Maria Paula Vicente Sarmento[1]

VERTICAL SEPARATION AND ACCESS PRICING: EFFECTS ON INVESTMENT INCENTIVES

The paper explores the impact of vertical separation on the incentive to invest in network upgrade when there is competition between a subsidiary firm and an independent firm at the downstream market. The issue is discussed under the two alternative regimes concerning the price of the vital input sold by the upstream firm: cost orientation regulation and absence of access price regulation. The study demonstrates that the investment incentive decreases with vertical separation under both regimes. However, it is not always true that investment incentive is higher without regulation.

Keywords: *vertical integration; vertical separation; investment incentives; access price regulation.*
JEL classification: L51; L96.

Марія Паула Віченте Сарменто

ВЕРТИКАЛЬНИЙ РОЗПОДІЛ ТА ЦІНА ВХОДЖЕННЯ ДО МЕРЕЖЕВОЇ СТРУКТУРИ ЯК ІНВЕСТИЦІЙНІ СТИМУЛИ

У статті досліджено вплив вертикального розподілу на мотивацію до інвестування в межах мережі в умовах конкуренції між мережевим підрядником та незалежною фірмою. Описано два альтернативних режими ціноутворення від головної фірми мережі – з регулюванням ціни та без нього. Показано, що мотивація до інвестування знижується в умовах вертикального розподілу за обох режимів. Проте доведено, що обсяги інвестування не завжди більші за відсутності регулятора.

Ключові слова: *вертикальна інтеграція; вертикальний розподіл; мотивація до інвестування; регулювання ціни входження.*
Форм. 14. Рис. 3. Літ. 37.

Мария Паула Виченте Сарменто

ВЕРТИКАЛЬНОЕ РАЗДЕЛЕНИЕ И ЦЕНА ВХОЖДЕНИЯ В СЕТЕВУЮ СТРУКТУРУ КАК ИНВЕСТИЦИОННЫЕ СТИМУЛЫ

В статье исследовано влияние вертикального разделения на мотивацию инвестирования в рамках сети в условиях конкуренции между сетевым подрядчиком и независимой фирмой. Описаны два альтернативных режима ценообразования от главной фирмы сети – с регулированием цены и без него. Показано, что мотивация к инвестированию снижается в условиях вертикального разделения при обоих режимах. В то же время доказано, что объёмы инвестирования не всегда больше при отсутствии регулятора.

Ключевые слова: *вертикальная интеграция; вертикальное разделение; мотивация к инвестированию; регулирование цены вхождения.*

1. Introduction. In network industries vertical separation is a crucial issue. In electricity, natural gas, railway, telecommunications or postal sectors, for example, there is an ongoing discussion on the degree of vertical separation between the firm that owns the network (typically the incumbent firm) and the firms that use the network to pursue their activity. Vertical separation concerns not only ownership but also, more subtly, the degree of firms' independence at decision levels. Firms that belong to the same vertical chain may have common ownership although they have some autonomy in decisions. In several network industries the degree of autonomy is

[1] University of Porto, Portugal.

imposed by regulatory authorities in order to create a level playing field in market segments where there is, or where regulatory authorities want to promote, competition. Some degree of decision autonomy corresponds to what we refer to as different degrees of vertical separation. Ownership separation is the strongest form of vertical separation. Legal, functional and accounting separation are lighter forms of vertical separation[2]. Vertical separation that involves some autonomy at the decision level typically is accompanied by the implementation of separate information systems and by employees training in order to respect "Chinese walls" built between business units, in order to prevent the discrimination of independent firms by the vertically integrated firm. In telecommunications, for example, most European countries had already implemented accounting separation. The UK introduced functional separation in 2006; Sweden and Italy have followed. In the electricity sector, after setting accounting unbundling of generation and retail stages from the network business (transmission and distribution), the European Commission required in 2003 legal unbundling in order to achieve competitive efficiency (Soares and Sarmento, 2012). In the postal sector, separating the delivery function from the upstream activities of acceptance, mail processing and transportation is in discussion both in the USA and Europe (Haldi and Olson, 2005).

A strong argument in favor of vertical separation is competition promotion by the creation of a level playing field in some market segments. Nevertheless, it is necessary to evaluate other effects of vertical separation in network industries, namely the impact on access price regulation, on sabotage, or on investment incentives.

This paper analyzes the effects of different degrees of vertical separation on network investment incentives comparing two regulatory policies regarding access price: regulation and no regulation. We follow Chikhladze and Mandy (2009) definition of vertical control which corresponds to our concept of vertical integration: "Vertical control means the extent to which the upstream monopolist can align the objective of its downstream affiliate with the objective of the overall firm". The extreme case of complete vertical integration occurs when the upstream firm has full control over subsidiary firms' decisions, while the extreme case of full vertical separation occurs when the subsidiary firm is completely autonomous in its decisions. Between these extremes remain all the cases where there are certain limitations on decisions' autonomy. Foros et al. (2007) also use a similar specification. However, differently from Chikhladze and Mandy (2009) and from us, Foros et al. (2007) assume that vertically integrated firm does not passively accommodate the regulatory policy on vertical separation.

