On the irrelevance of input prices from a regulatory perspective

Markos Tselekounis[a,†], Dimitris Varoutas[a], Drakoulis Martakos[a]

[a]National and Kapodistrian University of Athens, Greece

[†]Corresponding author: Department of Informatics and Telecommunications, National and Kapodistrian University of Athens, Panepistimiopolis, Ilissia, Athens, 15784, Greece, Tel.: +30 6942 467 887
E-mail address: markos@di.uoa.gr

ABSTRACT

The 1996 Telecommunications Act requires incumbent providers to lease network inputs to rivals at cost-based prices in order to secure lower prices and higher quality services through service-based competition. Once service-based competition has been established, the Act aims at promoting investment in alternative network infrastructures through facilities-based competition. Hence, access (input) price regulation aims at both securing service-based competition and promoting facilities-based competition. Sappington (Sappington, D. (2005). *American Economic Review*, 95(5), 1631-1638) uses the standard Hotelling model to show that input prices are irrelevant for an entrant's decision to make or buy an essential input for downstream production. Hence, he shows that input price regulation is not an efficient instrument to promote facilities-based competition. We show that input prices are also irrelevant for the maximization of social welfare and, as a result, input price regulation is also an inefficient instrument to secure service-based competition. Therefore, input prices are irrelevant from the regulatory perspective. In particular, we show that the efficient make-or-buy decision undertaken by an entrant is always socially optimal. Hence, when the entrant prefers to make the upstream input, both regulator's goals are fulfilled, whereas when the entrant prefers to buy the upstream input from the incumbent, the regulator fails to promote facilities-based competition.

1. Introduction

The Telecommunications Act of 1996 authorized new suppliers (entrants) of telecommunications services to have access to incumbent suppliers' key network elements at cost-based prices.[1] The purpose of this policy is "to promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies". Hence, the ultimate goal of this unbundling policy is twofold. First, it aims at inducing service-based competition in the downstream (retail) market which leads to lower prices, higher quality and higher social welfare. Second, once service-based competition has been established, it aims at promoting facility-based competition which leads to innovation and market growth. Service-based competition requires mandated access to the incumbent network, whereas facility-based competition requires investment in network infrastructure by incumbents and, especially, entrants.

The optimal access price that maximizes social welfare and promotes network investment is still an open issue. Existing studies on regulation and investment, mainly in broadband market, examine this issue from both theoretical and empirical perspective.[2]

Jorde, Sidak and Teece (2000) examine the impact of access price on total investment incentives. They show that regulating access prices based on TELRIC (Total Element Long-Run Incremental Cost) methodology discourages incumbents to invest and encourages entrants to deviate from socially optimal investment level and to delay entry. Ingraham and Sidak (2003) confirm empirically the result of Jorde, Sidak and Teece (2000). In addition, Friederiszick, Grajek and Roller (2008) study the correlation between unbundling and investment in 25 European countries for the period 1997-2006 and find that unbundling discourages infrastructure investment by entrants in fixed-line telecommunications but does not affect substantially the incumbent's investment in fixed-line services.

Vareda (2007) studies the effect of access price regulation on the incumbent's incentives to invest. He shows that unbundling may lower the incumbent's incentives to invest in quality upgrades but it also raises the incentives in cost-reduction investment. Hence, the aggregate effect of access price regulation on incumbent's incentives to invest is doubtful.

Another set of papers addresses and analyzes the effect of access price regulation on entrants' incentives to invest in alternative infrastructures. Crandall, Ingraham and Singer (2004) conclude that unbundling decreases facilities-based competition in the short term. However, they point out that their model cannot rule out the possibility that low UNE (unbundled network elements) rates encourage the entrants to rent at first, and then build facilities once they have some market experience. Cave and Vogelsang (2003), based on the fact that entrants will typically invest in replicable assets first and then progress to less replicable ones, suggest that at the initial stage of competition the access price for the less replicable network elements should be low but increasing over time as assets are

[1] See Armstrong (2002) and Valletti and Estache (1998) for an excellent and extensive review of the literature on access pricing.

