Universal Service Obligations in the Postal Sector: Endogenous Quality and Coverage*

Joan Calzada†
Universitat de Barcelona

February 15, 2006

Abstract

The liberalization of the postal sector endangers the maintenance of the universal service obligations. This paper examines the effects of entry when an incumbent operator is regulated with uniform price and quality constraints. I consider that the cost of a unit of mail depends on its quality and on the location of the senders. Senders have inelastic demands and differ in their willingness to pay for quality. The incumbent and one entrant play a three-stage game, first choosing which villages they cover, then the quality of the letters and finally the price. Valletti, Hoernig and Barros (2002) show that when an incumbent is regulated with a uniform pricing constraint the entrant chooses a low level of coverage to increase the incumbent's uniform price. Here, I show that when the qualities are determined endogenously the entrant can establish a higher level of coverage because he takes advantage of the lower competition to increase the level product differentiation and rise the incumbent's price. I also explain that in presence of network externalities firms use the level of coverage as a quality attribute that substitutes the quality of the service.

JEL Classification Numbers: D43, L51: Keywords: Postal Sector, Regulation, Universal Service, Quality, Coverage

*I would like to thank my colleagues of the Research Unit on Politicas Publicas y Regulacion Economica (GPRE) for their valuable comments on this work. This research has been financed by the "2004 Prize for a Post-doctoral Grant in Postal Economics", sponsored by De Post-La Poste (Belgium).This paper was written while the author was visiting the Tanaka Business School, at the Imperial College London, whose hospitality is gratefully acknowledged.

†Address for correspondence: Joan Calzada. Departament de Politica Economica. Universitat de Barcelona. Av. Diagonal, 690. Barcelona 08034. Spain. Email: calzada@ub.edu. Phone: ++ 34-93 403 47 43.

1 Introduction

In a liberalised market, the Universal Service Obligations (USO) guarantee that all consumers have access to the postal services.[1] The operator in charge of the universal service provides a basic package of services, at affordable uniform prices, with a minimum level of quality and in a well-defined geographic area. In spite of this, the viability of the USO may be threatened the entrants in the postal market only serve the profitable mailers, opt for niche markets and select product differentiation strategies. An analysis of this type of entry is essential to guide the public intervention in the sector. Governments need to be assured that when they introduce competition in the market they don't undermine the provision of the service to all the population. On the other hand, Governments should be aware of the impact of USO regulation on competition, and should take into account the interaction among the different USO regulations.[2] Different regulatory interventions may generate different entry strategies.

This paper analyses the interactions between quality (frequency, reliability) and coverage in a duopoly when the incumbent is regulated with a uniform pricing constraint. The entrant prefers to establish a lower level of coverage than the incumbent because the larger is the region covered solely by the incumbent the higher is the incumbent's uniform price. However, when the duopolists determine endogenously the quality of the service they take advantage of the reduction of competition produced by the differences of coverage to increase product differentiation. Therefore, the possibility to increase product differentiation lead the entrant to establish a higher coverage. More generally, I show that the impact of each universal service regulation depends on how are regulated the other aspects of the market.

The literature about the postal sector has analysed the distortions generated by different USO regulations, specially the establishment of a uniform price. In spite of this, very few works have considered the quality of the service. Crew and Kleindorfer (1998) develop a model that determines simultaneously the incumbent's reserved area needed to finance the USO and the extent of the USO. The authors argue that quality attributes of mail is a central aspect in the definition of the USO. Moreover, they emphasize that a strict regulation of the USO may jeopardise the benefits of competition. Entry can improve both static and

[1] The analysis of the universal service in network industries have been initiated by Crew and Kleindorfer (1998, 2001), Alleman *et al.* (2000), Laffont and Tirole (2000), Gasmi *et al.* (2000), Cremer, Gasmi, Grimaud and Laffont (2001) and Armstrong (2001) among others. Rosston and Wimmer (2000) compare different public programs to provide the universal service in the telecommunications sector.

[2] Rodriguez and Storer (2000) study different approaches to estimate the cost of the universal service. Chon, Flochel and Perrot (2000) analyse different mechanisms to fund the universal service. On the other hand, Anton, Vander-Weide and Vettas (1998) consider the strategic effects of subsidies to finance the USO.

dynamic efficiency because it stimulates service and costs innovations. However, under the USO, entry may not provide any of these effciency gains. To illustrate this situation the authors report that the entrant in the Swedish market, Citymail, offers "day-certain" delivery. However, it only delivers two days per week. Crew and Kleindorfer (2000, 2001, 2004 and 2005) argue that a meaningful USO is unlikely to be feasible absent a reserved area or some other method of funding. In Crew and Kleindorfer (2005) the authors claim that "it seems unlikely for most countries that lettermail USO can be supported without a reserved area, unless service standards are relaxed".

Cremer *et al.* (2001) analyse a duopoly in the postal market. Only the incumbent provides single-piece mail and the two duopolists provide bulk mail. Moreover, while the incumbent faces a uniform pricing constraint the entrant is left unregulated. In this model, coverage is considered a quality attribute and the coverage's level of the firms differs. Taking this into account, the authors show that the larger is the coverage of the entrant the more attractive is his product, and the lower is the price differential at which he can capture a positive market share.

Although the previous papers introduce the concept of quality into the study of the USO, the idea of the present analysis is more related with the literature on vertical product differentiation. In particular, I follow the model of Cremer, De Rycke and Grimaud (1997), which is modified to consider the coverage decision of firms. The authors of this paper analyse the welfare impact of quality in market structure, taking into account the utility of senders and addresses. They consider a duopoly that plays a two-stage game, first choosing qualities and then prices. In this context, two private duopolists establish an inefficient provision of quality. In spite of this, if one of the firms is a public operator and the budget constraint is not binding, the firms implement the first best qualities.[3] If the budget constraint of the public firm is binding, the equilibrium is not efficient but yields a higher level of welfare than a private equilibrium.

This paper is also very related with Valletti, Hoernig and Barros (2002), that study the strategic interaction between uniform pricing and coverage in the telecommunications sector. They show that price competition is critically affected by relative coverage (i.e. the ratio between the entrant's coverage and the incumbent's). This is because the entrant establishes a low coverage to enlarge the monopoly region of the incumbent and therefore force the increase of the incumbent's uniform price. On the other hand, they explain that the uniform pricing policy distributes the benefits of competition by lowering the prices of the customers in the incumbent's monopoly region, increasing the prices in the

[3]Cremer, Marchand and Thisse (1991) analyse a mixed oligopoly with horizontal product differentiation where firms choose their location and price in a model *a la* Hotelling. In particular, the authors study if the number of public firms that compete with private ones may affect social welfare.

duopoly area and reducing the number of villages covered by the service. The authors also show that when the incumbent is forced to increase his coverage the consumers that were previously served loss welfare because the incumbent's uniform price increases. Indeed, one of the contributions of Valletti, Hoernig and Barros (2002) is to show that there is a clear trade-off between larger coverage and higher welfare of served customers, and between the welfare of customers located in the regions covered by the two duopolists and in the regions served solely by the incumbent. The authors demonstrate that a uniform price creates an strategic link between otherwise unregulated geographical areas, which can lead to lower coverage chosen by both the incumbent and the entrant. In this paper I show that when firms can determine the level of product differentiation this result is not modified. The possibility of increasing product differentiation strengthens the impact generated by the reduction of the entrant's coverage.

