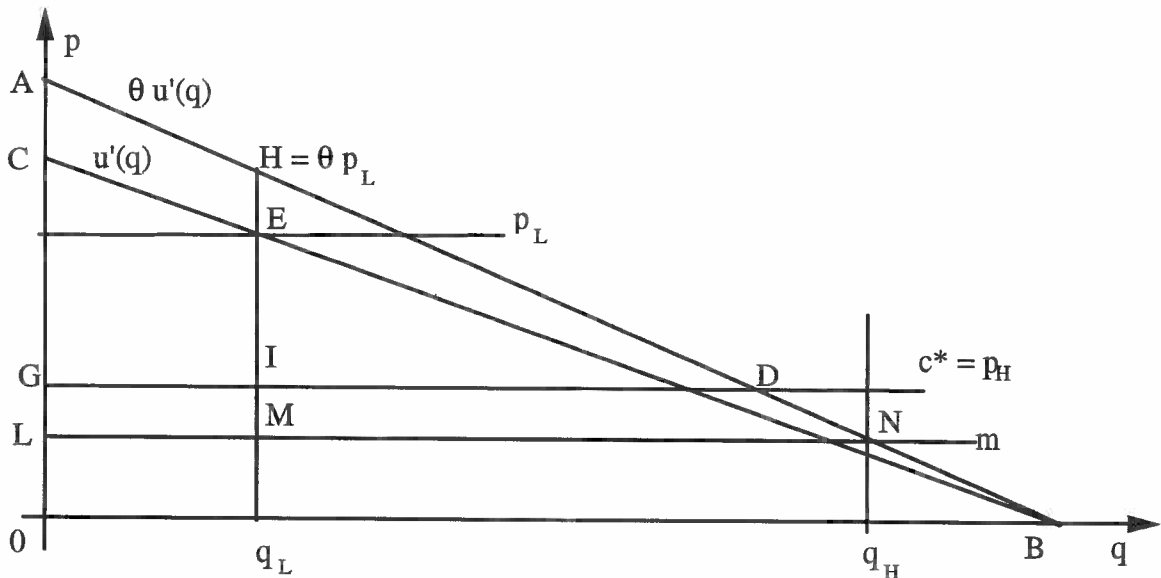
[Problem 3] $\max \Pi(Q^h) \equiv$
 $2Np^0q^0 + N_L T_L + N_H T_H + F(K_H) - NC(2N, Q^0 + Q) - c^0(2Nq^0) - c^*(N_L q_L + N_H q_H)$
 subject to:
[MME] $p^0 = v'(q^0)$
[IR_L] $T_L = u(q_L)$
[IC_H] $T_H = \theta u(q_H) - (\theta - 1) u(q_L)$
[AP] $F(K_H) = K_H (T_H - c^* q_H)$

It is easy to show how substituting the constraint [AP] the problem becomes exactly the same as the one examined in the monopoly case. This allows us to solve stage (3) as we get the values of q^0 , q_L and q_H . Given the [AP] condition, clearly the entrant is indifferent about entry for $p_H = c^* = m$, only if she serves the H type; otherwise, she will always incur in losses. Thus, we can assume that she enters and goes for the H type.

Clearly, the proposed solution is not necessarily the unique solution of the game; however, this is the only economically relevant solution, since it allows the incumbent to get the same results as if he was the only player. Notice how, in practice, the incumbent has a sort of control on the scale of entry, since by setting the appropriate access charge to the entrant (extracting all her profits) he can oblige the entrant to take the action he wanted to; that is in this case to go only for the high-demand type (setting $K = K_H$). The previous reasoning isolates the relevant points that will allow us to solve the general game.

4 A graphical exposition

It may be of some interest to give a representation of our game in the case of *quadratic utility function* $u(q) = q - (q)^2/2$. In fig. 1 the linear marginal utility functions $u'(q)$ and $\theta u'(q)$ are shown, as well as the optimal discriminatory marginal prices $p_H = OG = c^*$, $p_L = OF > c^*$.



It is immediate to derive graphically the quantities allocated per unit of customer (obtained in correspondence of the intersection between the curves representing the marginal utility and marginal

price for each type) and to verify that q_H is greater than q_L . The tariffs T_L and T_H (i.e. the gross revenue per unit of customer) are given by the integral from 0 to q_L and from 0 to q_H of the area which lies below the L type and the H type marginal utility function $u'(q_L)$ and $\theta u'(q_H)$. In the linear case T_L and T_H are respectively given by COq_LE and Hq_Lq_HD . The net revenues per customers' type are derived by subtracting the variable costs and are given by $CGIE$ and $CGIE + HID$. The H type enjoys a positive net surplus which amounts to $(\theta - 1) T_L$ (the area $ACEH$).

Let us first consider a competitor with the same marginal cost of the incumbent ($m=c^*$). If the non-linear monopoly tariffs T_L and T_H are maintained unchanged by the incumbent, the best the entrant can do, for any scale of entry, is to go for the H type and to get a gross profit per customer given by $CGIE + HID$ (always greater than $CGIE$). Hence, if the competitor enters she will certainly decide to do cream skimming, setting $p_H^e = m = c^*$.

Furthermore, she will enter only if her implicit participation constraint is satisfied; that is, the per customer access charge she must pay to the incumbent is lower than her gross profits per unit of customer ($CGIE + HID$).

To complete the argument, we just need to show that the optimal pricing for the incumbent is indeed to choose the monopoly tariffs T_L and T_H for any scale of entry. This seems obvious if we realise that, given an equally efficient competitor, the incumbent who expropriates all her gross profit is exactly in the same position as a monopolist.

In fact, if he increases q_L by a marginal amount he will gain $p_L - c^*$ (that is, segment ED) from his N low type customers, but he will lose $(\theta - 1) p_L$ (that is, segment HE) from his N_H high type customers, and similarly from the $K = K_H$ per customer access charge paid by the entrant. Hence, in practice his net marginal losses are $N(\theta - 1) p_L$, as if entry had not occurred. Basically, we have an internal optimum when marginal losses equate marginal gains; that is, $N(\theta - 1) p_L = N(p_L - c^*)$ which gives $p_L = c^*/(2 - \theta)$, that is independently of the scale of entry. Thus, the monopoly pricing T_L and T_H , derived analytically in the previous section, still represents the optimal pricing strategy for the incumbent for any scale of entry, which is exactly what we needed to show. As before, in practice, the incumbent has a sort of control of the scale of entry, since by extracting all her profits by means of the access charge he can oblige the entrant to set $K = K_H$.

Let us tackle the general game introducing a surplus taker competitor, for simplicity's sake but without any loss of generality, in order to show the general solution and how the incumbent's profit will vary, depending on the competitor's type. To achieve this aim we can simply add in the previous fig. 1 a line parallel to p_H in correspondence of m (which is less or equal to c^*).

With a more efficient competitor (with m less than c^*) the incumbent can increase the per customer access charge asking the entrant exactly her gross profits per unit of high-demand customer ($CLME + HMN$). This is in fact, on the basis of the previous reasoning, the new optimal per customer access charge, for any scale of entry (given the monopoly price $p_H = c^* > m$). In fact, as before, the competitor will enter only for non negative profits and will decide to do cream skimming, setting $p_H^e = m < c^*$.