There are other recent works that study the relationship between the degree of vertical separation and investment incentives. Pakula and Gotz (2010) and Cremer and Donder (2013) study the effects of different organizational structures on network operator's incentive to invest. Hoffler and Kranz (2011b) compare legal unbundling with complete vertical integration and full vertical separation. However, these authors build different models for each market structure. On the contrary, in the approach of Chikhladze and Mandy (2009), Foros et al. (2007) and ours, there is a unique model that integrates all the degrees of vertical separation. Under a different framework

[2] For a detailed description of the degrees of vertical separation in telecommunications see Cave (2006a). For a discussion on telecommunications and electricity sectors see Soares and Sarmento (2012).

Avenali et al. (2014) study how vertical separation (considering both functional and ownership separation) affect investment in network quality and social welfare.

Besides the above references our paper is also related to the literature on vertical integration, unbundling, access price regulation and investment incentives. Buehler et al. (2004) study the effects of vertical separation on investment incentives considering access price regulation. Rey and Tirole (2006) provide a survey on vertical integration and foreclosure, Guthrie (2006) offers a survey on infrastructure investment implications of different regulatory regimes. Cambini and Jiang (2009) provide a survey on the relationship between investment incentives and regulation applied to Internet broadband access. Foros (2004) and Kotakorpi (2006) analyze the effects of access price regulation on the incentive to invest considering vertical integration. Duarte et al. (2012) analyze the incentive of a vertically integrated firm to invest and to give access to a new and non-regulated wholesale technology.

When network access is a vital input to independent firms, the relationship between vertical separation and network investment incentives must be analyzed considering access price regulation. With vertical integration it is usual to find access price regulation, as it happens, for instance, with electricity or natural gas companies. Frequently access price regulation is an instrument to encourage the entry of new operators, increasing competition at the retail level and later on, after consolidation, new operators might be able to build their own networks, creating competition at the upstream level[3]. However, in the discussion of vertical separation arguments contesting access price regulation usually emerge. For instance, in 2005 Deutsch Telecom demanded the elimination of access price regulation when it announced its investment plans to build a new generation fiber optic network (Blum et al., 2007). Also, in the USA there has been some reduction in access price regulation in some telecommunications segments, as in broadband Internet access (Bauer, 2006). With the theoretical approach, Chikhladze and Mandy (2009) show that vertical separation and access price regulation might be complementary instruments of regulation.

To evaluate the effects of vertical separation on network investment incentives we consider two alternative regulatory regimes: one without regulation, where the upstream firm sets the input price in order to maximize its profits and one with regulation, where the regulator sets the access price. Access price regulation and intervention on vertical control are the tools used by regulation authorities, both in the USA and in many European countries, in telecommunication or electricity sectors, as documented by Chikhladze and Mandy (2009) and many other authors.

Our main conclusions regarding investment incentives are that, as expected, the investment incentive decreases with vertical separation, with or without access price regulation. Additionally, we conclude that it is possible to find situations where regulation leads to higher investment incentives than the absence of regulation. Hence, when analyzing the relationship between access price regulation and investment the regulatory authorities must consider the degree of vertical control they demand from vertically integrated firms.

The remainder of the paper is organized as follows: After the introduction, Section 2.1 presents the model; Section 2.2 describes the downstream market;

3 This is the argument of the Investment Ladder Theory (Cave and Volgelsang, 2003; Cave, 2006b).

Section 2.3 explains the regime without access price regulation; Section 2.4 presents the access price regulation regime; Section 2.5 compares these two regulatory regimes. Finally, Section 3 summarizes the conclusions.

2. The model.

2.1. Introduction. We consider an upstream monopoly (firm U) that sells network access to downstream firms (D_1 and D_2). The downstream market is an unregulated duopoly where firms compete for quantities of a homogenous product. The market structure is represented in Figure 1.

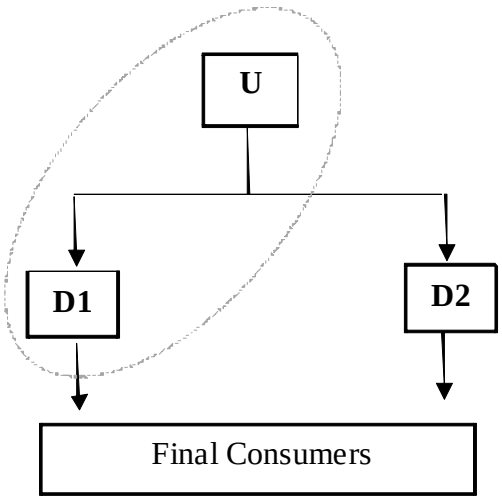


Figure 1. **Market structure,** *authors'*

The upstream monopolist undertakes an investment in network quality (denoted by I) that improves the service delivered by downstream firms and, therefore, increases the value that final consumers are willing to pay for the service. Applying this model to broadband Internet access, for example, we would say that investment increases communication speed and reliability, which are seen by consumers as important improvements in service quality, not only because they might have access to new services that require high speed (such as interactive audio and video), but also because conventional Internet services (web-browsing and e-mail) acquire greater value (Foros, 2004; Hausman et al., 2001). Then, with a better network there will be not only more consumption but also the attraction of new consumers. These features are represented in the model by a parallel shift in the retail market demand function represented by the linear function $p = 1 + \beta I - q_1 - q_2$, where p is the retail price, $\beta > 0$ represents the intensity of the investment effect on demand growth, I is the investment and q_1 and q_2 are the outputs of firms D_1 and D_2 respectively. We assume that the investment does not affect the slope of the demand but only its intercept[4].

