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COMPETITION, PRICING AND UNIVERSAL SERVICE IN THE POSTAL SECTOR

Universal Service Financing in Competitive Postal Markets: One Size Does Not Fit All

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Universal Service Financing in Competitive Postal Markets: One Size Does Not Fit All

Axel Gautier and Dimitri Paolini

Abstract

In the postal sector, the financial burden of the universal service depends on its content, the postal market characteristics and the country's geographical configuration. These three groups of factors affect both the direct cost of providing the service and the extent of competition on the market. In this paper, we consider countries with different geographical characteristics and we show that the choice of an appropriate mechanism to share the burden of universal service between market participants depends on the country configuration. Thus, for universal service financing, one size does not fit all.

KEYWORDS: universal service obligations, compensation fund, market liberalization, cream-skimming

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1. Introduction

In the European Union, Full Market Opening (FMO) of postal markets is now scheduled for 2011. FMO allows competitors of the incumbent postal operator to enter all the segments of the postal markets including mail delivery. At the same time, high standards for the universal service (daily collection and delivery, nationwide coverage, affordable tariffs) are maintained. In a liberalized postal market, competition may be a threat for the financing of the universal service. Indeed, new postal firms that are not subject to any universal service constraint will compete for the most profitable market segments, leaving the less profitable ones to the universal service provider, a phenomenon known as cream-skimming. This is currently the case in the European countries that already experienced FMO (and a substantial level of competition): new postal companies target the most profitable products (non-urgent bulk mail, for instance) and deliver mail in the most densely populated regions only, leaving the sparsely populated regions to the historical operator. FMO is thus a threat for the financial viability of the universal service provider (hereafter USP). And in a competitive market, the USP might be unable to maintain the same level of service.

Fulfilling universal service obligations (hereafter USO) is usually costly for the firm in charge. The cost of complying with the USO depends on three groups of factors: the definition of universal service (and, incidentally, its measurement), the postal market characteristics and the country's geographical configuration. Universal postal service is usually defined along three lines: the scope of products, the quality in its multiple aspects and the price constraints on universal service products. The precise content of these obligations differs substantially across countries (Ambrosini *et al.*, 2006) and the cost of complying with the obligations depends on their definition. Postal market characteristics, such as the mailing volume per inhabitant, the composition of the mail stream, the efficiency and the productivity of the historical operator, as well as the country's geographical characteristics such as the population density, the grouping index, the country's hilliness have an impact on the cost of handling and delivering mail and thereby on the profit of the USP.

These three groups of factors have a twofold impact on the cost of providing the universal service. They have a direct impact on the cost of producing the service and an indirect impact as they affect the extent of competition on the market. Valletti *et al.* (2002) show that the nature of price competition and the extent of coverage by incoming firms are altered by the imposition of coverage and/or uniform price constraints. Bloch and Gautier (2008) show that the efficiency of the USP determines the mode of delivery (access or bypass) adopted by competing postal operators. d'Alcantara and Gautier (2008) show that the countries' geographical characteristics have a major

impact on the entrant's scale of operations and on the profits of the historical operator. Thus the ability of the USP to finance the universal postal service in a liberalized environment depends on the definition of USO, the market, and the geographical characteristics. Heterogeneous countries are hence likely to be in different situations regarding the sustainability of the USO after FMO (PricewaterhouseCoopers, 2006).

Universal service may be non-sustainable in a liberalized environment. Moreover, even if universal service is sustainable, its financial burden may place the USP at a competitive disadvantage. For that reason, according to the third postal directive, whenever universal service obligations represent an *unfair financial burden* for its provider, the national regulator may introduce a compensation mechanism. The postal directive leaves two options to regulators: public compensation and cost-sharing between service providers. In this paper, we concentrate on the second option only. The idea is to create a universal service fund dedicated to the financing of the USO. This fund is fed by contributions from all market participants. In this paper, the tax is fixed at a level that guarantees a sustainable universal service in a competitive environment.[1]

Regulator must choose an appropriate tax base to finance the universal service fund. The choice of tax instrument and tax level has an impact on market prices, profits, the extent of competition and welfare (Anderson *et al.,* 2001, Choné *et al.*, 2002, Borsenberger *et al.*, 2010, Jaag and Trinkner, 2010). In this paper, we compare a series of tax instruments including an output tax, a revenue tax, an entry fee, a tax on covered routes and a pay-or-play. These USO funding mechanisms (and the USO themselves) are not '*competitively neutral*' as they affect the way firms compete on the market. With a USO funding mechanism, competitors' behavior might be modified in three different ways. The tax can induce (1) a change in the entrant's market behavior (2) a change in the entrant's scale of operations and (3) a change in the firm's entry decision. A change in the market behavior of the competitors can be either an induced change in the price reaction of the entrant in response to a fund collection scheme or a change in the bundle of products offered. Secondly, due to the funding mechanism, the operating scale of the competitors may change. Some routes, services or products, profitable before the imposition of a compensation mechanism may no longer be profitable afterwards. Or, under a pay-or-play mechanism, an operator may extend its operation if the play option turns out to be more profitable than the pay option. Note that the extent of entry has a second-order effect on the price charged by the firms, especially when a uniform pricing

[1] According to Boldron *et al.* (2009), "the burden (of the USO) is unfair if the USP's market power is not sufficient to counterbalance the weight of the USO to maintain a reasonable profit and is financially unsustainable if the USP incurs losses."