As before, the incumbent will maintain his optimal non-linear tariffs T_L and T_H for any scale of entry, because the first order condition relative to q_H does not depend on the value of N_H and the

additional K_H per customer profit (GLND) is fixed and does not affect the optimal level of q_L . This happens because, given p_H the additional *access profit* (GLND) remains untouched for any given level of p_L greater than p_H , so that the incumbent remains in the position of a monopolist, with an additional profit which depends only on the scale of entry $K = K_H$. A higher access charge would not be levied, since in that case entry would not occur and the incumbent would just get his monopoly profits, losing any additional access profit. On the other hand a lower access charge would not be levied either. In fact, if the incumbent increases q_L by a marginal amount he will gain $p_L - c^*$ (that is, segment EI) from his N low type customers, but he will lose $(\theta - 1) p_L$ (that is, segment HE) from his N_H high type customers, and similarly from the $K = K_H$ per customer access charge paid by the entrant. Hence, as before, his marginal losses are $N(\theta - 1) p_L$, as if entry had not occurred and the monopoly pricing T_L and T_H still represents the optimal pricing strategy for the incumbent for any scale of entry, which is exactly what we needed to show.

To complete the reasoning, we just need to consider the case of a less efficient competitor and of a positive network marginal subcost associated with the delivery of good 1 (that is, considering the case in which c^1 is greater than zero).

It can be shown that entry is not optimal for a less efficient competitor. If we assume c^* less than m , clearly the per customer access charge the entrant can afford to pay is less than the gross profits the incumbent can obtain by making use of the monopoly tariffs T_L and T_H for any scale of entry. It is obvious that knowing this outcome, the incumbent will set the per customer access charge greater than the competitor's gross profits, so that no entry would occur.

A positive level of c^1 creates no major problems. In fact, with a single competitor we can just limit to analyse two part tariffs, setting:

$$F(K_H, Q^e) = c^1 K_H q_H^e + H(K_H)$$

where $H(K_H)$ plays the same role of $F(K_H)$ in the previous analysis. In practice, the presence of an additional variable access cost just shifts the previous marginal costs curves upward from c^* to $c^1 + c^*$ for the incumbent and from m to $m + c^1$ for the entrant. However, once this has been taken into account, we can apply the previous reasoning simply by setting $p_H = c^* + c^1$ and $m' = m + c^1$. No other changes affect fig. 1.⁷

The previous results referred to the entrant's and the incumbent's pricing strategies are useful to solve the general game and to prove the following general statement.

Proposition 2

In the general model, without regulation, there is no competition for the L type in the market of good 1 (the non monopolised commodity). It is optimal for the incumbent to allow the entry of a cream skimming competitor, only if she is at least as efficient as the incumbent ($c^* \geq m$), and to set a

⁷ It might be interesting, before concluding the graphical analysis to notice how the fact that a more efficient competitor sets a marginal price less than p_H implies a surplus loss for the monopolist and the collectivity. In fact, if the marginal units $q_H^e - q_H$ were sold as inframarginal units to other H customers, or to L customers, they would produce (in this linear case) a surplus which is exactly the double of the previous one. In practice, very loosely instead of having a triangle we would have a rectangle; more precisely Pareto optimality implies equal marginal rates of substitution).

per customer access charge equal to the monopoly variable profits; that is, $T_H^e - c^* q_H$ (for $c^1=0$). In this way he can maintain the previous monopoly pricing independently of the scale of entry K ($<N$). When a more efficient competitor enters the market the incumbent prefers to have a duopoly rather than a monopoly in the market of good 1. He also finds it optimal to oblige the competitor to behave as a surplus taker. However, it would even be preferable for the incumbent (and for the maximisation of social welfare) that the competitor sells all the produced good 1 to the incumbent (without any losses) at the marginal cost, so that the latter is able to resell it to the consumers at the monopoly tariffs.

As before, we will just sketch of the proof of Proposition 2. Since we know that the incumbent fixes the access charge in order to maximise his profits, on the basis of the previous analysis we can ignore the presence of a less efficient competitor. In fact, allowing entry the incumbent will always get a lower per customer gross profit. Namely by asking the entrant a per customer access charge equal to her variable per customer profit he would be worse off, incurring in losses with respect to the monopoly profits, being $T_t - c^* q_t > T_t^e - m q_t^e$ (for $c^* < m$). On the other hand, for a more efficient competitor, the per customer gross profit advantage [that is, $(T_t^e - m q_t^e) - (T_t - c^* q_t)$] assumes the highest value if we have cream skimming competition. In practice, $(T_H^e - m q_H^e) - (T_H - c^* q_H)$ is greater than $(T_L^e - m q_L^e) - (T_L - c^* q_L)$ for c^* greater than m . Consequently, it is clear that, as the entrant has a fixed scale of entry, we can set $K = K_H$ (i.e. K_H is now given being no longer a control variable). The competitor's optimisation problem can therefore be stated as:

$$\begin{aligned} \text{[Problem 4]} \quad & \max \Pi(Q^e) \equiv K_H (T_H^e - m q_H^e) - F(K_H) \quad \text{subject to:} \\ \text{[IC}_H^e] \quad & T_H^e = \theta u(q_H^e) - (\theta - 1) T_L \end{aligned}$$

where T_L is the incumbent's optimal tariff determined in stage (3).

Solving the previous problem, we get the following first order conditions:

$$\text{[q}_H^e] \quad p_H^e = \theta u'(q_H^e) = m$$

Knowing m , the incumbent will set the per customer access charge equal to the entrant's per capita gross profits; that is $T_H^e - m q_H^e$. Furthermore, as the incumbent expropriates all the entrant's profits, it will be in his interest to oblige the competitor (by appropriately setting the access charge tariff) to behave as a surplus taker. From the previous reasoning we can write the access pricing condition [AP] as:

$$\text{[AP]} \quad F(K_H) = K_H (T_H^e - m q_H^e) = K_H [\theta u(q_H^e) - (\theta - 1) u(q_L) - m q_H^e]$$

which is needed in order to solve the incumbent's maximisation problem.

$$\begin{aligned} \text{[Problem 5]} \quad & \max \Pi(Q^h) \equiv 2Np^0 q^0 + N_L T_L + N_H T_H + F(K_H) - NC(2N) - c^0(2Nq^0) - c^*(N_L q_L + N_H q_H) \\ & \text{subject to:} \end{aligned}$$

$$\text{[MME]} \quad p^0 = v'(q^0)$$

$$\text{[IR}_L] \quad T_L = u(q_L)$$

$$\text{[IC}_H] \quad T_H = \theta u(q_H) - (\theta - 1) u(q_L)$$

$$\text{[AP]} \quad F(K_H) = K_H [\theta u(q_H^e) - (\theta - 1) u(q_L) - m q_H^e]$$

Solving [Problem 5] with respect to q^0 , q_L and q_H we obtain the very same first order

conditions of the monopoly case and in particular: $p_L = c^* / (2-\theta) = p_H / (2-\theta)$. This can easily be checked by substituting the four binding constraints into the objective function. Thus, solving the incumbent's problems we get the optimal values of q^0 , q_L and q_H . Given the previous result, the competitor is indifferent to enter or not, knowing that the best outcome is to break even, serving the H type. Thus, we can assume that she enters and does cream skimming. On the other hand, the incumbent cannot do better than to oblige the competitor to maximise her gross profits (behaving as a surplus taker) setting the per customer access charge equal to the entrant's per capita gross profits.