Finally, Fabra, Escribano and Gagnepain (2004) consider the interaction between quality and coverage in a spirit very similar to this paper. They model competition in a private duopoly where the incumbent covers all the population and has a regulated uniform price. The entrant is free to decide his coverage and can price discriminate considering the path of the mail. As in this paper, the authors consider that the prices of the two firms and the coverage of the entrant are endogenously determined. However, the qualities are set exogenously. The duopolists play a game in two stages. Firstly, given the qualities, the regulator contracts with the incumbent. The contract specifies the uniform price and a transfer that covers the incumbent's costs. Secondly, having observed the incumbent's price, the entrant chooses his coverage and the price for each path. One conclusion of this paper is that the optimal coverage of the entrant is larger the higher his quality advantage is. In my paper the entrant is able to increase product differentiation when he has a lower coverage than the incumbent does. Therefore, the endogenous nature of quality makes less necessary to reduce coverage in order to weaken competition and increase the price.

This paper analyses the impact of endogenous coverage and product selection when an incumbent postal operator establish a uniform price. The firms' equilibrium coverage strategy is the result of two forces. Firstly, the larger is the coverage the greater is the profit that the firms can obtain. Secondly, when the incumbent sets a uniform price the entrant can reduce his coverage to establish a higher price than the duopoly price. Valletti, Hoernig and Barros (2002) analyse the impact on the profits of increasing the difference in coverage when the qualities of the firms are fixed. On the other hand, the firms' equilibrium quality strategy is the consequence of two opposing forces. Firstly, firms choose the quality variety that is most profitable in terms of consumer's preferences and costs. This will make the firms choose a similar quality. Secondly, each firm wants to differentiate his products from those of his competitor because "product differentiation weakens

price competition and raises profits".[4] Cremer, De Rycke and Grimaud (1997) study the determination of qualities when the duopolists have the same coverage level. One contribution of the present paper with respect to the previous literature is to show that a reduction of coverage weakens competition and allows the firms to increase product differentiation. Therefore, the entrant obtains the same increase of prices with a smaller reduction of coverage. When the entrant reduces his coverage his price raise for two reasons. Firstly, the price of the incumbent increases with the size of the monopoly regions. And secondly, the increase of relative coverage allows the firms to increase their product differentiation in a greater extent than with a duopoly in all the country.

Finally, I extent the model to introduce network externalities, which implies that coverage is also a quality attribute. A first conclusion of this extension is that with network externalities firms can maintain their level of product differentiation spending less in quality. This occurs because the differences in coverage are considered as a type of product differentiation. On the other hand, I show that when networks externalities are important the entrant decides to increase his coverage, even if this reduces product differentiation.

The rest of the paper is organised as follows. Section 2 presents the model. Section 3 presents the optimal prices, qualities and coverage levels that would implement a benevolent regulator. Section 4 considers a private duopoly where one firm, the incumbent, is regulated with a uniform price. Sections 5 and 6 analyse the impact of imposing certain obligations on the quality and the coverage of the firms. Section 7 extents the model of section 2 to introduce network externalities. Finally, section 8 summarises our conclusions.

2 The model

Consider a duopoly with one incumbent postal operator ($i = 1$) and one entrant ($i = 2$) that commercialize a postal service. The firms potentially serve a continuum of villages $[0, \overline{\mu}]$, where $\overline{\mu}$ represents the size of the country. All villages have the same number of customers. Moreover, they are ordered according to the fixed cost of operating the service. If firm i decides to cover the village μ it has to pay the fixed cost $F(\mu)$, where $F(0) = 0$, $F'(\mu) = f(\mu) > 0$ and $F''(\mu) > 0$. This implies that villages differ in their profitability. For simplicity, consider that the fixed costs are the same for the two firms.

We assume that the entrant's coverage level is never larger than that of the incumbent, $\mu_2 \leq \mu_1$. As a result, while some villages are served by a duopoly, the rest form a monopoly region that is served exclusively by the incumbent. To elude the possibility that the clients of the entrant send letters to addressees located in

[4] Moorthy (1988).

the monopoly region we consider that letters are addressed to the sender's own villages. The last section of the paper partly relaxes this assumption to consider the presence of network externalities.[5]

Vertical differentiation is introduced in the model following the paper of Cremer, De Rycke and Grimaud (1997).[6] In particular, consider that all villages have a continuum of senders with mass 1. The senders have different preferences for the quality of the postal service, or more precisely for the frequency of the deliveries. We call $x \geq 0$ the quality of a letter. The sender's preference for quality is represented by θ, and this is uniformly distributed in the unit segment $\theta \in [\underline{\theta}, \overline{\theta}]$. On the other hand, senders have a perfectly inelastic demand that is normalised to one unit. Taking this into account, the surplus of a sender with type θ who sends one letter of quality x at price p is given by

$$\theta x - p.$$

We impose the universal service restriction that the prices of the incumbent have to be such that in equilibrium all the senders in the villages covered by the incumbent have to be able to access the service. Therefore, there is full participation in the villages covered by the incumbent.[7]

Each firm i offers a variant of quality x_i at price p_i. In what follows I assume that the incumbent offers a higher quality than the entrant, $x_1 > x_2$. This assumption reflects the current situation in the postal sector, where the incumbent's frequency of delivery is higher than those of his new competitors.[8] Taking this into account, one sender with type $\widetilde{\theta}$, located in one of the villages served by the duopoly, is indifferent between the incumbent and the entrant when

$$\widetilde{\theta} x_1 - p_1 = \widetilde{\theta} x_2 - p_2.$$

Therefore, the demand of the incumbent in the villages of the duopoly region is

$$\overline{\theta} - \widetilde{\theta} = \overline{\theta} - \frac{p_1 - p_2}{x_1 - x_2}. \tag{1}$$

On the other hand, the entrant's demand in each duopoly villages is $\widetilde{\theta} - \underline{\theta}$. That is, the entrant serves the senders with a lower preference for quality.

We assume that the firms marginal cost of providing letters is independent of the quantity. However, the cost is quadratic in quality, $C(x_i) = \frac{cx_i^2}{2}$.

[5] Alternatively, we could assume that the firms instead of covering the most profitable villages cover the most profitable paths. Fabra, Escribano and Gagnepain (2004) model this possibility.

[6] This paper is based on an specification introduced by Mussa and Rosen (1978) and developed in Cremer and Thisse (1994). These two papers consider that preferences are quasi-linear so that the marginal utility of income is constant and is the same for all consumers.

[7] In order to guarantee this result when $\mu_1 = \mu_2$ we need that $\underline{\theta} > 7/4$.

[8] Throughout the text we also discuss the consequences of having the opposite situation.