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constraint applies. In this case, larger market coverage triggers a more aggressive price reaction by the incumbent. Lastly, the funding mechanism may act as a barrier to entry and it may deter competitors from entering the market. In Finland for instance, the licensing requirements include a turnover tax for the operators that do not serve sparsely populated regions and it is considered as one of the main entry barriers. Currently, despite FMO, the historical operator still enjoys a monopoly position on the letter market.

The distortions induced by these taxes are not equivalent and different taxes lead to different market outcomes. In this paper we consider three hypothetical countries with heterogeneous geographical characteristics (as in d'Alcantara and Gautier, 2008) and we compare, for each country, the market outcome with the different tax instruments. We consider three countries that differ according to the amount of cross-subsidies in the pre-FMO monopoly situation. To be more precise, we consider:

- a "dual" country with two distinct regions, a large profitable urban region and a large unprofitable rural one;
- an "homogenous" country where a majority of the addresses are located in a fairly urbanized region;
- an intermediate "monotone" configuration.

The estimated market outcomes after FMO differ sharply in these three countries, with substantial differences in market coverage, for instance. This echoes the observed differences across European postal markets, where alternative end-to-end operators have nationwide coverage in The Netherland but cover only 40% of the addresses in Sweden, mainly the largest agglomerations.

The USO financing issue is a well-known story in theory but a very complex issue in practice. In this paper, we use a series of calibrated numerical examples to compare the various tax instruments. Our objectives are multiple. Firstly, we would like to estimate the distortions in prices and market coverage induced by the taxes. As we show in the paper, different taxes lead to substantially different market outcomes making the choice of an appropriate tax base sensitive. Second, our numerical simulations aim at deriving plausible values for the different taxes in the three country configurations. This is particularly interesting because a tax estimation based on a computation of the net cost of USO is likely to be misleading if it fails to recognize the distortionary effect of the tax.[2] For instance, if the cost estimate is based on a market scenario where an entrant covers half of the addresses and, after a tax is imposed, the entrant decreases substantially its coverage, the initial cost estimate is likely to be

[2] Jaag *et al.* (2009), Gautier and Wauthy (2010b).

wrong. And compensation for the USP based on this estimated cost is inappropriate because *the USO costing exercise is endogenous to its funding*.[3] Finally, we would like to shed light on the question of the most appropriate tax instrument. As the title of the paper suggests, we find that the optimal tax instrument depends on the country configuration and thus *one size does not fit all*.

2. The model

2.1 The base model

We consider three different countries with an identical population of N households. Households have a homogenous size and countries differ with respect to the distribution of households on their territory (see after).

In each country, there are two postal firms, the historical operator, firm I, and an entrant, firm E. As part of the USO, the incumbent operator must deliver mail nationwide at least five working days a week. There are no universal service constraints imposed on the entrant, who may then deliver mail less frequently only to part of the national territory. As results, products are not homogenous and firms have different cost structures.

The number of mailing items send to a household x depends on mail prices and on the bundle of products offered at x i.e., whether or not the entrant delivers mail at x. When the entrant covers x, the net utility a representative sender gets from mailing to x is given by:

$$U(q_i,q_e) = a_i q_i + a_e q_e - b_i \frac{q_i^2}{2} - b_e \frac{q_e^2}{2} - d q_i q_e - p_i q_i - p_e q_e$$

where q_i, q_e are the number of mails sent to x and p_i, p_e, their respective stamp prices. Duopoly demand functions, $q_i^D(p_i,p_e)$ and $q_e^D(p_i,p_e)$, are derived from the consumer's net utility maximization problem. When x is not covered by the entrant, the net utility of a representative sender is $U(q_i,0)$ and utility maximization gives the (monopoly) demand function, $q_i^M(p_i)$, for the incumbent.

The postal value chain consists of several activities. For each firm, we distinguish the upstream (collection and transport) and downstream (sorting and delivery) activities and we decompose the total cost between these two tasks. Because of the universal service, firms have a different cost structure. Panzar (1991) and de Bijl *et al.* (2006) among others argue that, unlike other network industries, a postal delivery network requires little sunk costs, since the main costs are workers, vehicles and buildings. Therefore, we consider that all the long run

[3] Boldron *et al.* (2009).

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costs of the entrant are variable. Things are different for the incumbent because of the universal service obligations usually imposed. If the incumbent must deliver nationwide with a given frequency (five or six times a week) and/or maintain services (delivery, post offices) in remote areas, this can generate substantial fixed costs, even in the long run.

The per-unit upstream costs, denoted c_i for the incumbent and c_e for the entrant, are constant, reflecting the fact that these activities are operated under constant returns to scale. The structure of the downstream (or delivery) cost differs among firms. For the incumbent, delivery at x involves two kind of costs: a fixed cost $F(x)$ per address and a constant cost per item d_i, which is, unlike the fixed cost, independent of the receiver's location. The fixed cost in the delivery activity results from the imposition of universal service obligations on the incumbent. The fixed cost per location depends on the characteristics of the receiver's location. Two main drivers of this cost are the grouping index (the number of delivery points per stop points) and the population density (Roy, 1999). These factors influence both the optimal delivery mode (pedestrian, bike or motorized) and the cost of delivery for each mode.