One may feel that the previous model has two major drawbacks. On one side, the scale of entry is exogenously given and the entry decision is limited to a binary choice. On the other side, the cost function of the entrant may seem "ad hoc", as in practice she has a fixed marginal cost m , till she serves a number of customers less than K and an infinite marginal cost from there onwards. These drawbacks are solved in proposition 3 and 4 modifying assumption (iv), as specified in the appendix.

Proposition 3

If we leave unchanged all the other assumptions and allow the potential competitor to choose any finite number of customers as her scale of entry -that is, $0 \leq k \leq K (< N)$ - in stage (2) the solution of the game will not change.

Proposition 4

Under assumptions (i), (ii), (iii), (iv)' and (v) allowing any finite discrete number of customers as scale of entry there is only cream skimming competition in the market of good 1 (the non monopolised commodity). It is optimal for the incumbent to allow entry, to set a per customer access charge equal to the monopoly variable profit and to maintain the previous monopoly pricing. The incumbent also finds it optimal to oblige the competitor to behave as a surplus taker. However, it would be preferable for the incumbent (and for the maximisation of social welfare) that the competitor sells all the produced good 1 to the incumbent (reaching only break-even profits), so that the latter is able to resell it to the consumers, applying the monopoly tariffs.

Finally, it may seem undesirable that the purchasing solution (that is, the one in which the incumbent buys all the output of the entrant to resell it to the customers) should be preferable to allowing entry and direct selling for the competitor. As this will in reality just complicate the model, without enriching it with further essential economic content we will briefly examine these problems in the appendix.

5 The Baumol-Willig rule

From the point of view of society, in a first best setting without price discrimination and redistributive concerns, the regulator should set the access pricing equal to the marginal cost of providing access. In fact, it is always possible to cover eventual budget deficits with lump sum transfers.

Unfortunately, such first best outcomes are not normally available, due, for instance, to the presence of a binding budget constraint and the impossibility to finance subsidies through lump sum taxes, as Baumol (1983) implies. Therefore, one should explicitly consider optimal departures from marginal cost pricing, analysing how both the powers that the public regulatory authority can use and

the possibility to allow transfers to the firm (a possibility that may be endogenised in the model, explicitly allowing for regulatory capture, as done by Laffont and Tirole) influence the final results.

Baumol (1983), considering a particular case, proposes a solution, known as the Baumol-Willig rule or the efficient component pricing rule, that can be used in order to attain some (Pareto) improvements. According to it, within non perfectly contestable industries access charges should be set equal to the marginal cost of access plus a term which reflects the opportunity cost of entry.⁸

Let us consider the original example where a vertically integrated incumbent operates a rail service connecting R, S and T. An entrant offers a perfect substitute on the competitive route connecting R and S and has access to the incumbent's track ST.⁹

Baumol just deals with the efficiency issue (implicit in consumers' choice) of not distorting "the relative competitive advantages" considering how, *ceteris paribus*, a non-discriminatory access price cap should be set by an outside regulator to enforce the "principle of parity" of implicit prices, given the inefficiency of a private bargaining process.

Even if Baumol does not believe that firms will adopt a Ramsey pricing policy voluntarily we may consider, as in Cave (1994), the case where the incumbent's retail price p for the service over RST is equal to average costs.

Let the incumbent's per unit incremental costs of providing track-space over ST and of providing track-space over RS and train space on RT be respectively ic_A and ic_i . The entrant's average incremental costs of track-space over RS and train space on RT is ic_e . In this case the equitable access charge F^* that the incumbent should charge is:

$$F^* = p - ic_i = ic_A + (p - ic_A - ic_i)$$

The optimal charge is set equal to the marginal cost of access (ic_A) plus the opportunity cost of access ($p - ic_A - ic_i$), i.e. the profits foregone by the incumbent by not serving the traffic. As the incumbent enjoys a fully compensatory pricing, this rule just increases the industry's efficiency, as in the case of a vertical merger. In fact, F^* is "economically compensatory", being the implicit access charge a merged monopolist would choose (for providing track-space over ST) when he faces with the question of which production process should be used for the segment RS. Furthermore it minimises the costs of production, as clearly the merged firm would always minimise costs. Thus, the rule just increases the industry's efficiency, as in the case of vertical merger.¹⁰

⁸ Furthermore, he shows that when dealing with linear pricing in a market characterised by vertical issues the collusive result is normally preferable to the competitive one [leading to a Cournot-like equilibrium, see e.g. Waterson (1984) chapter 5] as prices are closer to marginal costs. It may be useful to realise that both of these results exploit the very same efficiency enhancing properties, implicit in a potential vertical merger.

⁹ In the first case, where there is no integrated firm operating the entire service, Baumol does not search for the optimal pricing for each segment or the entire track but simply considers "what price setting *process* will best serve the interests of consumers". In this case, where both firms maximise profits, collusion would best serve the consumers' interests compared to Cournot competition. Clearly, the same type of setting (with independent Cournot-like profit maximisation model) should hold in the second case (i.e. when transfers are allowed), as Baumol does not even spend one more word in order to further specify matters.

¹⁰ In sum this rule just "offers Pareto optimal criteria for pricing efficiency" related to the "intermediate input" (the track-space from S to T); the very same one that the merged monopolist

However, as the train space will be offered at its marginal cost only in perfectly contestable markets (cf. n. 5 p. 355) nothing ensures us that $p - ic_i$ just covers costs the incumbent effectively incurs (apart from the broader sense of opportunity costs).

Hence, when the network is earning excessive returns, or is operated inefficiently, the application of the Baumol-Willig rule may lead to a situation in which the incumbent may earn super-normal profits or impose the costs of his inefficiency to competitors. However, for regulatory purposes, it may be useful to eliminate super-normal profits and inefficiency costs from the access charge, as it was done above by the assumption that the incumbent's price is equal to average costs. In any case, later, Baumol and Sidak (1994) eliminate these potential problems, assuming that efficient regulation has already solved them.