The individual profit functions for each firm are as follows:

firm U: $\pi_U = (w - c)(q_1 + q_2) - I^2/2;$

[4] This assumption was also used by Sarmento and Brandao (2007).

firm D_1: $\pi_1 = (p - w)q_1$;

firm D_2: $\pi_2 = (p - w)q_2$,

where c is the constant marginal cost of the upstream activity (with $c < 1$)[5], w is the input price (with $w \geq c$) and $I^2 / 2$ is the investment cost. We assume that the cost of buying other inputs is equal for both downstream firms and normalized to zero. Also, we assume that to produce one unit of the final good it is necessary to use one unit of network access.

As firms U and D_1 belong to the same economic group their decisions do not depend exclusively on individual profit, but also depend on the degree of vertical control inside the group. We follow the methodology of Chikhladze and Mandy (2009) to define the objective functions for each firm. The upstream firm maximizes the joint profit from the upstream activity and the retail activity of its subsidiary firm D_1. However, as the upstream firm might not have full control over firm's D_1 decisions, the objective function of D_1 is a linear combination of individual profit and joint profit, where the parameter $\lambda \in (0,1)$ represents the degree of control. The objective functions for each firm are represented as follows:

firm I (integrated firm): $\Pi_I = (w - c)(q_1 + q_2) + (p - w)q_1 - I^2 / 2$;

firm D_1 (affiliated firm): $\Pi_A = \lambda(p - w)q_1 + (1 - \lambda)\left[(w - c)(q_1 + q_2) + (p - w)q_1 - I^2 / 2\right]$;

firm D_2 (independent firm): $\Pi_2 = (p - w)q_2$.

This model allows an integrated analysis of all the possible cases of vertical separation, from complete vertical integration to full vertical separation. Under complete vertical integration (represented by $\lambda = 0$) firms U and D_1 have the same objective function: both maximize the integrated profit; under full vertical separation (represented by $\lambda = 1$) firm U maximizes the integrated profit, while firm D_1 maximizes its individual profit from retail business. This last case happens when firm D_1, in spite of having a common ownership with firm U, runs its businesses in an independent way.

It is worthwhile emphasizing that, as in Chikhladze and Mandy (2009), the parameter λ represents vertical control, not ownership[6]. Also, Foros et al. (2007) use similar methodology to study vertical control. As mentioned, Hoffler and Kranz (2011b) study with separate models some market structures, which they labeled as vertical integration, ownership separation, legal unbundling and reverse legal unbundling. Vertical integration and reverse legal unbundling in the Hoffler and Kranz (2011b) framework correspond to our extreme cases of complete vertical integration ($\lambda = 0$) and full vertical separation ($\lambda = 1$), respectively. Our model goes a step further as it allows the study of intermediate cases ($0 < \lambda < 1$), which happens when the upstream firm maximizes the joint profit function and the downstream affiliate

[5] We assume that the investment does not change marginal costs c. Hoffler and Kranz (2011b), Sarmento and Brandao (2009) and Vareda (2010) consider a different approach as they assume that upstream investment reduces marginal costs.

[6] The parameter λ represents the degree of separation of control rights between U and D_1, but cash flow rights continue to belong to the economic group that owns both. Therefore, vertical separation in the discussion involves a separation of control rights and cash flow rights.

maximizes a linear combination of the joint profit and individual profit with variable weights (represented by λ).

In order to analyze the model we build a game with the following stages: at stage 1 the upstream firm decides on the investment amount I. At stage 2 there is a decision about the access price w. We consider two regulatory regimes: i) the upstream firm decides w in order to maximize its profits (no access price regulation regime) or ii) the regulatory authority decides the uniform access price with cost-orientation (access price regulation regime). Finally, at stage 3, firms D_1 and D_2 simultaneously decide on quantities a la Cournot[7].

The game is solved by backward induction and the equilibrium concept used is subgame perfection.

2.2. Downstream market. At the retail market firms D_1 and D_2 choose the quantities that maximize their objective functions (stage 3). The profit maximizing quantities, conditional on w, I and the parameters β, λ and c, are

$$q_1(w,I;\beta,\lambda,c)=\frac{1+\beta I+w-2c}{3}-2\lambda\frac{w-c}{3}$$

$$q_2(w,I;\beta,\lambda,c)=\frac{1+\beta I+c-2w}{3}+\lambda\frac{w-c}{3}.$$

From these expressions some important conclusions emerge. First, if the regulator sets $w = c$, the degree of vertical separation would have no effect on optimal quantities[8]. Therefore, we restrict our analysis to $w > c$, so that wholesale market revenues also cover part of investment costs. Second, for w > c and taking w as given, the affiliated firm D_1 produces more than the independent firm D_2, and this difference is increasing with w and decreasing with λ. These conclusions were already pointed out by Chikhladze and Mandy (2009) and Foros et al. (2007), and result from the affiliated firm's cost advantage when there is vertical control. In the extreme case of complete vertical control (λ = 0) the affiliated firm has marginal cost of c while firm D_2 has marginal cost of w. With full vertical separation (λ = 1), both downstream firms have marginal cost equal to w and, therefore, they produce equal quantities. In the intermediate cases (0 < λ < 1) firm D_2 has marginal cost equal to w while the affiliated firm has marginal cost equal to $\lambda w + (1 - \lambda)\, c$. The difference between marginal costs, which results from partial elimination of double marginalization, is decreasing with λ. Third, taking w and I as given, the total quantity is decreasing with λ. This means that with full vertical control the total quantity offer at the market is higher, and this is due to partial elimination of double marginalization, as firm D_1 has marginal cost of c. Only firm D_2 has two margins because $w > c$.