For the entrant, there is no fixed cost in delivery. The per-unit downstream cost is denoted by $d_e(x)$ and it depends on the receiver's location. Panzar (1991) and de Bijl *et al.* (2006) document significant economies of scale in the delivery activity. By taking a constant delivery cost for the entrant, we implicitly assume that the entrant manages to capture a sufficiently large fraction of the mail stream to exploit these economies of scales. The entrant can exhaust the economies of scale by delivering larger volumes at a lower frequency.

Addresses x are ranked according to their delivery cost and these costs depend on the geographical characteristics at x (grouping index, population density, hilliness). Thus, the ranking of addresses according to their cost is identical for the two firms: $\partial F(x)/\partial x \geq 0$ and $\partial d_e(x)/\partial x \geq 0$. Later, we will make a stronger assumption and presume that the shape of the two functions $F(x)$ and $d_e(x)$ is identical. Since households are identical except for their delivery cost, the entrant who is not bounded to nationwide coverage will serve the lowest cost households first. Let us denote by n_e, the index of the last covered household. The whole set of addresses decomposes into a subset $[0,n_e]$ of contested addresses and a subset $[n_e, N]$ of insulated addresses where the historical operator remains as a monopolist.

When the entrant delivers to a subset n_e of the population, the profits of the incumbent and the entrant are respectively:

$$\Pi_i(p_i,p_e) = n_e(p_i - c_i - d_i)q_i^D + (N - n_e)(p_i - c_i - d_i)q_i^M - \int_0^N F(\tau)d\tau,$$

$$\Pi_e(p_i,p_e) = \int_0^{n_e} (p_e - c_e - d_e(\tau))q_e^D d\tau.$$

The first term in Π_i is the profit made by the incumbent on the n_e contested addresses; the second term is the profit made on the remaining $(N\text{-}n_e)$ isolated addresses and the last term is the fixed cost associated with a daily nationwide delivery.

The entrant's average delivery cost AC_e is equal to $\int_0^{n_e} d_e(\tau)d\tau / n_e$ and the entrant's profit can be expressed as:

$$\Pi_e(p_i, p_e) = n_e(p_e - c_e - AC_e)q_e^D .$$

Firms compete in prices. We suppose that, in a liberalized market, the historical operator is freed from price regulation except for the uniform price constraint that may still be imposed. The incumbent thus serves all the addresses at a uniform price p_i but the price level is not constrained.[4] The entrant serves only the addresses that are profitable at current market prices. Given that the entrant has a unit delivery cost that depends on the receiver's location, profit maximization calls for a different price for each address. Such a pricing behavior would make the entrant's tariff quite opaque and might be difficult to implement. Moreover, using a location-dependent stamp price would make the model complex to solve. For these reasons, we consider that the entrant applies a unique stamp price to the whole set of addresses it serves.[5,6] There are thus only two prices, p_i and p_e and no firm can discriminate among locations.

In the base market scenario with USO, we consider the following timing of the events:

1. The incumbent sets its price p_i
2. The entrant set its price p_e and decides on its market coverage n_e.

The entrant's price and coverage are given by:

$$\phi_e(p_i) = \arg\max_{p_e} \ \Pi_e(p_i, p_e),$$

$$n_e(p_i) = \arg\max_{n_e} \ \Pi_e(p_i, p_e).$$

The optimal prices (p_i^*, p_e^*) solve

$$p_i^* = \arg\max_{p_i} \ \Pi_i(p_i, \phi_e),\ p_e^* = \phi_e(p_i^*).$$

[4] In other words, market opening is a substitute to price regulation that eventually prevailed before FMO.

[5] As for the incumbent, the imposition of a uniform price constraint alters the entrant's market behavior, especially coverage decision (see Hoernig, 2006).

[6] For the entrant, the variation in the delivery cost across covered addresses is limited because it concentrates exclusively on the low-cost locations. The uniform price assumption may then be not so demanding.

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The equilibrium is unique and prices are strategic complements. The optimal market coverage is such that the entrant realizes a zero profit on the last covered address:[7]

$$(p_e^* - c_e - d_e(n_e^*))q_e^D(p_i^*, p_e^*) = 0$$

The effect of coverage on prices is *a priori* ambiguous: On the one hand, a higher coverage increases the entrant's average cost, and this pushes prices upward. On the other hand, a higher coverage makes the incumbent more aggressive in the price game and this pushes prices downward.

2.2 Financing universal service

In our base model, the incumbent may not be able to finance the universal service. This happens when optimal prices and coverage lead to $\Pi_i<0$. In this case, the combination of universal service and competition leads to the bankruptcy of the universal service provider and the USO are not sustainable without a subsidizing mechanism.

2.2.1 The financial burden of the universal service

Third postal directive (2008/6/EC) details the procedures that member states must follow to finance the universal service:

'Where a Member State determines that the universal service obligations, as provided for in this Directive, entail a net cost, calculated taking into account Annex I, and represent an unfair financial burden on the universal service provider(s), it may introduce (a) a mechanism to compensate the undertaking(s) concerned from public funds; or (b) a mechanism for the sharing of the net cost of the universal service obligations between providers of services and/or users.' (2008/6/EC, Article 7§3).

Before granting compensation for providing the universal service, it must be established that it entails a net cost and that it represents an unfair financial burden.