Cave (1994) points out that, with perfectly competitive entrants, social welfare may be enhanced by lowering p (the incumbent's retail price) and contemporaneously increasing F (the fixed access charge). This consideration leads him to conclude that the rule "is applicable only when the incumbent's retail prices are non-optimal". But this is not so even in the Baumol basic case. In reality, Cave refers to Armstrong and Doyle (1994), a model with linear pricing and without transfers. Their proposition 1 (closely related to Laffont and Tirole 1990a and 1994), simply states the optimality to set access charge in excess of the marginal cost of providing access, on the basis of a simplified Ramsey pricing formula: $(p - F - ic_i) / (p - F) = -k/\eta_E$ in which the elasticity of supply of the entrant is η_E . However, this proposition can be easily falsified in the plausible case in which the elasticity of supply of the entrant (in their model η_E) is infinite because she has constant marginal costs. That shows how the Baumol-Willig rule can be socially optimal in the original context.¹¹

We can now focus on the cream skimming model with non-linear pricing described earlier. Let us consider the conditions under which the Baumol-Willig rule is optimal. In practice, the per customer access charge f_H^0 which allows an equally efficient competitor who serves the H type (in the absence of fixed costs) to break even and to enter the market is equivalent to the parity charge derived by Baumol (in his example for the track ST). At the same time, the per customer access charge f_L^0 which allows an equally efficient competitor who serves the L type (in the absence of fixed costs) to break even and to enter the market would be equivalent to the parity charge (for track RS). According to Baumol, in order to avoid inefficient entry, all potential competitors should pay one of these two charges in order to enter the high or low demand market.¹²

would follow. Probably, this criteria may not necessarily hold if the two firms specialise on different types of customers having different demand elasticity. But this point is already implicitly recognised by Baumol (cf. p. 352). Cave (1994), as well as Armstrong and Doyle (1994), notice that this rule should incorporate components related to the variety of products (i.e. the demand for the services) provided over the network. However, this perhaps minor generalisation is already implicit in the definition of the marginal and the opportunity cost of access (the profits foregone by the incumbent) and recognised in the explicit assumption that parity holds only when the intermediate good "will face the same [final] demand conditions and incur the same marginal costs" (p. 352).

¹¹ It should also be noticed how there is no reason which justifies the asymmetry between the incumbent and the entrant; in particular the elasticity of supply for the incumbent does not appear in any point in the analysis.

¹² Naturally, the competitor will always prefer to serve only high-demand customers, as our analysis has demonstrated. Nevertheless, in general there may exist particular specifications of the cost function for which the competitor will instead maximise her profits by serving the L type.

These prices are clearly the optimal ones for the *incumbent* who faces an equally efficient competitor and, given the presence of monopoly tariffs, they also represent the minimum fixed access charge which avoids the entry of inefficient competitors.

However, they do not represent the socially optimal prices, even with the very simple ultra-liberal social welfare function given by the unweighted sum of consumer surplus and profits a la Loeb and Magat (1979), ignoring any excess burden considerations. Let us therefore consider optimal access pricing and the direction in which we must move in order to achieve Pareto improvements. In practice we can always reduce the access charge f_H^0 and increase f_L^0 till we reach a tariff corresponding to the equality of marginal prices and marginal costs of the incumbent; that is, the couple T_H^w and T_L^w for which we have $p_H = p_L = c^*$. Differently from Cave, the retail price is lowered, but contemporaneously the access charge is decreased too.

Under a full information setting whenever $p_H = p_L = c^*$ and $c^1=0$, if the regulator sets the unit access charges f_H^{BW} and f_L^{BW} following the Baumol-Willig rule, he will leave the incumbent's profits unchanged.

$$f_H^{BW} = T_H^w - c^* q_H^w \quad f_L^{BW} = T_L^w - c^* q_L^w$$

These "parity" unit access charges are optimal with any type of competitors.¹³ Hence, in the Loeb and Magat's setting, once the optimal regulated tariff (T_H^w and T_L^w) is reached, we may impose the Baumol-Willig pricing rule, as it represents the socially optimal access pricing policy for the whole society. However, in reality, it does not matter if the incumbent would instead set a higher access charge and expropriate (partially or totally) the more efficient competitor's profits. In any case, if we totally disregard redistributive concerns, the "parity principle" is fully applicable with optimal incumbent's retail prices, differently from what stated by Cave, even if lump sum transfers are available.

Alternatively, disregarding the issue of moral hazard -with no loss of insights, as shown by Vagliasindi and Waterson (1995), we can acknowledge the fact that taxes change the behaviour of economic agents creating unavoidable distortion costs, following for instance the cost of public funds' approach due to Laffont and Tirole, or imposing the presence of a binding break even budget constraint and the impossibility to finance through subsidies. In the first case (allowing for costly public transfers) we should have some distortion at the bottom, as in the monopoly case.¹⁴

If we consider now an equally efficient competitor (and $c^1=0$) the Baumol Willig rule turns out again to be optimal. In fact, it will prescribe setting the unit access charge:

$$f_H^{BW} = T_H^\lambda - c^* q_H^\lambda \quad f_L^{BW} = T_L^\lambda - c^* q_L^\lambda$$

However, because the public (or private regulated) firm's profits are now given an additional

¹³ Naturally, in this particular setting differently from what implicitly assumed by Baumol, lump sum transfers could be needed if the firm will not break even when the regulator impose the optimal tariffs T_H^w and T_L^w which equate marginal prices to marginal costs.

¹⁴ However, as these regimes will coincide only when the shadow cost of public funds λ goes to infinite the Pareto improvements would also be achieved by reducing the access charge f_H^0 and increasing f_L^0 till we reach the second best tariffs T_H^λ and T_L^λ corresponding to $p_H^\lambda = [1+\lambda(2-\theta)/(1+\theta)] p_L^\lambda$.

weight λ , since it is costly to get public revenue from taxes, the Baumol-Willig rule will no longer represent the socially optimal access pricing rule, apart from the case of equally or less efficient entrants. In fact, the incumbent is no longer able to (partially or totally) expropriate the most efficient competitor's profits, by setting a higher access charge. Hence, a departure from the Baumol-Willig rule, increasing the access charge will be welfare improving and total expropriation will be optimal as profits will be transferred from the competitor to the incumbent. Consequently, with full information -while the second best tariff (corresponding to $p_H^\lambda = [1+\lambda(2-\theta)/(1+\theta)] p_L^\lambda$) will hold- the socially optimal access pricing policy turns out to be the one in which the incumbent sets the following unit access charges:

$$\begin{aligned} f_H^\lambda &= \max\{T_H^e - mq_H^e; T_H^\lambda - c^*q_H^\lambda\} \\ f_L^\lambda &= \max\{T_L^e - mq_L^e; T_L^\lambda - c^*q_L^\lambda\} \end{aligned}$$

so that the incumbent profits are always maximised (when transfers are available).

We may rewrite the previous socially optimal unit access charges as follows, in order to show the differences with the one prescribed by the Baumol-Willig rule.

$$\begin{aligned} f_H^\lambda &= f_H^B + \max\{(T_H^e - T_H^\lambda) + (c^*q_H^\lambda - mq_H^e); 0\} \\ f_L^\lambda &= f_L^B + \max\{(T_L^e - T_L^\lambda) + (c^*q_L^\lambda - mq_L^e); 0\} \end{aligned}$$

Here, the additional terms $(T_t^e - T_t^\lambda) + (c^*q_t^\lambda - mq_t^e)$ [with $t = H, L$] simply represent the additional profits that, under full information, the incumbent public firm can make, taking full advantage of the efficiency of the entrant when $c^* > m$.