2.3. Absence of Access Price Regulation. Firm U chooses the access price that maximizes its objective function, which is

$$w^{noreg}(I;\beta,\lambda,c)=\frac{5(1+\beta I+c)-\lambda(1+\beta I+c)+4c\lambda^2}{10-4\lambda+4\lambda^2}.$$

[7] The assumption of Cournot competition is based on Kreps and Scheinkman (1983) result which proves that under certain conditions the Cournot outcome is the same as the outcome of a sequential decision process, where firms firstly choose capacity and secondly decide on prices. Also, it is justified by the fact that retail firms face capacity constraints.

[8] This result was already pointed out by Chikhladze and Mandy (2009).

Here it is important to note that with some vertical separation (ie, with $\lambda > 0$) firm D_2 is not foreclosed as it happens with vertical integration. With $\lambda = 0$ (full vertical integration), the value of w that maximizes U's objective function $(w(I;\beta,I,c)=\frac{1+\beta I+c}{2})$ does not allow a positive profit for firm 2 (this is a well known result from the vertical integration literature). When $\lambda > 0$ firm's D_2 profit is given by $\pi_2(I;\beta,I,c)=\frac{1}{4}\lambda^2(1+\lambda)^2\frac{(1+\beta I-c)^2}{(2\lambda^2-2\lambda+5)^2}$.

Considering the investment decision (stage 1) and using the above access price $w^{noreg}(I;\beta,I,c)$ the investment amount that maximizes U's objective function is $I^{noreg}(\beta,\lambda,c)=\frac{\beta(1-c)(5-2\lambda+\lambda^2)}{x}$, with $x=10-4\lambda-5\beta^2+4\lambda^2-\beta^2\lambda^2+2\beta^2\lambda$.

In order to ensure that the optimal investment is positive for all possible values of λ, we restrict our analysis to $\beta<\sqrt{2}$.

Assumption 1: Assume $\beta<\sqrt{2}$.

This constraint on the parameter that represents the effect of investment on demand is necessary as we consider that investment cost increases exponentially while the benefit of the investment is linear. Proposition 1 summarizes the main conclusion about investment incentive.

Proposition 1: Without access price regulation the incentive to invest decreases with vertical separation.

From the expression of $I^{noreg}(\beta,\lambda,c)$ we conclude that profit maximizing investment is decreasing with vertical separation. It is important to mention that this result is consistent with the main conclusions of Buehler et al. (2004). The intuitive explanation is as follows: if the integrated firm exerts a tight control over the decisions of its subsidiary (small λ) it can highly benefit from the investment. If, on the contrary, the upstream firm does not have a high vertical control on subsidiary's decisions, this firm follows individual objectives that damage integrated profits.

From the optimal investment value and by substitution we calculate the equilibrium values of the access price (w^{noreg}) and quantities (q_1^{noreg}, q_2^{noreg}):

$$w^{noreg}(\beta,\lambda,c)=\frac{c(\beta^2-4)\lambda^2+(1+3c-2c\beta^2)\lambda-5(1+c-c\beta^2)}{x};$$

$$q_1^{noreg}(\beta,\lambda,c)=\frac{(1-c)(2\lambda^2-5\lambda+5)}{x};$$

$$q_2^{noreg}(\beta,\lambda,c)=\frac{\lambda(1+\lambda)(1-c)}{x}.$$

Notice that under assumption 1 the access price without regulation is above the marginal cost c for all values of λ.

From these expressions it is straight forward to verify that the output of the subsidiary firm $q_1^{noreg}(\beta,\lambda,c)$ is decreasing with vertical separation. This is the expected result since with an increase in vertical separation the real costs of the downstream

firms get closer. Following this reasoning we could expect that the independent firm's output $q_2^{noreg}(\beta,\lambda,c)$ increases with vertical separation, however, this does not happen when β and λ are relatively high (more precisely, when $\beta > 1.354$ and $\lambda > \lambda_1$ with

$$\lambda_1 = \frac{5\beta^2 - \sqrt{10}\sqrt{18 - 17\beta^2 + 4\beta^4} + 10}{3\beta^2 - 8}).$$

This result is due to the effect of vertical separation on demand, through the investment. With a high degree of vertical separation there is a low incentive to invest, that affects negatively the demand growth and so the independent firm's output. Therefore, there is a tradeoff regarding the effects of vertical separation on $q_2^{noreg}(\beta,\lambda,c)$. When the investment effect on demand is strong $q_2^{noreg}(\beta,\lambda,c)$ decreases but, in the opposite case, the effect of vertical separation on the creation of a level playing field dominates and $q_2^{noreg}(\beta,\lambda,c)$ increases. The effect of vertical separation on demand through investment also exists for the quantity of the subsidiary firm. However, this effect goes in the same direction as the first effect described while for the independent firm the two effects go in opposite directions. Additionally, the subsidiary's output is higher than the independent's output, except when there is full vertical separation. This is the expected result as more vertical control increases the cost advantage of the subsidiary firm.