[2] See (Cambini and Jiang, 2009) for an excellent and extensive review of the literature on broadband investment and regulation.

replicated. This theory is widely known as "ladder of investment". Avenali, Matteucci and Reverberi (2008) argue for the efficiency of an access price that rises over time for fostering investment by new entrants. Using a simulation model, Christodoulou and Vlahos (2001) show that a "mix" of infrastructure and service competition with a gradually increasing price of the UNE from an initially low level to forward-looking costs stimulates investment by both incumbents and entrants.

From the above studies we infer that, although there is a great controversy about the effect of access regulation on investment incentives, most researchers agree that an access price too low may deter investment in alternative networks and an access price too high would discourage entrants from joining service-based competition. Hence, the regulatory policy should reflect the trade-off between the short-run benefits from service-based competition and long-run benefits of improved facility-based competition.

However, Sappington (2005) shows that input prices are irrelevant for an entrant's decision to make or buy an input required for downstream production. This result is striking since it negates most of the above studies. He uses the standard Hotelling model of competition to compare the new entrant's profits when it purchases an essential upstream input from the incumbent and when it makes the upstream input itself. He concludes that "the entrant undertakes the efficient make-or-buy decision if it purchases the upstream input from the incumbent whenever the incumbent is the least-cost supplier of the input, and produces the upstream input itself whenever it is the least-cost supplier of the input". In other words, the entrant compares its cost and the incumbent's cost of making the input in order to undertake the efficient make-or-buy decision. Hence, the actual level of input prices is irrelevant. According to Sappington, the reason of this striking result is that previous studies fail to take into account the impact of a new entrant's make-or-buy decision on subsequent retail price competition. After Sappington's suggestion, Gayle and Weisman (2007) consider alternative downstream interactions and show that input prices are not necessarily irrelevant in the Bertrand vertical differentiation model and are not irrelevant in the Cournot model.

As we have already mentioned above, the regulator aims at setting the access price that not only maximizes social welfare but also induces investment in alternative networks. Sappington (2005) studies the effect of input prices on the entrant's incentives to make the upstream input. In this paper, we complement Sappington's result by studying the effect of input prices on social welfare. Like Sappington, we use the standard Hotelling model and show that input prices are irrelevant for the regulator's goal to maximize social welfare. In particular, we show that when the incumbent (entrant) is the least-cost supplier of the input, social welfare is maximized when the entrant decides to buy (make) the input. Therefore, the efficient make-or-buy decision undertaken by the entrant maximizes social welfare.[3]

This indifference result is also striking because it proves that input prices affect neither service-based nor facilities-based competition.[4] In addition, we show that the

[3] Shim and Oh (2006) also state that the level of the input price does not affect the entrant's profits and the total social surplus. However, they do not combine this result with the entrant's efficient make-or-buy decision.

[4] It should be noted that the irrelevance of input prices on social welfare is sensitive to the particular model of competition employed.

efficient make-or-buy decision undertaken by the entrant is always socially optimal. Therefore, although it seems that access price regulation is an inefficient instrument of fulfilling the regulator's twofold goal, it always succeeds in maximizing social welfare.

The rest of the paper is organized as follows. Section 2 gives an outline of the basic assumptions and definitions of our model. Section 3 presents the main findings of this paper. The last section summarizes the key findings and makes regulatory implications.

2. Assumptions and definitions

We consider a duopoly case where there are two suppliers whose final services are differentiated á la Hotelling (1929). The two rivals are located at the two extremities of the market. The incumbent is located at point $L_i = 0$ and the entrant is located at point $L_e = 1$. *N* consumers are uniformly distributed on the unit interval [0,1]. Consumers are endowed with utility $U_L(L_j, P_j) = v - P_j - t(L_j - L)$. Consumer utility U_L has a peak where the consumer's location *L* and the firm's location coincide. The term $t(L_j - L)$ can be interpreted as the linear transportation (disutility) cost which the consumer located at point $L \in [0,1]$ incurs through the distance of transport. $v > 0$ can be interpreted as the reservation price and it is assumed that it exceeds the sum of price and transport cost in order to assure that each consumer buys one unit of the final service. P_j $(j = i, e)$ represents the price at which each provider supplies its final service.