Finally, imagine that firms play a dynamic game in three stages. Firstly, firms decide which villages they will serve. Secondly, having decided their coverage, firms choose the quality of their letters, which is homogenous for all their consumers. Finally, in a third stage, firms set the prices of the letters. The solution concept of the game is the subgame perfect Nash-equilibrium.

3 The optimal allocations

This section analyses the presence of a benevolent regulator that chooses the quality and coverage levels of the duopolists in order to maximise social welfare. The regulator's social welfare function is the unweighted sum of the consumer surplus and the profit of the firms:

$$\begin{aligned} W \quad &= \mu_2\left(\int_{\widetilde{\theta}}^{\overline{\theta}} (\theta x_1 - \frac{cx_1^2}{2})d\theta + \int_{\underline{\theta}}^{\widetilde{\theta}} (\theta x_2 - \frac{cx_2^2}{2})d\theta\right. \\ &+(\mu_1 - \mu_2)\int_{\underline{\theta}}^{\overline{\theta}} (\theta x_1 - \frac{cx_1^2}{2})d\theta - F(\mu_1) - F(\mu_2). \end{aligned} \tag{2}$$

In the duopoly region(the segment $[0, \mu_2]$), the consumers with a higher preference for quality prefer the incumbent, and those with a lower preference for quality prefer the entrant. In each village of the duopoly region $\widetilde{\theta}$ is the marginal consumer that is indifferent between the incumbent and the entrant. In the monopoly region, however, all consumers use the services of the incumbent.

The following proposition presents the levels of quality and coverage that maximize social welfare.

Proposition 1. *Given the relative coverage of the firms, $K = \frac{\mu_1}{\mu_2}$, the optimal qualities of the incumbent and the entrant are:*

$$x_1^o = \frac{8\underline{\theta} + 9K - 3(9K^2 - 8K)^{\frac{1}{2}}}{8c}; \quad x_2^o = \frac{8\underline{\theta} + 3K - (9K^2 - 8K)^{\frac{1}{2}}}{8c}. \tag{3}$$

When $\mu_1 = \overline{\mu} = 1$, the optimal coverage of the entrant satisfies

$$\mu_2^o = \frac{(108cf(\mu_2))^{\frac{1}{3}} - 2^{\frac{1}{3}}}{(64c^2 f(\mu_2)^2)^{\frac{1}{3}}}. \tag{4}$$

The proposition shows that the optimal quality allocations depend on the levels of coverage. Clearly, only when $K = 1$, i.e. when the two firms have the same coverage, the optimal qualities are the same than in the standard model of product differentiation developed by Moorthy (1988) and Cremer and Thisse (1994).

$$x_1^o = \frac{4\underline{\theta} + 3}{4c}; \quad x_2^o = \frac{4\underline{\theta} + 1}{4c}.$$

The optimal qualities are lower when the incumbent have a larger coverage than the entrant, $K > 1$, than when the two firms have the same coverage, $K = 1$. An explanation for this result is that with $K > 1$ it is optimal to improve the situation of the consumers in the incumbent's monopoly region. The incumbent offers a uniform high quality across all villages. Therefore, a reduction of the incumbent's quality reduces the surplus of the consumers with a high preference for quality in all villages, but increases the surplus of the consumers with a small preference for quality in the monopoly region. The bigger the monopoly region, the larger the reduction of the incumbent's quality imposed by the regulator. At the same time, the reduction of the incumbent's quality induces a reduction of the entrant's quality.

The determination of the optimal coverage's levels is complex because it requires choosing the coverage of each firm and the difference of coverage between them. However, this problem can be simplified if we fix the incumbent's coverage or if we assume that he covers all the country, $\mu_1 = \overline{\mu} = 1$. In this case, the optimal coverage of the entrant is the one stated in the proposition. Observe that in this particular case, if the marginal cost of coverage is sufficiently small $f(\mu_2) < \frac{1}{2c}$, the entrant must cover all the country and $K = 1$. By contrast, when the marginal cost of coverage is large, it is not worthy to duplicate the presence of an operator in all the villages.

Finally, notice that with the first best prices, $p_i = \frac{cx_i^2}{2}$, the firms make a loss equal to $F(\mu_i)$. If the regulator cares about the budget equilibrium of the firms she should establish higher prices.

4 Duopoly under uniform price and quality constraints

This section develops a model of competition between an incumbent postal operator and one entrant. The incumbent must establish a uniform price that is affordable for all the population of the villages where he operates. As it has been explained before, we consider that the incumbent and the entrant play a game in three stages. First, they decide the size of their networks, then they determine the qualities of their services and finally they set the prices. To analyse this situation we solve the problem by backwards induction.

4.1 Third stage: determination of prices

One the firms have established their qualities (frequencies of delivery) and the level of coverage, in the third stage of the game they set the prices. We assume that the price of the two firms is uniform across all locations. This constraint has important strategic effects for the incumbent. While he is a monopoly in the region $(\mu_2, \mu_1]$, he competes as a duopolist in the region $[0, \mu_2]$. Therefore, he establishes an intermediate price between the price of a duopolist and the monopoly price.

The incumbent maximizes the sum of the profits obtained in the duopoly and the monopoly regions, $\Pi_1 = \pi_1^m + \pi_1^d$.

$$\underset{\{p_1\}}{maximize} \ \Pi_1 = \mu_2(p_1 - \frac{cx_1^2}{2})(\overline{\theta} - \frac{p_1 - p_2}{x_1 - x_2}) + (\mu_1 - \mu_2)(p_1 - \frac{cx_1^2}{2}) - F(\mu_1). \quad (5)$$

By contrast, the entrant only obtains profits in the duopoly region.

$$\underset{\{p_2\}}{maximize} \ \Pi_2 = \mu_2(p_2 - \frac{cx_2^2}{2})(\frac{p_1 - p_2}{x_1 - x_2} - \underline{\theta}) - F(\mu_2). \quad (6)$$

Differentiating the profits of the firms with respect to the prices and rearranging the first-order conditions we obtain the following prices:

$$p_1 = \frac{1}{3}[(x_1 - x_2)(2\overline{\theta} - \underline{\theta}) + \frac{c}{2}(2x_1^2 + x_2^2) + 2(x_1 - x_2)(K - 1)], \quad (7)$$

$$p_2 = \frac{1}{3}[(x_1 - x_2)(\overline{\theta} - 2\underline{\theta}) + \frac{c}{2}(2x_2^2 + x_1^2) + (x_1 - x_2)(K - 1)]. \quad (8)$$

The prices depend on the qualities and the relative coverage, $K = \frac{\mu_1}{\mu_2}$. As $x_1 > x_2$ and $K \geq 1$, the incumbent's price is always higher than the price of the entrant. A more careful analysis of the prices allows to write the following result.