We also analyze the effects of vertical control degree on consumer welfare through the study of the total output. As we assume a linear demand function, the consumer surplus (CS) function is given by $CS = Q^2 / 2$. Hence, we analyze the sensitivity of CS to λ through the study of the sensitivity of total quantity to λ. Adding the optimal individual quantities we have $Q = \frac{(1-c)(3\lambda^2 - 4\lambda + 5)}{10 - 4\lambda - 5\beta^2 + 4\lambda^2 - \beta^2\lambda^2 + 2\beta^2\lambda}$.

We conclude that when $\beta > 0.70711$, an increase in vertical separation decreases total quantity; when $\beta < 0.70711$ an increase in vertical separation also decreases total quantity but only if the degree of vertical separation is not high, otherwise, when the vertical separation degree is already very high, total quantity increases with further vertical separation. As CS changes in the same direction as total quantity we summarize the conclusions on the effects of vertical separation in Proposition 2.

Proposition 2: Assume there is no access price regulation. Then: i) when $\beta > 0.70711$ an increase in vertical separation decreases CS; ii) when $\beta < 0.70711$ an increase in vertical separation decreases CS if $\lambda < \lambda_2$ with

$$\lambda_2 = \frac{5\beta^2 + \sqrt{5}\sqrt{9 - 10\beta^2 + 4\beta^4} - 5}{2 + \beta^2};$$

otherwise, an increase in vertical separation increases CS.

Proposition 2 is illustrated by two examples represented in Figure 2. Example 1 assumes $c = 0.2$ and $\beta = 0.9$. Example 2 assumes $c = 0.2$ and $\beta = 0.5$ In example 1 the minimal CS occurs for $\lambda = 1.1558$ (which is outside the admissible range for λ as $0 \le \lambda \le 1$), while in example 2 the minimal CS occurs for $\lambda_1 = 0.915$.

We observe that an increase in vertical separation reduces the incentive to invest and, if β is high ($\beta > 0.70711$), demand expansion is narrow and total quantity

decreases. For low values of β (β < 0.70711), the link between investment and demand is weak, and therefore the effect of vertical separation on consumer welfare varies with the degree of vertical separation. When vertical separation is low we have the same effect as with high β, however, when vertical separation is high, further increase in vertical separation produces positive effects on consumer welfare. This is explained by the positive effect of vertical separation on the promotion of retail competition that overcomes negative effects. These results are very relevant to policies that defend vertical separation arguing for the promotion of retail competition and the creation of a level playing field at the retail market, neglecting important effects on investment incentive and efficiency. Foros et al. (2007) already claim the attention for this feature of non-discrimination policies, as they may increase consumer prices.