The third postal directive contains guidance for how to measure the net cost of USO. The recommended measure is similar to the *profitability cost* of Panzar (2000) and Cremer *et al*. (2000).[8] According to the profitability cost approach, the net cost of the USO is measured as the difference between the

[7] With sequential decisions, the entrant has no incentives to strategically limit its market coverage (Valletti *et al.*, 2002).

[8] See Jaag *et al.* (2009) for a detailed discussion on the method for estimating the net cost of the USO prescribed by the third postal directive (Annex 1).

USP's profit in a market scenario with competition and USO and a counterfactual scenario with competition but without USO (the so-called '*unsubsidized market scenario*'). The net cost of the USO is thus the lost profit incurred by the USP specifically due to the imposition of USO independently of the liberalization process since in both scenarios the USP faces competition.

Whether this estimated net cost of the USO represents an unfair burden on the USP is a debatable question. For Boldron *et al.* (2009), several criteria of unfairness can be relevant, depending on the specific national situation: (i) When the burden exceeds a given share of USP's profits, (ii) when it prevents the USP to make a "reasonable profit" defined for the postal sector or (iii) when the USP's profits are obviously under proportionate compared to those of its competitors.

The choice of an appropriate criterion for fairness is obviously crucial as it determines whether or not the USP is eligible for compensation and the level of the funding. In the literature[9], criterion (ii) has often been used. The regulator must ensure that the universal service is indeed provided and that the USP collects a sufficient level of profit Π_0. A standard participation constraint with an exogenous outside option is thus added to the regulatory design problem. In the sequel, we will follow this approach and we will further assume that the USP's outside option, Π_0, is normalized to zero. The regulatory environment must be such that the universal service is *sustainable* in a competitive environment. In this view, the USP's compensation need does not correspond to the estimated net cost of the USO.

Finally, notice that financing the USP's deficit is legitimate only if (i) the operator is efficient i.e. costs are best-practice costs[10] and (ii) the USP realizes a non-negative profit in the unsubsidized market scenario.

2.2.2 The universal service fund

Different mechanisms can be used to finance USO (see Oxera, 2007 for a discussion related to the postal sector). In this paper, we consider a *universal service fund* that has the following features: first, the money collected by the fund is integrally transferred to the universal service provider. Second, the fund is financed by a uniform tax paid by all market participants and third, the tax rate is set at a level that guarantees a nil profit for the incumbent inclusive of the tax proceeds (as in Borsenberger *et al.*, 2010). All these assumptions imply that the tax does not modify the incumbent's behavior since any amount it pays to the fund is integrally paid back as compensation for the universal service. This, obviously, is not true for the entrant.

[9] For instance in Crew and Kleindorfer (1998), De Donder (2006) and Borsenberger *et al.* (2010).
[10] Inefficiencies resulting from the *imposition* of the universal service obligations might still be tolerated.

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We consider the following possible taxes:

- A lump-sum entry fee.
- An output tax on each mailing item.
- A revenue tax, proportional to the turnover.
- A coverage tax on each address covered by the entrant.
- A tax on each address that the entrant does not cover. This tax is a form of pay-or-play since the entrant has the choice between covering an address and contributing to the fund.

All these taxes are uniform i.e. independent of the mail destination.

In the subsidized scenarios, the timing of the events is modified as follows:

1. The regulator decides on a tax instrument.
2. The incumbent sets its price p_i.
3. The entrant set its price p_e and decides on its market coverage n_e.
4. The tax is set at level such that the incumbent profit plus the tax revenue is equal to zero.

2.2.3 The impact of the taxes

Taxes are not competitively neutral. The taxes affect the entrant's pricing and coverage behavior, which, in turn, trigger a reaction by the incumbent.[11] For greater clarity, let us consider for a while that the incumbent's price remains the same. At a given price p_i, the imposition of a tax potentially has two different impacts on the entrant. First, it can modify the entrant's best reply function ($\phi_e(p_i)$). Second, it can modify the number of routes where the entrant has decided to compete ($n_e(p_i)$). Table 1 lists and signs the impact on the price and market coverage of all possible taxes.

	Entry fee	*Output tax*	*Turnover tax*	*Coverage tax*	*Pay-or-play*
Price	=	+	+	=	=
Coverage	=	-	-	-	+

Table 1: Impact of taxes on the entrant's price and coverage for a given p_i

[11] The universal service itself is not neutral and the imposition of obligations such as a uniform price constraint or a universal coverage constraint modifies the way firms compete (Valletti *et al.* 2000, Gautier and Wauthy, 2010a).

The revenue and the turnover taxes shift the best reply function upward, leading to a higher price p_e. At the same time and despite the price increase, these taxes reduce the profit from each covered address. Thus, the entrant delivers mail to a smaller portion of the country. Taxes on covered or on non-covered routes do not modify the pricing behavior -the function ϕ_e is left unchanged- but they respectively decrease or increase the market coverage. An entry fee does not change the price nor the coverage but it can eventually modify the decision to compete as it may deter the firm from entering the market. Anticipating a modification in its rival behavior, the incumbent adapts its price in the first place. Our calibrated model aims at quantifying these effects.

2.2.4 Comparing tax instruments

Comparing the different tax instruments is far from obvious because the break-even tax proceeds are endogenous to the choice of a tax instrument. For that reason, our comparisons are based on a numerical exercise; some preliminary remarks on the choice of tax instrument are made in this section.