Proposition 2. *The price of equilibrium depend on the qualities offered by the firm and on the relative coverage K. Under a uniform pricing constraint p_1 and p_2 increase with x_1, and decrease with x_2 when the entrant's marginal cost of quality is small. An increase of x_1 increases the profits of the incumbent in the monopoly region, π_1^m, and the profits of the entrant, Π_2. It can also increase the profits of the incumbent in the duopoly region, π_1^d, if this region is sufficiently large. An increase of x_2 produce the opposite effects.*

An increase in the incumbent's quality rises his price. This is because it increases the product differentiation between the duopolist and the cost of providing the quality. The same type of reasoning explains why an increase of the

incumbent's quality allows the entrant to rise his own price: (1) the products become more differentiated; and (2) the incumbent's costs rise and he fixes a higher price. On the other hand, when the entrant's coverage is lower than those of the incumbent, $K > 1$, the monopoly region increases and he can establish a price that is closer to the monopoly price. This effect also increases the price of the entrant.

An increase in the entrant's quality may produce the opposite impact. The increase of quality rises the entrant's costs. However, this force can be compensated by an increase of competition generated by a lower product differentiation. On the other hand, the reinforcement of the competition in the duopoly region stimulates the incumbent to reduce his uniform price.

On the other hand, an increase in the incumbent's quality (and a reduction in the entrant's quality) increases the product differentiation and rises the profit of the entrant and the profit of the incumbent in the monopoly region. On the other hand, the incumbent sets a uniform price close to the monopoly price and obtains a greater profit in the duopoly region.

Finally, the effect of an increase in the incumbent's (or the entrant's) quality in the profit of the incumbent in the duopoly region depends on the level of coverage of the entrant. First, it increases the incumbent's uniform price to leave it even higher than those of a monopolist. Secondly, however, it increases the price of the entrant and the incumbent's profit in the duopoly region. When the entrant's coverage is large this second effect dominates the first, and the incumbent sets a price closer to the one that would establish a duopolist.

4.2 Second stage: determination of qualities

In the second stage, the firms determine the qualities of the services. Their election determines the level of product differentiation between firms and therefore the strength of competition.

Substituting the equations of prices (7) and (8) in the profit functions of the firms (5) and (6) we obtain:

$$\underset{\{x_1\}}{maximize}\ \Pi_1 = \frac{\mu_2(x_1 - x_2)}{9}((2\overline{\theta} - \underline{\theta}) + \frac{c}{2}(x_1 + x_2) + 2(K-1))^2 - F(\mu_1), \quad (9)$$

$$\underset{\{x_2\}}{maximize}\ \Pi_2 = \frac{\mu_2(x_1 - x_2)}{9}((\overline{\theta} - 2\underline{\theta}) + \frac{c}{2}(x_1 + x_2) + (K-1))^2 - F(\mu_2). \quad (10)$$

Solving the first order conditions of these problems we obtain the following qualities for the incumbent and the entrant:

$$x_1 = \frac{4\underline{\theta} + 5K}{4c}; \quad x_2 = \frac{4\underline{\theta} - K}{4c}. \tag{11}$$

We can also substitute these qualities into the equations of prices, yielding

$$p_1 = \frac{16\underline{\theta}^2 + 40\underline{\theta}K + 49K^2}{32c}; \quad p_2 = \frac{16\underline{\theta}^2 - 8\underline{\theta}K + 25K^2}{32c}. \tag{12}$$

If we now compare the qualities of a private duopoly with the optimal qualities in (3) we observe that for $K > 0$ the incumbent's quality is always higher than the optimal, and the entrant's quality is always lower. This conclusion generalises the result of Cremer, De Rycke and Grimaud (1997) that private firms choose a higher than optimal level of product differentiation in order to reduce the intensity of competition. By increasing product differentiation firms can set higher prices and obtain larger profits.

On the other hand, the analysis of the qualities also shows that the level of product differentiation depends on the difference of coverage levels.

Proposition 3. *With independence of which firm provides the highest level of quality, an increase in the level of relative coverage, K, rises product differentiation.*

From equation (11) we observe that an increase in the level of relative coverage, K, increases the quality of the high quality firm and reduces the quality of the low quality firm.[9] The increase of product differentiation appears regardless of which firm (the incumbent or the entrant) offers the high quality service. When the level of relative coverage increases, i.e. when the incumbent's monopoly region grows, the incumbent is interested in setting his uniform price closer to the price of a monopoly, and as a consequence competition weakens. In this situation, it becomes profitable to increase the level of product differentiation. This strategy reduces the incumbent's profits in the duopoly region, but this is compensated with larger profits in the monopoly villages. For the entrant, it is always profitable to reduce his coverage to increase the product differentiation. The reduction of coverage is compensated with higher prices in the remaining duopoly villages.

The result of Proposition 3 has important implications. It is a well-known conclusion of the literature about vertical differentiation that private markets may provide poor results with regards of service quality.[10] Proposition 3 shows that,

[9] When $K = 1$ the private duopolist establish the same qualities than in Cremer and Thisse (1994).

[10] See for instance Moorthy (1988), Cremer, Marchand and Thisse (1991), Cremer and Thise (1994) and Cremer, De Rycke ad Grimaud (1997).

in addition, an increase in the relative coverage of the firms weakens competition and allows to increase the level of product differentiation even more.

The following proposition further characterises the optimal behaviour of the firms in terms of quality.

Proposition 4. *For the incumbent and the entrant the qualities of the services are strategic substitutes,*

$$\frac{dx_1}{dx_2} = \frac{dx_2}{dx_1} = \frac{1}{3} > 0. \tag{13}$$

For any given level of relative coverage K, the increase in the quality of one firm increases the quality of the other, although in a smaller proportion. When the entrant increases his quality the incumbent rises his own quality to increase the level of product differentiation, although it does it less than proportionately in order to maintain his market share. As a result, product differentiation is reduced. By contrast, when the incumbent increases his quality, the entrant raises his own quality less than proportionately because he benefits with an increase of product differentiation.

4.3 First stage: determination of coverage levels

We finally analyse how firms establish their coverage in the first stage of the game. Considering the qualities of the firms in (11) we obtain the following profit functions:

$$\underset{\{\mu_1\}}{maximize} \quad \Pi_1 = \frac{\mu_2}{9c}(\frac{3K}{2})^3 - F(\mu_1), \tag{14}$$

$$\underset{\{\mu_2\}}{maximize} \quad \Pi_2 = \frac{\mu_2}{9c}(\frac{3K}{2})^3 - F(\mu_2). \tag{15}$$

Observe that when the two firms have the same coverage they obtain the same profits.[11] Differentiating the profit functions with respect to the level of coverage we obtain the optimal coverage strategies of the firms. The next proposition characterises the profit maximising prices, qualities and levels of coverage of the duopolists.