The case in which costly public transfers are available and the incumbent's budget is binding (in absence of entry) and remains binding afterwards (in presence of entry) is not substantially different from the previous one, apart from the fact that the value assumed by λ is in this case endogenously determined by the maximisation problem and does not reflect the marginal excess burden of public funds (financed by an optimal tax system).

On the other hand, we may also follow the approach due to Baron and Myerson (1982) which puts more weight on consumer's rather than on producer's surplus, obtaining similar results. As in the ultra-liberal case, there is no distortion at the bottom; hence, Pareto efficiency will be achieved when marginal prices equal marginal costs. However, now a lower weight ϕ (less than unity) is given to the per customer profits of the entrant. Thus, social welfare will increase when the entrant's profits are transferred to the public firm (and to consumers through the public budget) and the Baumol-Willig rule will no longer be a socially optimal access pricing policy in this framework.

Hence, under full information and following the optimal pricing $p_H = p_L = c^*$ (with $c^1=0$) the Baumol-Willig rule, that prescribes setting the unit access charges:

$$f_H^{BW} = T_H^\phi - c^*q_H^\phi \quad f_L^{BW} = T_L^\phi - c^*q_L^\phi$$

which leave the incumbent's profits unchanged is optimal with equally (or less) efficient competitors. Yet, analogously to the previous case, the socially optimal access pricing policy will set the unit access charges as:

$$f_H^\phi = f_H^{BW} + \max\{(T_H^e - T_H^\phi) + (c^*q_H^\phi - mq_H^e); 0\}$$

$$F_L^b = F_L^{BW} + \max\{(T_L^e - T_L^b) + (c^* q_L^b - m q_L^e); 0\}$$

However, if we consider a case in which lump sum transfers from or to the public (or private regulated) incumbent are no longer allowed and the incumbent's budget constraint is not binding (and/or the entrants profits are directly extracted by the policy maker through lump sum transfers) the Baumol-Willig rule would be a socially optimal access pricing policy.

It should be noticed how in the previous analysis we have always assumed that there is *no product differentiation* and that *the public (or private regulated) firm is not operated inefficiently*. However, we have shown how, even within this context, the application of the Baumol-Willig rule may lead to sub-optimal results following the Laffont and Tirole approach or even adopting the Baron and Myerson social welfare function.

Nevertheless, the parity principle is fully applicable and the Baumol-Willig pricing rule may be socially optimal when it is possible to avoid those particular redistributive concerns, which lead to valuing the entrant's profits lower. This shows that assuming perfect regulation in a full information framework without any product differentiation issue, the Baumol-Willig rule may be a useful efficiency reference point (as explicitly claimed by Baumol), even if it does not always represent the optimal access pricing policy.

6 Some remarks on vertical separation

To examine the problem of vertical separation we need to change assumption (v), focusing on a specific example of vertical separation; that is, the separation between the production of good 0 and of the intermediate good from the production of good 1. Apart from that, we will maintain the same assumptions and the basic rules of the game.

(v)' With vertical separation instead of dealing with a single incumbent we have two new firms. The first, the upstream monopolist, produces only Q^0 (good 0) and the intermediate good, sustaining the related costs NC , which depend, as before, on the number of customers to be served ($2N$) and on the total quantity of commodities ($Q^0 + Q$) which flows through the network. To simplify matters, we keep on assuming c^1 equal to zero:

$$NC(2N, Q^0 + Q) = NC(2N) + c^0 Q^0$$

The upstream monopolist will also set an access charge tariffs $F^i \geq 0$ for the second firm, i.e. the downstream incumbent (as well as for any potential downstream entrant $F^e \geq 0$). The latter, as the incumbent in the vertical game, is characterised by the previous *cost and revenue functions*, defined exactly as in (iii).

The downstream incumbent, like the competitor, will produce a positive amount of good 1 ($Q^1 = N_L q_L + N_H q_H$) only if his participation constraint PC (with reservation net profits equal to zero, for simplicity's sake) is satisfied:

$$[PC] \quad \pi^i = R(Q^i) - c^* Q^i - F^i = N_L T_L + N_H T_H - c^*(N_L q_L + N_H q_H) - F^i(N_L, N_H, Q^i)$$

6.1 Price discrimination and vertical separation

Allowing for price discrimination and complete information, in the absence of regulation, we do not need to bother with any incentive compatibility constraints. In fact, in this case the upstream

incumbent can expropriate the entire gross profits of the downstream incumbent and of the downstream entrant π^j (for $j=i,e$) simply by setting the two tariffs $F^j = \pi^j$ in such a way that gross profits $\Sigma \pi^j = \Sigma \pi^j(Q^j) + F^j$ (for $j=i,e$) are maximised when c^1 is equal to zero, so that the previous production levels (in the absence of vertical separation) are reached. In practice, the upstream monopolist will set the previous access price for the entrant, hypothecating from the downstream incumbent a per customer tariff equal to $N_H - c^* q_H$ for each high-demand customer and $N_L - c^* q_L$ to give access to each low-demand customer. The perfectly discriminatory tariffs will be greater than the gross profits if the downstream producer will not set tariffs and quantities equal to the marginal price of the upstream monopolist. In this way, the downstream incumbent is prevented from decreasing the marginal price of the L type increasing his own profits, but reducing the total profits. The previous results may be summarised in the following proposition.

Proposition 5

Under assumptions (i) (ii) (iii) (iv) and (v)' allowing the upstream monopolist to make use of any type of access price discrimination (between downstream producers) there is only cream skimming competition for good 1 and the upstream monopolist is able to reach the same result as without vertical separation. It is optimal for the upstream incumbent to set the per customer access charge equal to the downstream firm's profits and in particular to oblige the downstream incumbent to maintain the previous monopoly pricing strategy, and the competitor to behave as a surplus taker.

In this way vertical separation does not introduce major changes in the model; the only difference being the fact that it is now the upstream monopolist who gets the entire profits of the three firms, as the downstream incumbent and the entrant just break even.

Allowing instead only for non-linear pricing, we will need to satisfy an incentive compatibility constraint, as we should deal with the two competitors as if we were under an incomplete information setting. In practice, regulation commonly is minimal, in that it simply forbids discrimination between different downstream producers of good 1. In order to examine a more interesting setting we will now consider the introduction of assumption (iv)' (see appendix) allowing for endogenous scale of entry of the downstream competitor.

Proposition 6

Under assumptions (i) (ii) (iii) (iv)' and (v)' allowing any finite number of customers as the scale of entry but no discrimination between downstream producers by the upstream monopolist there is only cream skimming competition for good 1. Furthermore, the upstream monopolist is able to reach the same result as with complete price discrimination only if it is possible to re-sell access rights, or the access charge is a function of the consumption bundles of the different customers. In these cases, as before, the upstream incumbent will set the per customer access charge equal to the downstream firm's profits and will oblige the downstream incumbent to maintain the previous monopoly pricing strategy, and the competitor to behave as a surplus taker. A sketch of the proof of this proposition is in the appendix.