Suppose that the aggregate industry profits ($\Pi_i+\Pi_e$) are positive. In such a case, if the historical operator is not able to cover all its cost ($\Pi_i<0$), a lump-sum transfer from the entrant can be used to sustain the USO. An entry fee equal to $-\Pi_i$ is compatible with competition on the market and does not affect the entrant's behavior who keeps the same price and maintains the same coverage. When this tax instrument is available, it is likely to be optimal.[12]

When aggregate profits are negative, a lump-sum fee equal to the incumbent's losses would act as an entry barrier. The entrant would no longer be able to have positive after-tax profits and, therefore, it refuses to compete with the historical operator. *A distortionary tax is then a necessary condition for a sustainable USO*.

A distortive tax finances the USO through two different channels: firstly, the tax is an additional source of income for the USP. Secondly, the tax reduces competition on the market: price competition is less fierce and/or the entrant has a lower coverage[13] (cfr. Table 1) and, thereby, the incumbent's profit increases. Hence, the total revenue for the incumbent (profit + tax revenue) increases with the level of the tax. The regulator must choose the tax level that leaves a zero profit to the USP. However, such a tax may not be compatible with competition on the market. Indeed, a higher tax means that the entrant's profit decreases and it

[12] For Mirabel *et al.* (2009) using a non-neutral instrument is recommended since it can countervail the inefficiencies created by the universal service.

[13] Except for the pay-or-play that, incidentally, intensifies competition. For that reason, the pay-or-play (as we have defined it) is probably not an appropriate option for the postal sector.

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is not always possible to find a distortionary tax such that aggregate industry profits are positive. For that reason, the most distortionary tax instruments (on the output and the revenue) should not be dismissed *a priori*. Indeed, these might be the only taxes compatible with competition on the market and universal service provision.

The comparison between output and revenue taxes has a long tradition in public economics. Anderson *et al.* (2001) show that unit taxation can be more efficient than *ad-valorem* taxation under Bertrand competition with differentiated products when the aggregate demand is sufficiently inelastic and firms produce at different costs, two assumptions that we made in this paper. In a related paper, Borsenberger *et al.* (2010) study the issue of the appropriate tax base. They compare *ad-valorem* and output taxes and find that the latter dominates the former when the tax rate is uniform (applied equally to all products and operators). With a uniform tax, the universal service product (the single-piece letter) is taxed, and, accordingly, the preferred tax is the one that imposes the lowest tax burden to the USP. The entrant's share of the total output is likely to be larger than its share of the total revenue mainly because of the specific price and mark-up structures in postal activity. The more contestable segment (bulk mail) is the one with the lowest price (generating high volume and low revenues) but the highest mark-up, whereas the market with the highest price (single piece mail) is also the one with the lowest mark-up. Thus the entrant's contribution to the USO financing is proportionally higher with the output tax. In line with these works, we find, in our numerical simulations, that *ad-valorem* taxes are dominated by output taxes.

3. Calibrated market outcomes

3.1 Calibration hypothesis

We consider three hypothetical countries with an identical population of 2m households. Households are identical except for the fact that they are located in different geographical areas with different associated delivery costs.

We use the following parameters to calibrate the demand functions: (1) At a price of 0.40€, the mail demand faced by a monopoly incumbent is equal to 200 items per household. (2) The price elasticity of the monopoly demand function is equal to -0.2. (3) At equal prices, 20% of the mail items to households x are delivered by the entrant and (4) when the entrant is 20% less expensive, this proportion increases to 50%. (5) The displacement ratio is equal to 0.9. The displacement ratio (Armstrong *et al.*, 1996) measures the business stealing effect of the competitor on the incumbent's mailing volume. A displacement ratio of 0.9

is commonly accepted for the postal sector.[14] This means that 90% of the mails carried by the entrant are 'stolen' from the incumbent.

We assume that p_i=0.40€ is the monopoly break-even price with a volume per household equal to 200. Costs and revenues at this price are both equal to 160m€. To calibrate the incumbent's cost parameters c_i, d_i and $F(x)$, we assume that 70% of the total costs incurred at the monopoly break-even price are fixed. Thus, the variable costs per item c_i+d_i are equal to 0.12€. The fixed cost per-receiver depends on its location x. To calibrate the function $F(x)$, we use two types of information: (1) the ratio between the average unit delivery cost in the first and the last quintile is equal to 5. This value is in line with those estimated by Boldron *et al.* (2006).[15] (2) We specify the shape of the function $F(x)$ and we consider that it differs across countries. For each country, the total fixed cost is equal to 112 m€ but the distribution of this cost along the country differs.

In country 1, the **homogenous** configuration, 60% of the addresses are located in a fairly urbanized region with a fixed cost per address equal to 56€ per year. In country 2, the **monotone** configuration, the fixed cost per address is monotonically increasing from 22.4€ per year in the first quintile to 112€ in the last quintile. In country 3, the **dual** configuration, there is a large urban region (40% of the country) and a large rural region (40% of the country) and fixed delivery costs are respectively equal to 22.4€ and 112€. Figure 1 represents the fixed cost per household in the three hypothetical countries we consider.

The total fixed cost (the area below the curves in figure 1) is identical for all three configurations and only its distribution among addresses differs. Thus, the monopoly solution under uniform price and universal coverage constraints is identical. The only difference is the relative importance of cross-subsidies. At the break-even price of 0.40€, the loss-making addresses that the firm must serve as part of the USO account for a deficit of 14.9m€, 23.3m€ and 33.5m€ in the homogenous, monotone and dual configuration compensated by an equivalent profit realized on the profitable addresses.