Proposition 5. *A private duopoly where the incumbent offers the high quality service satisfies:*

[11] From Cremer, De Rycke and Grimaud (1997) it can be proof that the two firms obtain the same profit when they have the same level of coverage.

$$p_1^e = \frac{12\underline{\theta}^2}{7c}; \quad p_2^e = \frac{30\underline{\theta}^2}{49c},$$

$$x_1^e = \frac{12\underline{\theta}}{7c}; \quad x_2^e = \frac{6\underline{\theta}}{7c},$$

$$\frac{18\underline{\theta}^2}{49c} = f(\mu_1); \quad K^e = \frac{4\underline{\theta}}{7} > 1. \tag{16}$$

The proposition shows that the incumbent always chooses a higher coverage than the entrant and therefore $K^e > 1$.[12] To see the intuition of this result note that the first-order condition of the problem in equation (15) shows that the entrant always prefers to reduce his coverage as much as possible, because this strategy increases the incumbent's monopoly region. As a result, the incumbent increases his uniform price and the competition is relaxed. In spite of this, when the relative coverage is higher than K^e, the incumbent's uniform price don't allows that all the consumers in the villages covered by the incumbent will be able to afford the service.[13] Therefore, the entrant can not force an increase of the incumbent's price by increasing the relative coverage beyond K^e. On the other hand, the incumbent is interested in increasing his coverage in order to obtain more profits. However, if the marginal cost of coverage $f(\mu_1)$ is sufficiently high he will choose a level of coverage below $\overline{\mu}$.

Another consequence of Proposition 4 is that the entrant obtains a larger profit than the incumbent. Indeed, from equation (14) and (15) we observe that when $\mu_2 < \mu_1$ the entrant has a higher profit.[14] This situation reflects that the entrant has more power in determining the price and the quality of the incumbent that vice versa. And this advantage appears regardless of which firm is providing the high quality, because the entrant always tries to increase K to rise the incumbent's uniform price.

Finally, the next result shows the best responses of the firms when their rivals modify the coverage.

Proposition 6. *For the incumbent the levels of coverage are strategic substitutes, while for the entrant they are strategic complements*

$$\frac{d\mu_1}{d\mu_2} < 0; \quad \frac{d\mu_2}{d\mu_1} > 0. \tag{17}$$

[12]See footnote 7.

[13]When the relative coverage is set at K^e all consumers in the duopoly region continue participating in the market.

[14]The result that the low quality firm has a high profit is consistent with Moorthy (1988) for the case where firms choose products simultaneously.

This proposition is the same than Proposition 1 in Valletti, Hoernig and Barros (2002), who analyse the effects of a uniform pricing constraint in a private duopoly. The first part of the proposition shows that an increase in the coverage of the entrant forces the incumbent to reduce his coverage. This occurs because the incumbent is forced to reduce his uniform price and as a consequence some high cost villages that were previously attended are not profitable anymore.

On the other hand, the second part of the proposition shows that when the incumbent increases the number of villages covered the entrant increases his coverage as well. An increase in the incumbent's coverage rises K. In this situation, even if the entrant increases his coverage the incumbent does not modify his prices (unless $K < \frac{4\theta}{7}$).

5 The regulation of quality

In the previous section we have seen that private duopolists choose an inefficient level of product differentiation: the low quality level is too low and the high quality level is too high. Next we analyse the impact of regulating the qualities of the firms to bring them closer to the optimal allocations. We study the impact of these policies assuming that the duopolists know the extension of the regulatory intervention before they have decided their levels of coverage.

Proposition 7. *A regulation that reduces the incumbent's quality below x_1^e reduces in a smaller proportion the entrant's quality and reduces the coverage of the incumbent and the entrant. Compared to the unregulated case, the consumers of the incumbent and the entrant have a lower quality and pay a lower price.*

As explained in Proposition 4, a reduction of one unit in the quality of the incumbent reduces the quality of the entrant by 1/3. The reduction of product differentiation cuts down the prices and forces the incumbent to reduce his coverage. The entrant can maintain the relative coverage at K^e by reducing his coverage as well.

In general terms, the benefit generated by the reduction in the incumbent's quality is the reduction in the prices of the firms. In spite of this, not all consumers take profit from this situation. First, the incumbent reduces his coverage. And second, some consumers of the incumbent would prefer to pay for a higher quality.

The next proposition presents the effects of increasing the entrant's quality to bring it closer to the efficient level and reduce product differentiation. As stated by Cremer, De Rycke and Grimaud (1997), the imposition of a minimum quality standard appears to be "the most natural instrument to achieve an increase in average quality".[15] The reason for this is that an increase in the low quality level

[15] Ronnen (1991) and Crampes and Hollander (1994) also analyse the establishment of a minimum quality standard.

also increases the high quality level. However, as in the previous situation, when firms anticipate this regulation they reduce their coverage.

Proposition 8. *A regulation that increases the quality of the entrant above x_2^e increases in a lower proportion the quality of the incumbent. The reduction of product differentiation reduces the prices and reduces the coverage of the entrant and the incumbent. Compared to the previous situation, consumers receive a higher quality and pay a lower price. Some consumers that before were served by the entrant in the duopoly region now switch to the incumbent, and some villages are not covered.*

When the regulator establishes a minimum quality level for the entrant there is a reduction of product differentiation that cuts down the prices. As a result, a group of high cost villages that were previously served are not profitable anymore. To sum up, the establishment of a minimum quality standard for the entrant lowers the price but reduces the coverage of the firms.

6 The regulation of coverage

A key aspect of the Universal Service policy in the postal sector is the obligation of the incumbent to serve some non-profitable villages (or regions) of the country. The obligation of ubiquity together with the establishment of a uniform price implies that in most countries the incumbent operator subsidise the loss-making regions with the revenues obtained in the profitable zones. In a liberalized sector, however, the viability of this policy is threatened by the entry into the low-cost regions. Next, we analyse the separate effects of imposing a minimum level of coverage in the incumbent and the entrant in order to avoid this situation.

Proposition 9. *A regulation that increases in the coverage of the incumbent increases the coverage of the entrant and maintains the qualities and the prices of the firms unaltered. Compared to the previous situation, the consumers pay the same and have the same quality. Some consumers that before were in the monopoly region now are served by the entrant and are better off. More villages are covered.*

The incumbent is forced to guarantee the provision of the service at an affordable price to all consumers of the villages that are covered. Therefore, a regulation that increases the incumbent's coverage must guarantee that the incumbent's uniform price is left unaltered. On the other hand, when the incumbent increases his coverage the best response of the entrant is to increase his coverage to maintain the relative coverage at K^e and optimize the level of product differentiation and the price. As K is kept constant, the qualities and the prices of the firms do not change.

The establishment of a minimum coverage level for the incumbent brings the postal service to a group of villages that previously were not attended. On the other hand, a group of villages that before were in the monopoly region after the regulation are served by a duopoly.

In contrast to this result, Valletti, Hoernig and Barros (2002) find that an increase in the incumbent's coverage rises the price of the incumbent and the entrant. In their model, an increase in the incumbent's coverage rises the entrant's coverage less than proportionately and as a result K increases. The prices of the two firms increase because the increase of the monopoly region makes the incumbent more accommodating. In this model, by contrast, the strategy of the entrant is to keep K constant because the incumbent's uniform price can not increase without reducing the participation of the consumers in the monopoly villages. In this model, there are not groups of consumers than can be worse than before.

Finally, the next proposition studies the consequences of imposing a minimum coverage level on the entrant.