Each unit of the downstream service requires one unit of an upstream input and one unit of the downstream input. Each firm supplies its own downstream input. The unit costs of producing the downstream input are c_d^I and c_d^E for the incumbent and the entrant, respectively. The incumbent's and entrant's unit costs of producing the upstream input are denoted by c_u^I and c_u^E, respectively. Without loss of generality, we further assume that the unit cost of producing the downstream input is the same for the two retailers and is set to zero.

The price at which the entrant can purchase the upstream input from the incumbent is denoted by *w*. The regulator sets the input (access) price that maximizes social welfare. Then the entrant decides whether it will buy the upstream input from the incumbent or produce it itself. Once the entrant has made its efficient make-or-buy decision, the providers choose their retail prices that maximize their profits. Finally, consumers make their purchase decisions.

3. Findings

In this section we estimate the input price that maximizes social welfare (*SW*) defined as the unweighted sum of profits and consumer surplus. We use the backward induction method to solve this problem. Equilibrium prices (*p*), output levels (*Q*), profits (*Π*), consumer surplus (*CS*) and social welfare (*SW*) are as characterized in Lemmas 1 and 2. Prices, outputs and profits for the incumbent and the entrant are denoted by the superscript *I* and *E*, respectively. The subscript *M* (respectively, *B*) denotes prices,

outputs, profits, consumer surplus and social welfare following the entrant's decision to make (respectively, buy) the upstream input.

LEMMA 1: *If the entrant chooses to produce the upstream input itself, equilibrium retail prices, outputs, profits, consumer surplus and social welfare are (for* $i, j = I, E, i \neq j$ *):*

(1) $$P_M^i = t + \frac{2c_u^i + c_u^j}{3}$$

(2) $$Q_M^i = N[\frac{1}{2}(1 + \frac{c_u^j - c_u^i}{3t})]$$

(3) $$\Pi_M^i = N[\frac{(3t - c_u^i + c_u^j)^2}{18t}]$$

(4) $$CS_M = N[v - \frac{5}{4}t - \frac{c_u^I + c_u^E}{2} + \frac{(c_u^I - c_u^E)^2}{36t}]$$

(5) $$SW_M = N[v - \frac{1}{4}t - \frac{c_u^I + c_u^E}{2} + \frac{5(c_u^I - c_u^E)^2}{36t}]$$

LEMMA 2: *If the entrant chooses to buy the upstream input from the incumbent, equilibrium retail prices, outputs, profits, consumer surplus and social welfare are (for* $i, j = I, E, i \neq j$ *):*

(6) $$P_B^i = w + t$$

(7) $$Q_B^i = N\frac{1}{2}$$

(8) $$\Pi_B^I = N(\frac{t}{2} + w - c_u^I)$$

(9) $$\Pi_B^E = N\frac{t}{2}$$

(10) $$CS_B = N(v - w - \frac{5}{4}t)$$

(11) $$SW_B = N(v - c_u^I - \frac{1}{4}t)$$

Sappington (2005) discusses the entrant's efficient make-or-buy decision by comparing equations (3) and (9). His main finding is stated in proposition 1:

PROPOSITION 1 (Sappington): *Regardless of the established price (w) of the upstream input: (a) the entrant prefers to buy the upstream input from the incumbent when the incumbent is the least-cost supplier of the input (i.e.* $\Pi_B^E > \Pi_M^E$ if $c_u^{\mathrm{I}} < c_u^{\mathrm{E}}$*) and (b) the entrant prefers to make the upstream input itself when it is the least-cost supplier of the input (i.e.* $\Pi_{\mathrm{M}}^E > \Pi_{\mathrm{B}}^E$ if $c_u^{\mathrm{E}} < c_u^{\mathrm{I}}$*).*

From proposition 1 we infer that input prices are irrelevant for the entrant's make-or-buy decision. Furthermore, from (11) we infer that input prices do not have an impact on social welfare. Hence, input prices are irrelevant not only for the entrant's make-or-buy decision, but also for the regulator's goal to maximize social welfare. The reason is that a marginal change in input price causes a unit increase in incumbent's profits and a unit decrease in consumer surplus. As social welfare is the unweighted sum of profits and consumer surplus, it is thus not affected by a marginal change in input prices.