[14] De Donder *et al.* (2006).

[15] They estimate a ratio of 3.1 for UK & Wales, 4.3 for France, 4.4 for Germany, 4.9 for Italy and 7.7 for Spain.

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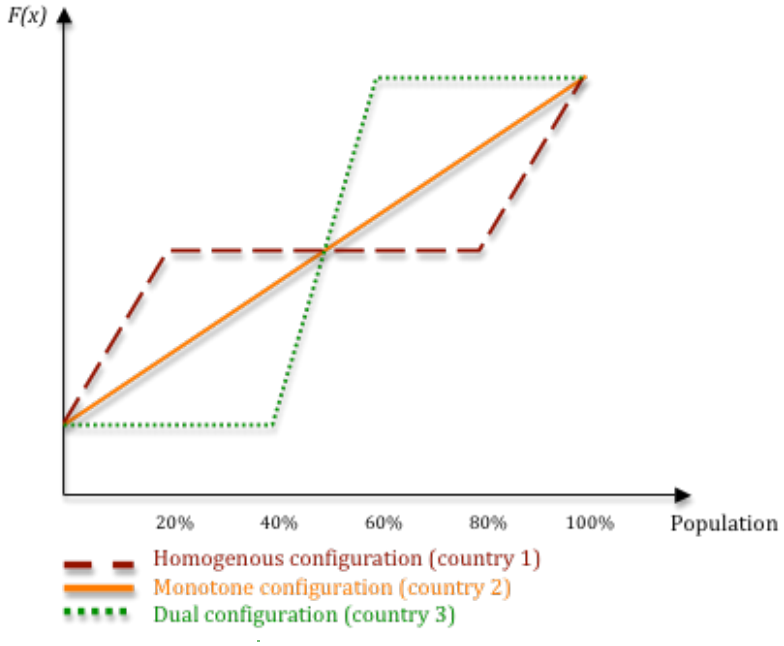

Figure 1: The three country configurations

Last, we must parameterize the entrant's cost function. We assume that the entrant's unit cost of handling a unit of mail to x is 20% lower than the average unit cost of an incumbent monopolist. The entrant's cost is thus $c_e+d_e(x)=0.8[c_i+d_i+F(x)/200]$ and this cost has the same shape as $F(x)$, represented on figure 1.

The entrant's cost is computed on the basis of the monopolist's average cost at x but the actual cost differential will be larger than 20%. Indeed, consider a location x where the incumbent's average cost is equal to 0.40€ before market opening. The entrant's cost of delivering a unit of mail to x is 20% lower that is to say 0.32€. Now suppose that the incumbent looses half of the mail stream to x, its actual average cost increases to 0.68€ because of the fixed cost. In this case, the entrant is 53% cheaper than the incumbent for delivery at x.

Our model is thus calibrated to give a large cost advantage to the entrant. The entrant can create such an advantage by offering low cost products (less frequent delivery, pre-sorted mail, fewer postal counters…) and hiring cheaper staff.[16]

[16] Heitzler and Wei (2010) document that, in (former West) Germany, the delivery staff's hourly wage (7.71€) paid by the competitors (before the introduction of the minimum wage legislation) is 37% lower than the corresponding wage paid by the incumbent (12.13€).

3.2 Calibrated results

3.2.1 The profitability net cost of the USO

In this section, we present our numerical simulations. For each country, our starting point consists of two market scenarios: (1) a scenario with competition but without USO, the 'unsubsidized market scenario' and (2) a scenario with competition and universal service obligations (uniform price + universal coverage) imposed on the incumbent but without universal service financing. To avoid additional assumptions on the incumbent's cost structure and the degree of product differentiation, we consider that the products offered by the firms are identical in all the market scenarios. These two market outcomes illustrate that countries, that were identical before FMO (same break-even price, same welfare), are no longer identical after market liberalization. In particular, the market penetration of the entrant varies considerably across countries (as in d'Alcantara and Gautier, 2008) with consequences on the firms' profitability and the USO funding.

	Homogenous	*Monotone*	*Dual*
n_e	20%	35%	46%
n_i	87%	78%	57%
p_i (€)	0.43-0.76	0.28-0.76	0.32-0.76
p_e (€)	0.32	0.27	0.27
Π_i (m€)	34.5	17.8	10.9
Π_e (m€)	7.9	2.8	7.1

Table 2: Unsubsidized market scenario: competition, no USO

Table 2 reports summary results for the scenario without USO. In this case, firm I can price discriminate between contested and non-contested routes. On the latter it applies the monopoly price of 0.76€. On the former, standard price competition takes place. When the incumbent is relieved from the USO, it serves only the profitable addresses (n_i). 13% of the addresses in the homogeneous country, 22% in the monotone country and 43% in the dual country are not profitable even for a monopolist. Competition is limited to the low-cost addresses and thus the country configuration is a key determinant of the degree of competition. Competition is rather limited in the homogenous country and intense in the dual one.[17]

[17] When competition is limited, the regulator may impose some form of price regulation.