Proposition 10. *A regulation that increases the coverage of the entrant decreases the coverage of the incumbent and the product differentiation between the firms. Compared to the previous situation, the consumers of the incumbent and the entrant pay a lower price. Some of the consumers that before were served by the incumbent in the monopoly region now are served by the entrant and are better off. Some consumers that previously were served by the entrant in the duopoly region now are served by the incumbent.*

The establishment of a minimum coverage on the entrant decreases the relative Coverage, and by Proposition 6 it reduces the coverage of the incumbent. The reduction of the monopoly region strengthens competition and forces a reduction of product differentiation. The joint effect of lower product differentiation and the reduction of the monopoly region is a reduction of prices.

The higher coverage of the entrant favors the switch of operator in some villages that previously were in the monopoly region. On the other hand, the reduction of relative coverage reduces the value of the indifferent consumer in each village. Some consumers that previously were served by the entrant now move to the incumbent.

To summarise, the overall number of villages served by the duopolists increases with the imposition of a minimum coverage on the incumbent and decreases with the imposition of a minimum coverage on the entrant. In spite of this, both types of regulations increase the size of duopoly area. Finally, while a regulation over the incumbent maintains the qualities and the prices of the firms unaltered, a similar regulation on the entrant reduces the qualities and the prices.

7 Competition with network externalities

This section extents the model of section 2 to introduce network externalities. Assume that consumers obtain a higher utility when they belong to a large network, as they can send letters to more addressees. We denote by b the magnitude of this network externality. In this case, one sender with type $\widetilde{\theta}$ located in one villages of the duopoly region will be indifferent between the incumbent and the entrant when

$$\widetilde{\theta}x_1 + b\mu_1 - p_1 = \widetilde{\theta}x_2 + b\mu_2 - p_2 \tag{18}$$

Therefore, when there is full participation the incumbent's demand in these villages can be written as

$$\overline{\theta} - \widetilde{\theta} = \overline{\theta} - \frac{p_1 - p_2 + b(\mu_2 - \mu_1)}{x_1 - x_2} \tag{19}$$

On the other hand, the entrant has a demand equal to $\widetilde{\theta} - \underline{\theta}$. In this new model, the demand of the incumbent will be greater the larger is his coverage with respect to those of the entrant.

Now, solving the problem of the firms as in the previous sections we obtain the following profit-maximising qualities:

$$x_1^n = \frac{4\underline{\theta} + 5K}{4c} - \frac{2b(K-1)\mu_2}{3K}; \quad x_2^n = \frac{4\underline{\theta} - K}{4c} - \frac{2b(K-1)\mu_2}{3K}. \tag{20}$$

Observe that for any given level of relative coverage K, the level of product differentiation is the same than before. In spite of this, when $K > 1$ the presence of network externalities reduces the qualities because the firms. The firms use the level of coverage as a quality attribute. With network externalities the duopolists can differentiate their products in the same extent than before but spending less in quality.

On the other hand, network externalities increase the price of the incumbent and decrease the price of the entrant. Moreover, a higher price allows the incumbent to reach more villages.

Finally, the next proposition analyses the relative coverage when there are network externalities.

Proposition 11. *For a given $\underline{\theta}$, if b is small, the entrant reduces his coverage to establish $K > \frac{4\underline{\theta}}{7}$ and as a result the product differentiation increases. If b is sufficiently large the entrant increases his coverage and $K < \frac{4\underline{\theta}}{7}$.*

Network externalities offer the consumers an additional source of utility. This implies that the incumbent can increase his uniform price with respect to the case where no externalities exists and at the same time maintain the full participation in all the villages covered. This can be undertaken with an increase of K. In spite of this, when the network externalities are sufficiently important, they reduce considerably the quality and increase the price of the incumbent. In this situation, in order to guarantee the full participation in all villages covered by the incumbent it is necessary to reduce the relative coverage. Moreover, if network externalities are very important the entrant prefers to increase his coverage than to increase the monopoly region and the product differentiation.

8 Conclusions

This paper has analysed several universal service regulations that are generally used in the postal sector. In particular, we have studied the effects of establishing a uniform price on the incumbent when the firms can endogenously determine their quality and coverage. In accordance with the previous literature, we have shown that when the incumbent is regulated with a uniform price, the entrant establishes a low level of coverage in order to enlarge the incumbent's monopoly region, force him to increase his uniform price and obtain higher profits. At the same time, the reduction of competition favors the increase of product differentiation by the duopolists. Therefore, the entrant can obtain the same increase of prices with a lower reduction of coverage.

On the other hand, we have analysed how the relation between quality and coverage is affected by network externalities. We explain that in this context, the coverage can be considered as a quality attribute. As a consequence, given fixed levels of coverage, the presence of network externalities allows firms to establish lower qualities. Besides, if the externalities are important, the entrant will prefer to increase his level of coverage even if this forces a reduction in the level of product differentiation.

The analysis of the interaction between coverage and quality helps to better understand the implications of the Universal Service Obligations (USO). In the postal sector, the USO has been traditionally designed to offer a standard service at a uniform and affordable rate. However, the liberalization of the market affects the viability of the USO in several ways. The entry in the low cost regions reduces the profitability of the incumbent and forces a reduction in the quality of the services.

In the postal sector, the establishment of a uniform quality constraint creates a clear trade-off between the coverage of the operators and the quality they can offer. This implies that the high-cost regions can only be served profitably by reducing the quality of the service. In this context, entry in the low cost villages

would call for a simultaneous reduction of the incumbent's coverage and the quality. The European Union has faced this problem by granting a reserved area to the incumbent, but it is possible to establish other mechanisms to fund the USO.[16] A solution suggested by Crew and Kleindorfer (1998) to alleviate the charge of the USO is to re-examine the role of the service standards in the sector and, in some circumstances, reduce the quality of the service. "For example, outlying areas might receive service three days a week instead of the typical five or six currently. In other areas Saturday service might be eliminated. In the United Kingdom, twice daily deliveries might be eliminated in most areas. Another variable to consider might be to slow delivery. For example, in the case of First Class post in United Kingdom, instead of providing service on the next day, First Class service would be redefined for outgoing areas to mean service on the second business day."[17]

All these approaches consider that an intervention in the postal sector is required because the entrants cream-skim the market serving only the low cost villages. In this paper, we show that, in addition, the entrants may establish a low level of coverage in order to incentive the incumbent to increase his uniform price and to modify the quality of his service. This behavior could be minimized complementing the regulation of the incumbent with the imposition of some quality and coverage regulations on the entrant. This could imply, for example, to impose the coverage of some high-cost regions or to increase the number of delivery days per week.

Appendix

Proof of Proposition 1. Maximizing W with respect to $\widetilde{\theta}$ we obtain the optimal marginal consumer in each village $\mu \in [0, \mu_2]$,

$$\widetilde{\theta} = \frac{c(x_1 + x_2)}{2}. \tag{21}$$

Substituting this expression into the welfare function in (2) and maximising with respect to the two qualities we obtain

$$-\frac{1}{2}\underline{\theta}^2 + \frac{1}{2}(\frac{c(x_1 + x_2)}{2})^2 = cx_2\frac{c(x_1 + x_2)}{2} - cx_2\underline{\theta}, \tag{22}$$

$$-\frac{1}{2}\underline{\theta}^2 + \frac{1}{2}(\frac{c(x_1 + x_2)}{2})^2 = cx_1\frac{c(x_1 + x_2)}{2} - cx_1\underline{\theta} + \frac{\mu_1}{\mu_2}[(\frac{1}{2}\overline{\theta}^2 - cX_1\overline{\theta}) - (\frac{1}{2}\underline{\theta}^2 - cx_1\underline{\theta})]. \tag{23}$$

[16] Armstrong (2001) proposes the creation of a USO fund financed by the entrants via a tax.
[17] Crew and Kleindorfer (1998).