It is of high interest to examine the impact of the entrant's efficient make-or-buy decision on social welfare. When the entrant prefers to make the upstream input itself, social welfare is given by (5) and when the entrant prefers to buy the upstream input from the incumbent, social welfare is given by (11). By comparing (5) and (11), we can state the following proposition:

PROPOSITION 2: *Regardless of the established price (w) of the upstream input: (a) the society prefers the entrant to buy the upstream input from the incumbent when the incumbent is the least-cost supplier of the input (i.e.* $SW_B > SW_M$ if $c_u^{\mathrm{I}} < c_u^{\mathrm{E}}$*) and (b) the society prefers the entrant to make the upstream input itself when it is the least-cost supplier of the input (i.e.* $SW_M > SW_B$ if $c_u^{\mathrm{E}} < c_u^{\mathrm{I}}$*).*

From Proposition 1 and 2, we infer that if $c_u^{\mathrm{I}} < c_u^{\mathrm{E}}$ both the entrant's profits and social welfare are maximized when the entrant chooses to buy the upstream input from the incumbent and if $c_u^{\mathrm{E}} < c_u^{\mathrm{I}}$ both the entrant's profits and social welfare are maximized when the entrant chooses to make the upstream input itself. Hence, the maximization of social welfare is in line with the entrant's efficient make-or-buy decision.

PROPOSITION 3: *The efficient make-or-buy decision undertaken by the entrant is always socially optimal.*

Proposition 3 presents another very significant finding: although access price regulation neither affects the efficient make-or-buy decision undertaken by the entrant nor the social welfare, the regulator always succeeds in fulfilling the maximization of social welfare. When $c_u^{\mathrm{E}} < c_u^{\mathrm{I}}$ the entrant chooses to make the upstream input and as a result it invests in alternative infrastructure, which is socially optimal. In this case, the regulator's twofold aim is fulfilled and the trade-off between service-based and facility-based competition disappears. On the contrary, when $c_u^{\mathrm{I}} < c_u^{\mathrm{E}}$ the entrant chooses to buy the upstream input from the incumbent, which is also socially optimal. In this case, the society only enjoys the short-run benefits from service-based competition.

However, from (8) and (10) we infer that when the entrant chooses to buy the input, access price regulation affects both the incumbent's profits and consumer surplus. In particular, there is a transfer of money from consumers to incumbent, which equals the input price. Hence, the entrant passes on the cost of buying the input to consumers. If the regulator's priority is to maximize consumers' utility, it should set the input price to zero. Alternatively, if the regulator can bind the incumbent to invest its extra profits from the upstream market to network facilities, it may set the access price to a level equal or below CS_B. The latter policy induces investments in network infrastructures by the incumbent but does not provide incentives for facilities-based competition. The reason is that the incumbent's unit cost of producing the upstream input is expected to decrease and as a result the entrant will find it profitable to buy the input from the incumbent. Another alternative is that the regulator sets a positive input price that allows the incumbent to recover the fixed costs that typically incurs in practice. In each case, the regulator's priority does not affect social welfare and the entrant's profits, but only consumer surplus and the incumbent's profits.

4. Conclusions

The primary objective of this paper was to examine whether input prices are irrelevant from regulatory point of view. The ultimate goal of regulators is to maximize social welfare and to promote investments in alternative infrastructures (especially by entrants, in order to induce facilities-based competition). Sappington (2005) uses the Hotelling model to show that input prices are irrelevant for an entrant's decision to make or buy an upstream input required for downstream production. Using the same model, we showed that input prices are also irrelevant for the maximization of social welfare. By combining Sappington's results with ours, we have concluded that input prices are irrelevant from the regulatory point of view.