6.2 The downstream incumbent maximisation problem: a reflection.

It may be interesting to show that the downstream incumbent will not set the monopoly pricing

when confronted with the following tariff function:

$$\begin{aligned}
 F(N_L^j, N_H^j, Q^j) &= \pi^m && \text{for } N_L^j=N; N_H^j=N-\hat{K} \text{ and } Q^j=Nq_L^m+(N-\hat{K})q_H^m \\
 &= \pi^e && \text{for } N_L^j=0; N_H^j=\hat{K} \text{ and } C=\hat{K} q_H^e \\
 &= \max(\pi^j + \epsilon) && \text{elsewhere for } j = i, e \text{ and } \epsilon > 0
 \end{aligned}$$

Once he chooses the access charge $F(N_L^j, N_H^j, Q^j) = \pi^m$ (because otherwise he will incur losses) he can do strictly better than break even by modifying his pricing away from monopoly pricing. In order to deal with this case we may write the downstream incumbent's maximisation problem in the presence of entry with the additional quantity and participation constraint $[Q^m]$ and $[PC^i]$ derived from the access pricing constraint:

$$\begin{aligned}
 [\mathbf{DI.1}] \quad & \max \pi^i(Q) \equiv NT_L + (N - \hat{K})T_H - p^m - c*[Nq_L + (N - \hat{K})q_H] && \text{subject to:} \\
 [\mathbf{IR}_L] \quad & u(q_L) - T_L = 0 \\
 [\mathbf{IC}_H] \quad & \theta u(q_H) - T_H = \theta u(q_L) - T_L \\
 [\mathbf{Q}^m] \quad & Q = Q^m = Nq_L^m + (N - \hat{K})q_H^m \\
 [\mathbf{PC}^i] \quad & \pi^i = R(Q) - c*Q - \pi^m = NT_L + (N - \hat{K})T_H - c*[Nq_L + (N - \hat{K})q_H] - \pi^m
 \end{aligned}$$

It is easy to notice how, substituting $[\mathbf{IR}_L]$ and $[\mathbf{IC}_H]$ into the objective function, assuming the other constraints to be automatically satisfied, the problem $[\mathbf{DI.1}]$ becomes exactly the same as the incumbent's problem in the absence of the access price issue. But clearly, the quantity produced in this unconstrained case will be greater, as the marginal price of the L type is always lower, since $N_H = N - \hat{K}$ and $N_L = N$.

In fact, solving the unconstrained maximisation problem we end up with:

$$\begin{aligned}
 [q_H^i] \quad & p_H^i = \theta u'(q_H^i) = [1 - (\theta - 1) N_H/N_L] u'(q_L^i) = c^* = p^m && \text{No distortion at the top} \\
 [q_L^i] \quad & p_L^i = u'(q_L^i) = c^* / [1 - (\theta - 1) N_H/N_L] < c/(2 - \theta) && \text{Distortion at the bottom}
 \end{aligned}$$

Thus, we would be back to the equation $[\mathbf{a}]$, previously derived for the basic model, but with the complication that the downstream incumbent's choice is constrained by the fact that he cannot produce a quantity greater than $Q^m = Nq_L^m + (N - \hat{K})q_H^m$ and he must serve a number of customers equal to $N_H = (N - \hat{K}) < N$ and $N = N_L$. Clearly, as p_L^i is strictly less than p_L^m we have q_L^i strictly greater than q_H^m consequently $Q^i = Nq_L^i + (N - \hat{K})q_H^i$ strictly greater than Q^m so that the constraint is binding. On the other hand, as the downstream incumbent can break even with the monopoly tariff, his participation constraint $[\mathbf{PC}^i]$ is automatically satisfied by the solution of the maximisation problem. Having noted this, the general solution of the maximisation problem $[\mathbf{DI.1}]$ becomes exactly the same as the revenue maximisation problem of the incumbent (for a given Q equal to Q^m) in the absence of the access price issue. In fact, from $[Q^m]$, since the produced quantity is fixed, so are all costs and the downstream incumbent maximises profits simply by maximising his revenue subject to $[Q^m]$:

$$\begin{aligned}
 [\mathbf{DI.2}] \quad & \max R^i(Q) \equiv N T_L + (N - \hat{K})T_H - p^m && \text{subject to:} \\
 [\mathbf{IR}_L] \quad & u(q_L) - T_L = 0 \\
 [\mathbf{IC}_H] \quad & T_H = \theta [u(q_H) - u(q_L)] - T_L \\
 [\mathbf{Q}^m] \quad & Q = Q^m = Nq_L^m + (N - \hat{K})q_H^m
 \end{aligned}$$

Hence, in the presence of vertical separation, equation [4] $\theta u'(q_H) = (2-\theta)u'(q_L)$ no longer holds as is shown by the solution of the previous maximisation problem [DL2]. In particular, from the first order conditions that characterise an interior solution we obtain the usual optimal relationship between the two marginal prices:

$$p_H^i = \theta u'(q_H^i) = [1 - (\theta - 1) N_H/N_L] p_L^i = [1 - (\theta - 1) N_H/N_L] u'(q_L^i)$$

and between q_L^i and q_H^i with the fixed values $N_H = (N - \hat{K}) < N$ and $N = N_L$.

Furthermore, the usual 'no distortion at the top' condition $p_H^i = c^*$ no longer holds. In fact, as the production quantity is constrained, the relevant marginal cost for the downstream incumbent includes a positive shadow price and is greater than c^* . Consequently, while the bundle of the high-demand customers q_H^i is decreased, the bundle of the low-demand customers q_L^i is increased. Hence, in this case the upstream monopolist can no longer impose the monopoly tariffs on the downstream incumbent, so that the maximisation solution of the latter creates a tariff distortion which affects (in the sense of reducing) the profits of the downstream entrant. In practice, the type of tariff previously proposed collapses, as the surplus taker downstream entrant no longer necessarily breaks even under the new tariffs fixed by the downstream incumbent.

This poses a major problem for the upstream monopolist, as there is a trade off not only between rent extraction and efficiency, but also between rent extraction and profit maximisation.

9 Final remarks

The main conclusion that we can derive from this analysis is how pervasive the standard monopoly result is. In particular, in the absence of access price regulation, we commonly find that there is no distortion at the top and some distortion at the bottom of the pricing structure. In one sense this can be seen intuitively as a corollary of the proposition well known (though not universally true) in vertical integration, namely that a monopolist can take its profit only once. Therefore, the corollary is that competition at one stage has no beneficial impact. What is interesting is that this remains true quite broadly, in a model with non-linear access pricing.

An important factor differentiating our vertical game from a game played in the absence of vertical issues is that there is a unique strategy of competition for the entrant. In fact, when the incumbent remains the monopolist of an intermediate good which is consumed both internally and by any potential competitors, cream skimming turns out to be the only profitable strategy left to a potential competitor. We have proved how when an equally efficient competitor enters the market of good 1 it is optimal for the incumbent to set the per customer access charge equal to the monopoly variable profits, maintaining the previous monopoly pricing strategy, independently of the scale of entry K . When a more efficient competitor enters the market, however, the incumbent strictly prefers to have a duopoly rather than a monopoly. He also finds it optimal to oblige the competitor to behave as a surplus taker.