Defining $K = \frac{\mu_1}{\mu_2}$ and solving we obtain the first part of the proportion. Finally, substituting the optimal qualities into the welfare function, assuming that $\mu_1 = \overline{\mu} = 1$ and differentiating with respect to μ_2 we obtain the entrant's optimal coverage. □

Proof of Proposition 2. Taking into account the equation of prices in (7) and (8) we obtain the following results:

$$\frac{\partial p_1}{\partial x_1} = \frac{1}{3}[(2\overline{\theta} - \underline{\theta}) + 2cx_1 + +2(K-1)] > 0, \tag{24}$$

$$\frac{\partial p_1}{\partial x_2} = \frac{1}{3}[-(2\overline{\theta} - \underline{\theta}) - cx_2 + -2(K-1)], \tag{25}$$

$$\frac{\partial p_2}{\partial x_2} = \frac{1}{3}[-(\overline{\theta} - 2\underline{\theta}) + 2cx_2 - (K-1)], \tag{26}$$

$$\frac{\partial p_2}{\partial x_1} = \frac{1}{3}[(\overline{\theta} - 2\underline{\theta}) + cx_1 + (K-1)] > 0. \tag{27}$$

When the entrant's marginal cost of quality (cx_2) is sufficiently small then $\frac{\partial p_1}{\partial x_2}$ and $\frac{\partial p_2}{\partial x_2}$ are negative.

To analyse how the modification of the qualities impact the profits of the firms observe the following results:

$$\frac{d\Pi_2}{dx_1} = \frac{\partial \Pi_2}{\partial p_1}\frac{\partial p_1}{\partial x_1} > 0, \tag{28}$$

$$\frac{d\Pi_2}{dx_2} = \frac{\partial \Pi_2}{\partial p_1}\frac{\partial p_1}{\partial x_2} < 0, \tag{29}$$

$$\frac{d\pi_1^m}{dx_1} = \frac{\partial \Pi_1^m}{\partial p_1}\frac{\partial p_1}{\partial x_1} > 0, \tag{30}$$

$$\frac{d\pi_1^m}{dx_2} = \frac{\partial \Pi_1^m}{\partial p_1}\frac{\partial p_1}{\partial x_2} < 0, \tag{31}$$

$$\frac{d\pi_1^d}{dx_1} = \frac{\partial \Pi_1^d}{\partial p_1}\frac{\partial p_1}{\partial x_1} + \frac{\partial \Pi_1^d}{\partial p_2}\frac{\partial p_2}{\partial x_1}, \tag{32}$$

$$\frac{d\pi_1^d}{dx_2} = \frac{\partial \Pi_1^d}{\partial p_1}\frac{\partial p_1}{\partial x_2} + \frac{\partial \Pi_1^d}{\partial p_2}\frac{\partial p_2}{\partial x_2}. \tag{33}$$

The signs of equations (32) and (33) depend on the entrant's level of coverage. First, observe that $\frac{\partial p_1}{\partial x_1} > \frac{\partial p_2}{\partial x_1}$. Taking into account that with the price of

equilibrium $\frac{\partial \pi_1^d}{\partial p_1} < 0$, if $\frac{\partial \pi_1^d}{\partial p_1} > \frac{\partial \pi_1^d}{\partial p_2}$ we have that $\frac{d\pi_1^d}{dx_1} < 0$. However, when the duopoly area is large it may be that the second term in the right hand-side of equation (30) is bigger than the first, because the price is closer to the one that will establish a duopolist. In this case, $\frac{d\pi_1^d}{dp_1} < 0$ is small. As a result, an increase in x_1 may generate an increase in the profit of the incumbent. For the same reason, an increase of x_2 may generate a decrease in the profit of the incumbent. □

Proof of Proposition 3. Equation (11) defines the qualities of the firms when the incumbent provides the high quality service. From them, we obtain the effect of an increase in the level of relative coverage:

$$\frac{d(x_1 - x_2)}{dK} = \frac{3}{2c}. \tag{34}$$

On the other hand, the qualities of the two firms when the entrant provides the high quality service are:

$$x_2 = \frac{4\underline{\theta} + 4 + K}{4c}; \quad x_1 = \frac{4\underline{\theta} + 4 - 5K}{4c}. \tag{35}$$

In this case, the effect of a variation in the level of relative coverage satisfies:

$$\frac{d(x_2 - x_1)}{dK} = \frac{3}{2c}. \tag{36}$$

□

Proof of Proposition 4. Consider the profit function of the incumbent. The first and second order conditions yield:

$$\frac{(2\overline{\theta} - \underline{\theta})}{2} - cx_1 + K - 1 - \frac{c}{4}\frac{(x_2^2 - x_1^2)}{(x_1 - x_2)} = 0,$$

$$-\frac{3c}{4} < 0. \tag{37}$$

Taking this into account we can write

$$\frac{dx_1}{dx_2} = -\frac{\frac{c}{4}}{-\frac{3c}{4}} > 0. \tag{38}$$

From the entrant's profit function we obtain that the first and second order conditions are

$$-\frac{(\overline{\theta}-2\underline{\theta})}{2}-cx_2-\frac{(K-1)}{2}+\frac{c}{4}\frac{(x_1^2-x_2^2)}{(x_1-x_2)}=0, \tag{39}$$

$$-\frac{3c}{4}<0. \tag{40}$$

From them we obtain

$$\frac{dx_2}{dx_1}=-\frac{\frac{c}{4}}{\frac{-3c}{4}}>0. \tag{41}$$

Therefore, the firms react less than proportionately to an increaseof the quality of their rival. □

Proof of Proposition 5. The first order conditions of Π_2 with respect to μ_2 is always negative. The result of the proposition are obtained considering that $K=\frac{4\overline{\theta}}{7}$. □

Proof of Proposition 6. The first and second order conditions of the incumbent's profit with respect to μ_1 are

$$\frac{1}{2c}(\frac{3K}{2})^2-f(\mu_1), \tag{42}$$

$$\frac{3}{2c\mu_2}(\frac{3K}{2})-f'(\mu_1)\leq 0. \tag{43}$$

The second-order condition is only satisfied when the cost function $F(\mu_1)$ is sufficiently convex. In this case,

$$\frac{d\mu_1}{d\mu_2}=-\frac{-\frac{9\mu_1^2}{4c\mu_2^3}}{\frac{9\mu_1}{4c\mu_2^4}-f'(\mu_1)}<0. \tag{44}$$