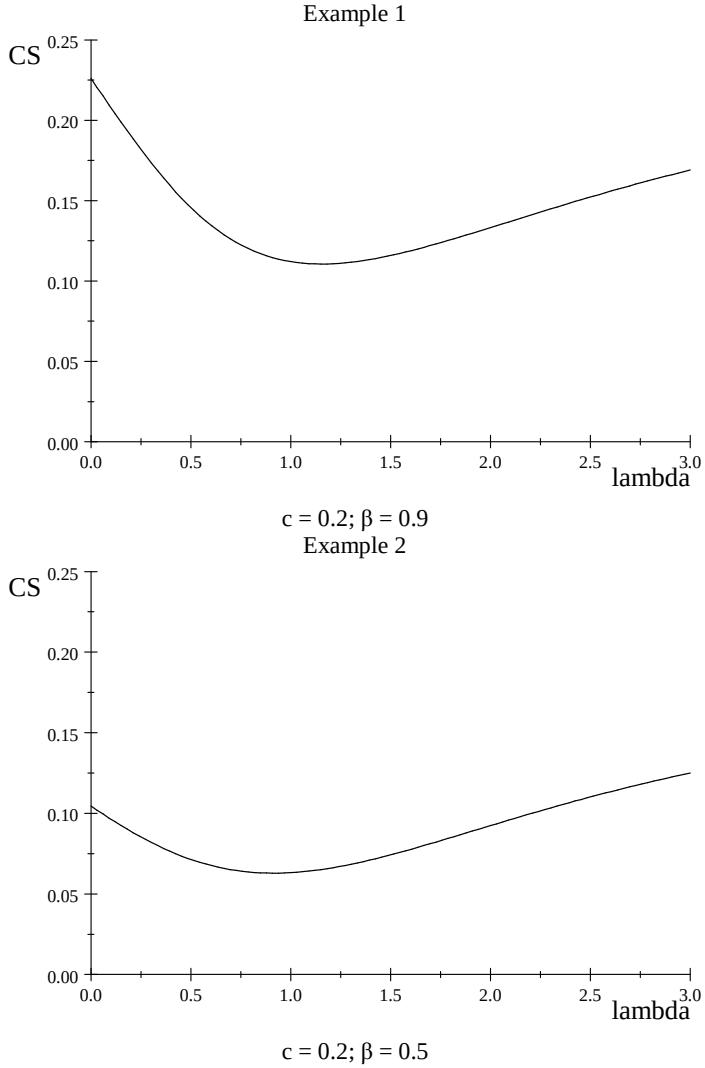


Figure 2. **Illustration of Proposition 2,** *author's*

2.4. Access Price Regulation. Here the regulator adopts a cost-based orientation, setting the access price equal to the marginal cost of providing access (c) plus a fraction (α) of the investment total cost: $w = c + \alpha C(I)$, with $\alpha < 1$[9]. With this regulatory policy firm *U* shares the cost of investment with downstream firms. To simplify the calculus we assume that $\alpha = 1 / I$. Then, access price is equal to the marginal cost of providing access plus the average cost of investment. This means that the independent firm bears a fraction of investment cost undertaken by the upstream firm in order to expand the demand. Both downstream firms benefit from the investment and this justifies access price being above marginal cost. This is consistent with the observation of an access price above marginal cost in order to cover the upstream firm's fixed costs as it happens, for instance, with the long-run incremental cost regulatory instrument.

At stage 1 the investment that maximizes the firm *U*'s objective function is

$$I^{reg}(\beta,\lambda,c) = \frac{(1-c)(5+4\beta-\lambda)}{y}, \text{ with } y = 23-10\beta-2\lambda-4\beta^2+2\lambda^2+2\beta\lambda.$$

Assumption 1 ensures that the optimal investment is positive for all possible values of λ. Analyzing $I^{reg}(\beta,\lambda,c)$ we conclude that the optimal investment is decreasing with λ.

Proposition 3: With access price regulation the optimal investment is decreasing with the degree of vertical separation.

This result is also consistent with Buehler et al. (2004) and has an intuitive explanation: if the integrated firm exerts tight control over the decisions of its subsidiary, independent retailer has less benefit from demand expansion and therefore the integrated firm has strong incentives to invest.

Plugging the optimal investment value on the results of the second and third stage of the game we obtain the equilibrium values of access price (w^{reg}) and quantities (q_1^{reg}, q_2^{reg}):

$$w^{reg}(\beta,\lambda,c) = c + \frac{(1-c)(5+4\beta-\lambda)}{2y};$$

$$q_1^{reg}(\beta,\lambda,c) = \frac{(1-c)(2\lambda^2-2\beta-5\lambda-2\beta\lambda+17)}{2y};$$

$$q_2^{reg}(\beta,\lambda,c) = \frac{(1-c)(\lambda-6\beta+\lambda^2+2\beta\lambda+12)}{2y}.$$

It is straight forward to verify that access price with regulation is lower than without it. We also verify that the output of the subsidiary firm is decreasing with vertical separation. Regarding the output of the independent firm we find a similar result as without regulation: it is decreasing with vertical separation except for high values of β and λ (in this case for $\beta > 1.2096$ and $\lambda > \lambda_3$ with $\lambda_3 = \frac{2\beta-4\beta^2+3\sqrt{10\beta-4\beta^2-8\beta^3+21}}{2\beta+4}$).

Also, we find that subsidiary's firm output is higher than the independent's firm output, except in the extreme case of full vertical separation, when both firms produce the same output.

[9] We follow the definition of cost based regulation described in Sarmento and Brandao (2013).

Regarding the effect of vertical control on *CS* we followed the same methodology that we use for the access regulation regime. The total output is given by: $Q^{reg} = \frac{(1-c)(29+3\lambda^2-4\lambda-8\beta)}{2(23-10\beta-2\lambda-4\beta^2+2\lambda^2+8\beta\lambda)}$. We conclude that an increase in vertical separation always has a negative effect on total quantity.

Proposition 4: With access price regulation an increase in vertical separation decreases *CS*, for all admissible values of β.

This is a quite different result from the one obtained without regulation, where there are some cases where consumer welfare increases as a response to more vertical separation. Here the increase in vertical separation that decreases the incentive to invest also decreases total quantity and *CS*. This effect more than compensates the positive effect of vertical separation on retail competition promotion.

2.5. Comparison of the Two Regimes. The main objective of the paper is to evaluate the effects of vertical separation on the incentives to invest considering two regimes of access price: regulation and no regulation. Comparing the optimal investment of both regimes we conclude that investment is not always higher without regulation than with access regulation, as frequently considered. This main result of the paper is summarized by Proposition 5.

Proposition 5:

i) if $\beta > 1.25$ the investment is higher without regulation than with access regulation, for any degree of vertical separation;