Another interesting result was that the entrant's efficient make-or-buy decision is always socially optimal. In other words, the entrant's efficient decision always maximizes social welfare. Therefore, when the entrant prefers to make the upstream input itself, both regulatory goals are fulfilled. This result is very significant because the regulator succeeds in fulfilling its goals without affecting either the entrant's efficient make-or-buy decision or the social welfare. However, when the entrant prefers to buy the upstream input from the incumbent, the regulator's goal to promote facilities-based competition cannot be fulfilled.

In addition, we showed that, although input prices are irrelevant for make-or-buy decisions and for the maximization of social welfare, it can be used by the regulator in order to fulfill other goals, such as the maximization of consumer surplus, the promotion of investments by the incumbents and the recovery of the fixed cost that the incumbents typically incur in practice.

The main implication from this article is that regulators should perceive the particular model that characterizes the retail competition between the providers in order to forecast the impact of access price regulation on providers' strategies and consumers' utility, which in turn affect the fulfillment of regulators' goals.

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Appendix

Proof of Lemma 1

Let $\hat{L} \in [0,1]$ denote the location of the consumer that is indifferent between purchasing from the incumbent and the entrant when the entrant chooses to make the upstream input. See Sappington (2005) for equations (1) to (3) and the equation that gives the location of the indifferent consumer. Consumer surplus is given by

$$\text{(A1)} \quad CS = N\{\int_0^{\hat{L}} [v - P_1 - t(L-0)]dL + \int_{\hat{L}}^1 [v - P_2 - t(1-L)]dL\} \Rightarrow$$

$$\text{(A2)} \quad CS = N[v - \frac{t}{2} + \hat{L}(P_2 - P_1) - P_2 + t\hat{L}(1-\hat{L})]$$

Substituting (1) in (A2) provides:

$$\text{(A3)} \quad CS_{\text{M}} = N[v - \frac{5}{4}t - \frac{c_u^I + c_u^{\text{E}}}{2} + \frac{(c_u^I - c_u^{\text{E}})^2}{36t}]$$

Social welfare is the sum of both providers' profits and consumer surplus.

Proof of Lemma 2

See Sappington (2005) for equations (6) to (9) and the equation that gives the location of the indifferent consumer when the entrant chooses to buy the upstream input from the incumbent. Substituting (6) in (A2) provides the consumer surplus when the entrant chooses to buy the upstream input from the incumbent.

$$\text{(A4)} \quad CS_B = N(v - w - \frac{5}{4}t)$$

Social welfare is the sum of both providers' profits and consumer surplus.

Proof of Proposition 1

See Sappington (2005).

Proof of Proposition 2

From equations (5) and (11) in the text:

(A5) $SW_M >=< SW_B$

(A6) $N[v - \frac{1}{4}t - \frac{c_u^I + c_u^{\mathrm{E}}}{2} + \frac{5(c_u^I - c_u^{\mathrm{E}})^2}{36t}] >=< N(v - c_u^I - \frac{1}{4}t)$

(A7) $\frac{(c_u^{\mathrm{E}} - c_u^I)}{2}[\frac{5(c_u^{\mathrm{E}} - c_u^I)}{18t} - 1] >=< 0$

Like Sappington (2005), we assume that both the incumbent and entrant serve retail consumers in equilibrium. Hence, $\left|c_u^j - c_u^i\right| < 3t$ (*for* $i, j = I, E, i \neq j$). From (A7) we infer that:

a. if $c_u^{\mathrm{E}} = c_u^I$, then $SW_M = SW_B$
b. if $c_u^{\mathrm{E}} > c_u^I$, then $SW_M < SW_B$
c. if $c_u^{\mathrm{E}} < c_u^I$, then $SW_M > SW_B$

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