For the second part of the proposition note that the entrant always prefers to reduce μ_2 until $K=\frac{4\overline{\theta}}{7}$. When the incumbent increases μ_1 the entrant modifies μ_2 to maintain K constant at $\frac{\mu_1}{\mu_2}=\frac{4\overline{\theta}}{7}$. □

Proof of Proposition 10. An increase of μ_2 decreases the level of relative coverage.

$$\frac{dK}{d\mu_2}=\frac{1}{\mu_2}(\frac{d\mu_1}{d\mu_2}-K)<0. \tag{45}$$

The indifferent consumer can be defined as

$$\widetilde{\theta} = \frac{1}{3}[(\overline{\theta} + \underline{\theta}) + \frac{c}{2}(x_1 + x_2) + (K-1)] = \underline{\theta} + \frac{K}{2}. \tag{46}$$

Therefore, the value of the indifferent consumer decreases with a reduction of K. □

Proof of Proposition 11. With network externalities the incumbent's price is

$$p_1 = \frac{1}{3}[(x_1 - x_2)(2\overline{\theta} - \underline{\theta}) + cx_1^2 + \frac{c}{2}x_2^2 + (K-1)(b\mu_2 + 2(x_1 - x_2))]. \tag{47}$$

For a given $\underline{\theta}$ and $K = \frac{4\underline{\theta}}{7}$ we have

$$\underline{\theta}x_1 + b\mu_1 - p_1 = \frac{-b\mu_2(bc\mu_2(7-4\underline{\theta})^2 + 12(1-4\underline{\theta})\underline{\theta}^2)}{72\underline{\theta}^2}. \tag{48}$$

For a small b this equation is negative and for a great b it is positive.

Consider now the profit of the entrant with network externalities. When b is large the entrant prefers to increase his coverage instead of product differentiation.

$$\Pi_2 = \frac{\mu_2 3K}{92c}(\frac{3K}{2} + \frac{b(K-1)\mu_2(4-3K)}{3K})^2 - F(\mu_2). \tag{49}$$

Differentiating this expression with respect to μ_2 we observe that for a sufficiently large b the entrant sets $\mu_2 > \frac{7\mu_1}{4\underline{\theta}}$, which implies a greater relative coverage than without externalities. □

References

[1] Anton, J., J. Vander Weide, N. Vettas (1998) Strategic Pricing and Entry under Universal Service and Cross-Market Pricing Constraints, *International Journal of Industrial Orgnization*,20, pp.611-629.

[2] Armstrong, M. (2001) Access Pricing, Bypass, and Universal Service, *American Economic Review*, May, Vol. 91, No. 2, pp. 297-301.

[3] Chon, P., L. Flochel and A. Perrot (2000) Universal Service Obligations and Competition, *Information Economics and Policy* , 12 (3), pp. 249-259.

[4] Cremer, H., M. De Rycke, A. Grimaud (1997) Service Quality, Competition, and Regulatory Policies in the Postal Service, *Journal of Regulatory Economics* , 11 (5), pp. 5-19.

[5] Cremer, H., F. Gasmi, A. Grimaud and J.-J. Laffont (1998) *Economics of Universal Service: Theory*, The Economics Development Institute of the World Bank, Washington DC.

[6] Cremer, H., F. Gasmi, A. Grimaud and J.-J. Laffont (2001) Universal Service: an Economic Perspective, *Annals of Public and Cooperative Economics*, Vol. 72. No. 1, pp. 5-43.

[7] Cremer, H., A. Grimaud, J.-P. Florens, S. Marcy, B. Roy and J. Toledano (2001) Entry Competition in the Postal Market: Foundations for the Construction of Entry Scenarios, *Journal of Regulatory Economics*, 19 (2), pp. 107-121.

[8] Cremer, H., M. Marchand, J.-F.Thisse (1991) Mixed Oligopoly with Differentiated Product, *International Journal of Industrial Organization* , 9, pp. 43-53.

[9] Cremer, H., J.-F. Thisse (1994) Commodity taxation in a differentiated oligopoly *International Economic Review* , 35, pp. 613-633.

[10] Crew, M.A. and P.R. Kleindorfer (1998) Efficient Entry, Monopoly and the Universal Service Obligation in Postal Service, *Journal of Regulatory Economics* , 14 (2), pp. 103-25.

[11] Crew, M.A. and P.R. Kleindorfer (2000) Liberalisation and the Universal Service Obligation in Postal Services, in M. A. Crew and P. R. Kleindorfer (eds.) *Current Directions in Postal Reform*. Boston. Kluwer Academic Publishers.

[12] Crew, M.A. and P.R. Kleindorfer (2001) Whither the USO under Competitive Entry, in M. Crew and P. Kleindorfer (editors), *Future Directions in Postal Reform* . Kluwer Academic Publishers.

[13] Crew, M. A. and P.R. Kleindorfer (2003) Access and the USO for Letters and Parcels, in M.A. Crew and P.R. Kleindorfer (eds.) *Competitive Transformation of the Postal and Delivery Sector*. Boston, MA: Kluwer Academic Publishers.

[14] Crew, M.A. and P.R. Kleindorfer (2004) Access and the USO for letters and Parcels, in M. Crew and P. Kleindorfer (editors), *Competitive Transformation of the Postal and Delivery Sector* . Kluwer Academic Publishers.

[15] Crew, M.A. and P.R. Kleindorfer (2005) Competition, Universal Service and the Graveyard Spiral, in M. Crew and P. Kleindorfer (editors), *Regulatory and Economic Challenges in the Postal and Delivery Sector* . Kluwer Academic Publishers.

[16] Fabra,N., A. Escribano and P. Gagnepain (2004) Competition in Postal Markets: Quality, Coverage and Universal Service, *Mimeo* .

[17] Gasmi, F.J.-J. Laffont and W.W. Sharkey (2000) Competition, universal service and telecommunications policy in developing countries. *Information Economics and Policy* , 12 (3), pp. 221-248.

[18] Laffont, J.-J., and J. Tirole (2000) *Competition in Telecommunications* . The MIT Press, Cambridge, MA.

[19] Moorthy, S. (1988) Product and Price Competition in a Duopoly, *Marketing Science* , 7, pp. 141-168.

[20] Mussa, M. and S. Rosen (1978) Monopoly and Product Quality, *Journal of Economic Theory* , 18, pp. 301-317.

[21] Rodriguez, F., and D. Storer (2000) Alternative Approaches to Eestimating the Cost of USO in Post, *Information Economics and Policy* , 12, pp. 285-299.

[22] Ronnen, U. (1991) Minimum Quality Standards, Fixed Costs, and Competition, *RAND Journal of Economics* , 22 (4), pp 490-504.

[23] Rosston, G. and B. Wimmer (2000) The State of the Universal Service, *Information Economics and Policy* , 12 (3), pp. 261-83.

[24] Valletti, T., S. Hoernig and P. Barros (2002) Universal Service and Entry: The role of uniform pricing and coverage constraints, *Journal of Regulatory Economics* , 21:2, pp. 169-190.

[25] Valletti, T. (2000) Minimum Quality Standards under Cournot Competition, *Journal of Regulatory Economics* , 18(3), pp. 235-45.