Another result which we have derived is that the purchasing solution (that is, the one in which the incumbent buys all the output of the entrant to resell it to the customers) should be preferable to allowing entry and direct selling for the competitor. In practice, we have shown how this solution depends only on the indivisibility of the number of customers' problem, so that it will always appear

in one way or another. Also allowing the entrant to choose an endogenous scale of entry in reality just complicates our model, without enriching it with essential economic contents. In fact, if we leave unchanged all the other assumptions and allow the potential competitor to choose any finite number of customers as her scale of entry -that is, $0 \leq k \leq K (< N)$ - the solution of the game will not change.

Finally, we have shown how the same results derived for a vertically integrated industry still hold under vertical separation when: a) perfect discrimination between downstream producers is not forbidden; and/or b) it is possible to resell access rights.

We have provided a framework in which the problem of the direct interactions between access pricing regulation (including the policies toward price discrimination) and competition could be analysed. Our analysis has shown the standard approach (that is, modelling competition as simple bypass) to be an unsatisfactory way of dealing with the problem of competition in a second degree price discrimination model.

The general conclusion that we can derive is that competition will not obviate the need for regulation even in a full information setting.¹⁵ In a vertical framework, even when there is no product differentiation and the firm has been efficiently operated the application of a simple parity rule (such as the Baumol-Willig rule) may lead to suboptimal results. It is then easy to realise that as long as a competitor needs to use the incumbent's facility differentially from the reverse process, their interaction needs to incorporate some regulation (at least to keep it at a fair level), as argued by Waterson (1994).

¹⁵ This is true in the absence of access pricing where the general welfare implication is that competition for low-demand customers or by inefficient entrants should not be allowed (a problem that does not arise in the presence of vertical issues).

APPENDIX

In what follows we will first show how it is possible to refine the model of assumptions (i)-(v) in order to have a single optimal scale of entry chosen by the potential competitor at stage (2) of our game. Clearly, this first drawback is more apparent than real. In fact, we can easily demonstrate the following propositions.

Proposition 3

If we leave unchanged all the other assumptions and allow the potential competitor to choose any finite number of customers as her scale of entry -that is, $0 \leq k \leq K$ - in stage (2) the solution of the game will not change.

Proof of Proposition 3

Entry is still not optimal for a less efficient competitor. In fact, for any possible scale of entry (given $c^* < m$) the per customer access charge that allows entry is less than the gross profits the incumbent can obtain from the monopolist tariffs T_L and T_H . Thus, the per customer access charge will be greater than the competitor's gross profits and consequently entry would not take place.

On the other hand, for a more efficient competitor the entrant has a per customer gross profit advantage, which is given, and reaches its maximum value if she serves the H type. Hence, for the incumbent it is optimal not only to have cream skimming, but also to oblige an efficient competitor to maximise the scale of entry, setting k equal to K . This can be done decreasing (by a small amount ϵ , very close to zero) the per customer access charge associated with the maximum scale of entry. Hence, as before we end up with $k_H = k = K$.

Let us now tackle the two drawback jointly showing that if we consider an increasing marginal cost for the competitor and allow her to choose any finite number of customers as her scale of entry -that is, $0 \leq k \leq K$ - at stage (2) of the game, we may have a unique solution of the game, but the purchasing solution due to the indivisibility of the number of customers will not disappear.

Let us change the initial assumption (iv) considering the specific case of a competitor that is more efficient than the incumbent only if she keeps himself relatively small; that is, she doesn't preempt either of the two types' markets for good 1.

(iv)' the competitor can choose any *scale of entry* $0 \leq k \leq K$ in terms of number of customers:

$$k = K_L + K_H < N \quad K=1,2, \dots, N$$

She must pay an access charge F fixed by the incumbent dependent both on the scale of entry K and on the total output Q^e :

$$F(K_L, K_H, Q^e) \geq 0$$

Finally, she has an increasing production cost function:

$$C^e(k, Q^e) = m(k) Q^e$$

where $m(k)$ represents a continuously differentiable marginal cost function (with respect to the scale of entry) that satisfies the following properties: (1) it is increasing with the scale of entry; (2) its initial value is lower than the incumbent's marginal cost; (3) it intersects the incumbent's marginal cost when the scale of entry is less than the number of customer of any type.

The competitor will enter the non monopolised good market if the usual participation constraint is satisfied:

$$[IR^e] \quad \pi^e(Q^e) = K_L(T_L^e - m Q_L^e) + K_H(T_H^e - m Q_H^e) - F(K_L, K_H, Q^e) \geq 0$$

With assumption (iv)' we have thus removed the two drawbacks and we can now state the following proposition, assuming, for simplicity's sake but with no loss of generality c^* equal to zero.

Proposition 4

Under assumptions (i), (ii), (iii), (iv)' and (v) allowing any finite discrete number of customers as scale of entry there is only cream skimming competition in the market of good 1 (the non monopolised commodity). It is optimal for the incumbent to allow entry, to set a per customer access charge equal to the monopoly variable and to maintain the previous monopoly pricing. The

incumbent also finds it optimal to oblige the competitor to behave as a surplus taker. However, it would be preferable for the incumbent (and for the maximisation of social welfare) that the competitor sells all the produced good 1 to the incumbent (reaching only break-even profits), so that the latter is able to resell it to the consumers, applying the monopoly tariffs.

Proof of Proposition 4

As before, we will only give a sketch of the proof of Proposition 4. Entry is optimal only when the competitor is more efficient -that is, for low marginal costs $m(k)$ less than c^* - being possible for the incumbent to set the per customer access charge greater than the gross profits he had obtained from the monopoly tariffs T_L and T_H . Thus, for any possible scale of entry, it is also in the incumbent's interest that the entrant has the greatest per customer gross profit advantage and this implies cream skimming competition and surplus taking behaviour.

Thus, the incumbent in order to maximise his profits subject to the entrant's participation constraint will ask her to pay exactly his gross profit and to set K in such a way to maximise her gross profits $K [T_H^e - m(K)q_H^e]$ minus the net surplus $K[T_H - c^*q_H]$ that he would have extracted from the K customers in the absence of competition. In reality, for K as a discrete variable we should require that the marginal gains connected to an unitary change of K starting from the optimal one \hat{K} be greater than the marginal losses.

The optimal internal solution for the entrant in the case in which the variable k could assume all continuous values would be reached when the losses due to the fact that she is no longer serving an additional H type customer equal the gains derived by the decrease in the marginal cost $m(K)$ upon the K residual customers; that is, $\hat{K} m'(\hat{K})q_H^e$. In practice, $m'(\hat{K})$ represents just the reduction in the entrant's marginal cost due to the decrease in one unit of customer $m(\hat{K}) - m(\hat{K} - 1)$, and is simply multiplied for the quantity sold; that is, $(\hat{K} - 1) q_H^e = Q^e$.