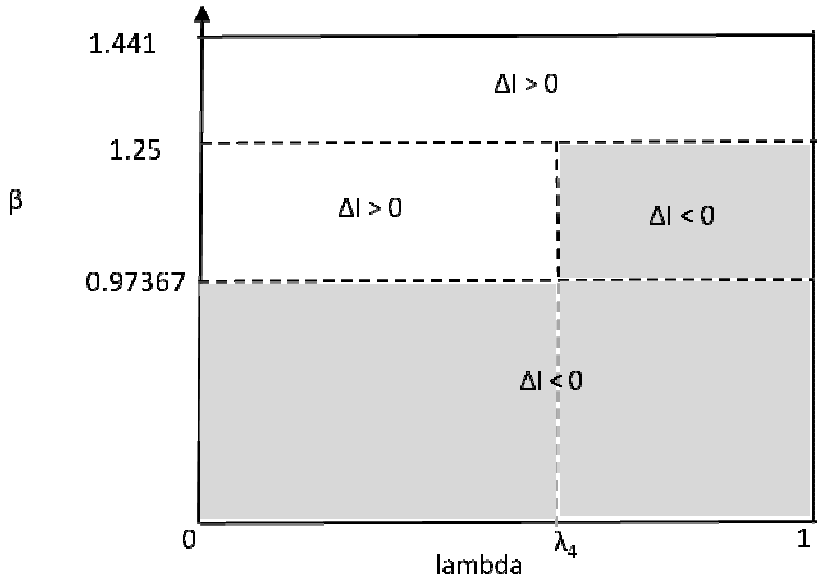
ii) if $0.9736 < \beta < 1.25$ investment is higher without regulation for low levels of vertical separation, that is, for $\lambda < \lambda_4$ with $\lambda_4 = \frac{1}{2} + \frac{1}{4}(\sqrt{\beta^2+36\beta-36} - \beta)$; for high levels of vertical separation the opposite happens;

iii) if $\beta < 0.97367$ investment is higher with regulation, for any degree of vertical separation.

Proposition 5 is illustrated in Figure 3.

The results described by ii) and iii) of Proposition 5 are unexpected and are the main contribution of the paper for the discussion on vertical separation effects. The aim of access price regulation is to protect independent retail firms from asymmetric market structure caused by the bottleneck asset that leads to a cost advantage of the integrated firm. However, the negative impact on investment is traditionally pointed as one crucial drawback of this regulatory policy. Here we show that it is not always true that access price regulation leads to lower investment than the absence of regulation.

The intuition for this result goes as follows. Depending on the investment impact on demand and on the degree of vertical separation it is possible that access price regulation stimulates investment more than the absence of regulation. This is explained by the effect of access price regulation combined with vertical separation policy on the position of the independent firm. Access price regulation protects the independent firm and if, cumulatively the degree of vertical separation is strong, the independent retailer has incentives to expand its activity. This gives the upstream firm incentive to invest in demand expansion in order to increase profits from wholesale activity.



ΔI = optimal investment without regulation – optimal investment with regulation

Figure 3. **Illustration of Proposition 5,** *authors'*

The above is in line with Chikhladze and Mandy (2009) results who conclude that when access price is above marginal cost, strong vertical control decreases sabotage incentives. Therefore, it might be optimal to have access price regulation and vertical integration (also, Chikhladze and Mandy (2009) conclude that access price regulation and vertical control policy can be complements). Here we conclude that vertical separation implemented with access price regulation decreases investment incentives and in some cases can also decrease consumer surplus. Hence, it is necessary to analyze carefully regulatory policies on networks that advocate strong vertical separation simultaneously with access price regulation.

3. Conclusions. We conclude that under both regimes concerning access price definition the impact of vertical separation on the independent firm's market position depends on the intensity of investment effect on demand. This is so because there is a trade-off between low increase in demand (caused by low investment) and the creation of a level playing field at the downstream market.

Regarding the effect of vertical separation on consumer surplus we find two different results: without regulation, vertical separation not always reduces consumer welfare while with access price regulation vertical separation always reduces consumer welfare. These results call for the attention of regulatory authorities when evaluating the possibility of maintaining access price regulation and simultaneously demanding deeper vertical separation from incumbent firms. The argument for vertical separation lies in the promotion of retail competition, but this might be achieved at consumer surplus expenses.

Concerning investment incentives we reach two main conclusions. First, the optimal investment is decreasing with vertical separation, with or without regulation. Second, when comparing the optimal investment under the two regimes we conclude

that it is possible to find some situations where regulation leads to higher investment incentives. These situations crucially depend on the degree of vertical separation. Therefore, the most interesting contribution of the paper is that regulatory authorities must take into deep consideration the vertical degree of control when evaluating the impact of access price regulation on investment, and should not take for granted that access price regulation always has negative effects on investment incentives.

References:

Avenali, A., Matteucci, G., Reverberi, P. (2014). Broadband Investment and Welfare under Functional and Ownership Separation. Information Economics and Policy, 28: 70–82.

Bauer, J. (2006). From Static Efficiency to Innovation Focus: The Turnaroun. In: Baake, P., Preissl, B. (eds). Local Loop Unbundling and Bitstream Access: Regulatory Practice in Europe and the U.S. of U.S. Unbundling Policy: DIW Berlin.

Beard, T., Kaserman, D., Mayo, J. (2001). Regulation, Vertical Integration and Sabotage. The Journal of Industrial Economics, 49(3): 319–333.

Blum, U., Growitsch, C., Krap, N. (2007). Broadband Investment and the Threat of Regulation: Preventing Monopoly Exploitation or Infrastructure Construction? Review of Network Economics, 6(3): 342–354.

Buehler, S., Schmutzler, A., Benz, M. (2004). Infrastructure quality in deregulated industries: is there an underinvestment problem? International Journal of Industrial Organization, 22(2): 253–267.

Cambini, C., Jiang, Y. (2009). Broadband Investment and Regulation: A Literature Review. Telecommunications Policy, 33: 559–574.

Cave, M. (2006a). Six Degrees of Separation Operational Separation as a Remedy in European Telecommunications Regulation. Communications and Strategies, 64: 2–15.