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Table 3 reports summary results for our base market scenario with competition and USO. In this case, firm I must have nationwide coverage and it can no longer price discriminate. The most noticeable effects are the sharp drop in the incumbent's profit and the large increase in the entrant's profit. The magnitude of these two related effects depends on the importance of the pre-FMO internal cross-subsidies. More room for cream-skimming implies both higher profits for the entrant and larger losses for the incumbent. Detailed results for this scenario are available in Tables 6 to 8 (column 1). Notice that, except in the homogenous case, uniform pricing stimulates market expansion by the entrant i.e. both firms increase their market coverage under USO.

	Homogenous	*Monotone*	*Dual*
n_e	20%	58%	50%
p_i (€)	0.43	0.42	0.44
p_e (€)	0.32	0.34	0.33
Π_i (m€)	-5.5	-24.2	-26.4
Π_e (m€)	7.9	12.1	19.2

Table 3: Base scenario: competition and USO

The difference in the incumbent's profit between these two market scenarios is the net cost of the USO according to the profitability cost approach (Panzar, 2000 and Cremer *et al.*, 2000).

Homogenous	*Monotone*	*Dual*
40m€	42m€	37.3m€

Table 4: The net cost of USO

In parallel with the net cost of the USO for the incumbent, it should be noticed that the imposition of USO leads to a more favorable market outcome for the incumbent. The following table reports the profit increase for the entrant compared to the no-USO scenario. Imposing universal coverage and uniform price constraints hurts the incumbent but benefits to the entrant. In this respect, it is legitimate that the entrant contributes to the financing of the universal service.

Homogenous	*Monotone*	*Dual*
0€	9.3m€	12.1m€

Table 5: Increase in the entrant's profit due to USO

In our simulations, the USP's compensation is not based on such an estimated cost of the USO. As it can be seen in tables 7 and 8, the entrant's market coverage changes relative to the base scenario when the regulator imposes a tax. Thus, the net cost of the USO is estimated on the basis of a market scenario that is no longer relevant when the USO is funded.[18] For that reason, our USO funding exercise does not rely on an estimated cost of the USO. Rather, the USO funding must guarantee a sufficient profit level to the USP, normalized to zero in our numerical exercises.

3.2.2 Financing a sustainable USO

As it is clearly stated in table 3, the universal service cannot be sustained without a subsidizing scheme. We calibrate the market outcomes with four different tax instruments: an entry fee, a coverage tax, an output tax and a revenue tax. The pay-or-play option that stimulates market expansion and thus further deteriorates aggregate profits is never a feasible option in this model. Likewise, the lump-sum entry fee that requires positive aggregate profits is neither a feasible option in the monotone and the dual configurations. Indeed, when the losses made by the universal service provider exceed the benefits made by the entrant, an entry fee is incompatible with competition on the market i.e. either the entry fee deters entry or it is not enough to finance the USO. When aggregate profits are negative, the regulator must use a distortive tax to subsidize the USP. Hence, *competitively neutral financing is a myth when the burden of the USO is shared among market participants*.

As an alternative to the universal service fund, we consider a market scenario where the USO no longer includes the uniform price constraint. In this case, the incumbent sets two prices: one for the contested addresses and one for the monopolized addresses. Eventually, we consider that the monopoly price is regulated and set at its lowest possible level compatible with a non-negative profit. In this latter case, competition and price regulation coexist in a liberalized market.

[18] See Jaag *et al.* (2009), Boldron *et al.* (2009) and Gautier and Wauthy (2010b) for discussions on the endogenous cost of the USO.

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3.2.3 The 'homogenous' country

	Base scenario	*Output tax*	*Revenue tax*	*Coverage tax*	*Non-uniform price*
Market coverage (10^3 of address)	20% (400)	20% (400)	20% (400)	20% (400)	20% (400)
Prices (€)					
p_i	0.43	0.45	0.46	0.46	0.43-0.76 (0.46*)
p_e	0.32	0.34	0.34	0.33	0.32
Mail volume (per address)					
q_i^M	193	189	187	187	128 (187*)
q_i^D	73	69	61	56	73
q_e^D	133	133	141	145	133
Net profits (m€)					
Π_i	-5.5	0	0	0	28.2(0*)
Π_e	7.9	7.9	8.4	8.7	7.9
Welfare (m€)	192	189	188	187	142 (189*)
Tax rate	/	0.02€	5%	2€	/
Tax paid by E (m€)		1.06	0.95	0.8	

* Regulated price

Table 6: Homogeneous country

In the homogenous country, 60% of the households are located in a fairly urbanized region (the 'homogeneous' region) and, in the pre-FMO scenario, the incumbent just breaks even on these addresses. In a liberalized market, the entrant will either cover the whole set of addresses in the homogeneous region or none of them. The incumbent has thus two strategies; either it allows large-scale entry and the entrant's coverage is above 80% or it uses a limit price to deter entry in the homogeneous region. It turns out that this latter strategy is the most profitable for the incumbent who maximizes its profit (or in this case, minimizes its losses) with a limit price. The incumbent's profit maximizing price is thus a corner solution. The price p_i is such that the entrant makes an ε-negative profit

on each address in the homogeneous region. When the regulator imposes a tax, the incumbent firm continues to use a limit price and the tax has no impact on market coverage.[19]

The four tax instruments are available to the regulator. Universal service can be financed with a 5.5m€ entry fee, a 0.02€ tax on each unit of mail, a 5% tax on revenue or a 2€ tax on each address covered by the entrant. In the homogenous country, the lump-sum tax dominates the other available options because any distortive tax leads to higher prices for both firms. Note that, due to the limited elasticity of demand, most of the tax is passed to consumers. For instance, in the case of the output tax, the entrant's price increase is almost equal to the tax and the incumbent can deter entry in the homogeneous region with a higher price.