In any case, if (as it should be) the access charge F is equal to the entrant's gross profits $\hat{K} [T_H^e - m(\hat{K}) q_H^e]$ the access pricing condition (needed in order to solve the incumbent's maximisation problem) is practically the same as [AP] used in [Problem 5], once we set K and m respectively equal to \hat{K} and $m(\hat{K})$:

$$[AP]' \quad F(\hat{K}) = \hat{K} [T_H^e - m(\hat{K}) q_H^e] = \hat{K} [\theta u(q_H^e) - (\theta - 1) u(q_L^e) - m(\hat{K}) q_H^e]$$

Thus, the incumbent, solving the maximisation problem [Problem 5] will obtain the very same monopoly first order conditions with respect to $q^e q_L$ and q_H , as derived in the previous analysis. As before, the competitor will enter in stage 2 knowing she will break even by serving the H type only. Thus, we can assume that she will enter and do cream skimming. In stage (1) of the game the incumbent, as already argued, cannot do better than to oblige the competitor to maximise her gross profits (behaving as a surplus taker) by setting the access charge tariff equal to the entrant's gross profits $\hat{K} [T_H^e - m(\hat{K}) q_H^e]$. As before, the fact that the competitor's marginal price p_H^e is less than the incumbent's one p_H implies a surplus loss -which amounts to the integral of $\hat{K} [\theta u'(q) - u'(q_H)]$ for q that goes from q_H to q_H^e for the incumbent and the society. If the marginal units $\hat{K} (q_H^e - q_H)$ were purchased by the incumbent at their marginal cost $m(\hat{K})$ and then sold as inframarginal units to the high-demand customers (or even to the low-demand ones) there would be no longer any surplus loss. We believe that no further comments are needed, as these refinements add more complications than fundamental economic contents.

Proof of Proposition 6

Given our simplified assumptions about the cost function, we will simply verify that at the end the downstream incumbent's and the entrant's incentive compatibility constraints are satisfied by the solution of the game. Furthermore, in order to simplify matters and to allow for the comparison of the two cases with or without vertical separation we will just build up the solution of the incumbent's problem obtained in the proof of proposition 4.

In fact, the best that the upstream incumbent can do (following proposition 5) is to set the access charge tariff $F^e = \hat{F}$ equal to the entrant's gross profits $\hat{K} [T_H^e - m(\hat{K})q_H^e]$ and the per customer tariff for the downstream incumbent equal to the incumbent's gross profits $T^j - c^*q^j$ for each type of customer. In fact, in this way the total profit of the industry is maximised and fully

expropriated. This is possible in two special settings:

- 1) when it is possible for a downstream producer to resell access rights;
- 2) the general access charge tariff $F(N_L^j, N_H^j, q_L^j, q_H^j)$ depends in a separate way upon the consumption bundles (q_L^j, q_H^j) of the two customers' types and not just on the aggregate consumption Q^j .

In what follows we will examine the two cases in a separate way. Let us start from the first one. Here the upstream monopolist can exploit one of the downstream producers in order to impose total price discrimination. In fact, denoting by π^j the downstream producer's gross profits (as before) he can simply set the following tariff function:

$$F(N_L^j, N_H^j, Q^j) = \max \Sigma \pi^j \quad \text{for } N_L^j = N; N_H^j = N - \hat{K} \text{ and } Q^j = Nq_L + (N - \hat{K})q_H + \hat{K} q_H^e$$

$$= \max (\pi^j + \varepsilon) \quad \text{elsewhere for } j = i, e \text{ and } \varepsilon > 0$$

Clearly, then no downstream producers can break even if he (or she) picks up separately his (or her) own offer. The downstream incumbent can break even only if he buys the access for $N_L = N$ and $N_H = N - \hat{K}$ customers and produces the monopoly bundles q_L and q_H , and finally the downstream entrant breaks even only if she buys the access for $N_H = \hat{K}$ and behaves as a surplus taker.

Let us turn now to case (2) where we have a general access charge tariff $F(n_L, n_H, c_L, c_H)$ function of the consumption bundles in a separate way.

In this case the upstream monopolist will adopt the following tariff function:

$$F(N_L^j, N_H^j, q_L^j, q_H^j) = \pi^m \quad \text{for } N_L^j = N, N_H^j = N - \hat{K}, q_L^j = q_L^m, q_H^j = q_H^m$$

$$= \pi^e \quad \text{for } N_L^j = 0, N_H^j = \hat{K}, q_L^j = q_L^e, q_H^j = q_H^e$$

$$= \max (\pi^j + \varepsilon) \quad \text{elsewhere, for } j = i, e \text{ and } \varepsilon > 0$$

Clearly then each one of the two downstream producers can break even if he (or she) picks up his (or her) own offer; while the incumbent can break even only if he buys the access for $N_L = N$ and $N_H = N - \hat{K}$ customers and produces the monopoly bundles q_L^m and q_H^m , finally the downstream entrant breaks even only if she buys the access for $N_H = \hat{K}$ customers and behaves as a surplus-taker.

References

- Armstrong, M. and C. Doyle (1994) "Access pricing, entry and the Baumol-Willig rule", Discussion Paper in Economics and Econometrics, University of Southampton, n. 9422.
- Baumol, W. (1983) "Some subtle pricing issue in railroad regulation", *International Journal of Transport Economics*, 10, 341-55.
- Baumol, W. and G. Sidak (1994) *TOWARD COMPETITION IN LOCAL TELEPHONY*, MIT Press, Cambridge.
- Baron, D. and R. Myerson (1982) "Regulating a monopolist with unknown costs", *Econometrica*, 50, 911-30.
- Cave, M. (1994) "The role and effectiveness of network access regulation", mimeo, Brunel University.
- Laffont, J. and J. Tirole (1986) "Using cost observation to regulate firms", *Journal of Political Economy*, 94, 614-41.
- Laffont, J. and J. Tirole (1990a) "The regulation of multiproduct firms I and II", *Journal of Public Economics*, 43, 1-66.
- Laffont, J. and J. Tirole (1990b) "Optimal bypass and creamskimming", *American Economic Review*, 80, 1042-1061.
- Laffont, J. and J. Tirole (1993) *A THEORY OF INCENTIVES IN PROCUREMENT AND REGULATION*, MIT Press, Cambridge.
- Laffont, J. and J. Tirole (1994) "Access pricing and competition", *European Economic Review*, 38, 1673-1710.
- Loeb, M. and W. Magat (1979) "A decentralized method of utility regulation", *Journal of Law and Economics*, 22, 399-404.
- Tye, M. (1984) "Some subtle pricing issue in railroad regulation: Comment", *International Journal of Transport Economics*, 11, 2-3, 207-16.
- Vagliasindi, M. (1994) *NON-LINEAR PRICING, REGULATION AND COMPETITION*, M.Phil Thesis, Oxford.
- Vagliasindi, M. and M. Waterson (1995) "Access and cream skimming in network industries", *Warwick Economic Research Paper*, University of Warwick, 9508.
- Vickers, J. (1995) "Competition and regulation in vertically related markets", *Review of Economic Studies*, 62, 1-17.
- Waterson, M. (1984) *THE ECONOMIC THEORY OF THE INDUSTRY*, Cambridge University Press, Cambridge.
- Waterson, M. (1994) "The future for utility regulation", in Corry, D.; Souter, D. and M. Waterson (eds.), *REGULATING OUR UTILITIES*, Institute for Public Policy Research, 104-30.