Cave, M. (2006b). Encouraging Infrastructure Competition Via The Ladder of Investment. Telecommunications Policy, 30: 323–237.

Cave, M., Vogelsang, I. (2003). How Access Pricing and Entry Interact. Telecommunications Policy, 27: 717–727.

Chikhladze, G., Mandy, M. (2009). Access Price and Vertical Control Policies for a Vertically Integrated Upstream Monopolist when Sabotage is Costly. Working Paper, University of Missouri.

Cremer, H., De Donder, P. (2013). Network Investment under Legal and Ownership Unbundling. Review of Network Economics, 12(1): 27–59.

Duarte, B., Pereira, P., Vareda, J. (2012). Incentives to Invest and to Give Access to Non-regulated New Technologies. Information Economics and Policy, 24: 197–211.

Economides, N. (1998). The Incentive for Non-Price Discrimination by an Input Monopolist. International Journal of Industrial Organizational, 16: 271–284.

Foros, O. (2004). Strategic Investments with Spillovers, Vertical Integration and Foreclosure in the Broadband Access Market. International Journal of Industrial Organization, 22: 1–24.

Foros, O., Kind, H., Sorgard, L. (2007). Managerial Incentives and Access Price Regulation. European Journal of Law and Economics, 23: 117–133.

Guthrie, G. (2006). Regulating Infrastructure: The Impact on Risk and Investment. Journal of Economic Literature, 44(4): 925–972.

Haldi, J., Olson, W. (2006). Enhancing Competition by Unbundling the Postal Administration. In: Crew, M., Kleindorfer, P. (eds). Progress toward Liberalization of the Postal and Delivery Sector: Springer, 49: 173–189.

Hausman, J., Sidak, J. (2005). Did Mandatory Unbundling Achieve Its Purpose? Empirical Evidence from Five Countries. Journal of Competition Law and Economics, March, 1: 173–245.

Hausman, J., Sidak, J., Singer, H. (2001). Cable modems and DSL: Broadband Internet access for residential customers. AER Papers and Proceedings, 91: 302–307.

Hoffler, F., Kranz, S. (2011a). Imperfect Legal Unbundling of Monopolist Bottlenecks. Journal of Regulatory Economics, 39, 273–292.

Hoffler, F., Kranz, S. (2011b). Legal Unbundling can be a Golden Mean Between Vertical Integration and Ownership Separation. International Journal of Industrial Organization, 29(5): 576–588.

Kirsh, F., von Hirschhausen, C. (2008). Regulation of NGN: Structural Separation, Access Regulation, or No Regulation at All? Communications and Strategies, 69: 63–83.

Kotakorpi, K. (2006). Access Price Regulation, Investment and Entry in Telecommunications. International Journal of Industrial Organization, 24: 1013–1020.

Kreps, D., Scheinkman, J. (1983). Quantity Precommitment and Bertand Competition yield Cournot Outcomes. Rand Journal of Economics, 14: 326–337.

Mandy, D. (2000). Killing the goose that may have laid the golden egg: Only the data know whether sabotage pays. Journal of Regulatory Economics, 17(2): 157–172.

Mandy, D., Sappington, D. (2007). Incentives for Sabotage in Vertically Related Industries. Journal of Regulatory Economics, Springer, 31(3): 235–260.

Pakula, B., Gotz, G. (2010). Biased Quality Investments and Organizational Structures in Network Industries – An Application to the Railway Industry. Working Paper.

Rey, P., Tirole, J. (2007). A Primer on Foreclosure. In: Armstrong, M., Porter, P. (eds). Handbook of Industrial Organization. Vol. III (pp. 2145–2220). North Holland.

Sarmento, P., Brandao, A. (2007). Access Pricing – A Comparison Between Full Deregulation and Two Alternative Instruments of Access Price Regulation: Cost-Based and Retail-Minus. Telecommunications Policy, 31: 236–250.

Sarmento, P., Brandao, A. (2009). Next Generation Access Networks: The Effects of Vertical Spillovers on Access and Innovation. FEP Working Paper No. 321.

Sarmento, P., Brandao, A. (2013). Airport's Profit Sharing: Effects on Investment Incentives, Competition and Social Welfare. European Journal of Transport and Infrastructure Research, 13(4): 291–314.

Sibley, D., Weisman, D. (1998). Raising Rivals' Costs: The Entry of an Upstream Monopolist into Downstream Markets. Information Economics and Policy, 10: 451–470.

Soares, I., Sarmento, P. (2012). Unbundling in the Telecommunications and the Electricity Sectors: How Far Should it Go? European Research Studies Journal – Special Issue on Energy, Vol. XV: 157–194.

Tropina, T., Whalley, J., Curwen, P. (2010). Functional Separation within the European Union: Debates and Challenges. Telematics and Informatics, 27: 231–241.

Vareda, J. (2010). Access regulation and the Incumbent Investment in Quality-Upgrades and Cost-Reduction. Telecommunications Policy, 34: 697–710.

Weisman, D. (1998). The Incentive to Discriminate by a Vertically-Integrated Regulated Firm: A reply. Journal of Regulatory Economics, 14: 87–91.

Weisman, D., Kang, J. (2001). Incentives for Discrimination when Upstream Monopolist Participates in Downstream Markets. Journal of Regulatory Economics, 20(2): 125–139.

Стаття надійшла до редакції 12.02.2015.