Instead of a universal service fund, the regulator can relax the universal service obligations. Without the uniform price constraint, the incumbent can charge a different price on the non-contested addresses that represent 80% of the population. If it applies the monopoly price, it makes considerable profits. And the regulator can pass this surplus to consumers by fixing a limit price.

3.2.4 The 'monotone' country

	Base scenario	*Output tax*	*Revenue tax*	*Coverage tax*	*Non-uniform price*
Market coverage (10^3 of address)	58% (1.159)	53% (1052)	48% (897)	29% (580)	35% (712)
Prices (€)					
p_i	0.42	0.48	0.5	0.46	0.28-0.76 (0.53*)
p_e	0.34	0.42	0.41	0.34	0.27
Mail volume (per address)					
q_i^M	195	183	180	187	128 (173*)
q_i^D	108	104	88	64	170
q_e^D	97	88	103	137	59
Net profits (m€)					

Table 7: Monotone country

[19] Note that the taxes are calibrated to leave a zero profit to the incumbent. Thus, in principle, the incumbent is indifferent between the large and low-scale entry. We focus on the strategy (the limit price) that minimizes the incumbent's losses.

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Table 7, continued.

Π_i	-24.2	0	0	0	13.1 (0*)
Π_e	12.1	9.0	8.7	4.3	2.8
Welfare (m€)	185	180	176	185	159 (189*)
Tax rate	/	0.087€	23.6%	13.7€	/
Tax paid by E (m€)		8.05	9.6	7.95	

* Regulated price

In the monotone configuration, the entrant covers 58% of the country in the base scenario. In this scenario, the universal service provider is making losses and these losses cannot be fully compensated by a lump-sum tax since aggregate profits are negative. To reach financial viability, the regulator can use an output, revenue or coverage tax but the market outcome varies substantially with these three different options.

A sustainable output tax must be equal to 0.087€ per mail unit handled by the entrant and the total tax revenue accounts for 8.05m€. Prices increase sharply due to the limited elasticity of the demand, but despite that, the entrant's profitability per covered address declines and the entrant reduces its market coverage to 52% of the territory. The revenue tax rate is equal to 23.6%, quite a large percentage, and the proceeds are 9.6m€. The price differential is a bit larger and the entrant's coverage down to 48% of the addresses. The tax on covered addresses has a stronger impact on the market coverage. With a 7.95€ tax on each household covered, the entrant delivers only to 29% of the addresses. The entrant's price is identical compared to the unsubsidized scenario while the incumbent's price increases because a lower coverage makes price competition less fierce (Valletti *et al.*, 2002). The coverage tax leads to lower prices and a lower coverage. Given that products are close substitutes, the coverage tax welfare dominates the other tax instruments. Notice that, with all these taxes, the contribution of the entrant to the universal service fund is quite large relative to the gross profit. The ratio between net (after tax) and gross (before tax) profit is 0.52 with the output tax, 0.47 with the revenue tax and 0.36 with the coverage tax.

Finally, an alternative to the universal service fund is to abandon the uniform price constraint. In such a case, the incumbent has two stamp prices: one (=0.76€) that applies to the addresses where it remains the sole provider and another (=0.28€) for the lower cost addresses challenged by the entrant. With non-uniform price, firms compete for 35% of the delivery routes, considerably less than in the unsubsidized scenario, and both firms have positive profits. The

incumbent price increases dramatically on the non-challenged routes compared to the pre-FMO situation but the regulator has some room for decreasing this monopoly price. As a matter of fact, the lowest possible price on the non-contested routes compatible with a non-negative profit is equal to 0.53€. If competition on the contested routes and regulation on the monopolized routes are mixed, the welfare is equal to 1.89m€ and it is actually higher than with the universal service taxes.

3.2.5 The 'dual' country

The dual country has a large urban region with a low delivery cost per address and a large rural region with associated higher costs. Cross-subsidies are more important and the selective entry of an alternative firm only on the most profitable routes has even more serious consequences on the incumbent's profit. As a matter of fact, the entrant has a smaller operating scale than in the monotone case (50% of the population is covered in the base scenario) but higher profits. Despite that, a lump-sum entry fee cannot finance the incumbent's losses.

Higher taxes in the dual country are necessary to distort the incumbent's behavior and to restrict competition. These taxes push the prices upward but their effect on coverage is limited mainly because the slope of the cost functions is steeper than in the monotone case.

	Base scenario	*Output tax*	*Revenue tax*	*Non-uniform price*
Market coverage (10^3 of address)	50% (1018)	49% (982)	47% (870)	46% (933)
Prices (€)				
p_i	0.44	0.51	0.52	0.32-0.76 (0.67*)
p_e	0.33	0.41	0.40	0.27
Mail volume (per address)				
q_i^D	191	178	176	128 (144*)
q_e^D	74	79	60	142
q_i^M	130	110	129	82
Net profits (m€)				
Π_i	-26.4	0	0	1.4 (0*)
Π_e	19.2	13.3	12.4	7.1

Table 8: Dual country

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Table 8, continued.

Welfare (m€)	180	176	172	163 (179*)
Tax rate	/	0.105€	30%	/
Tax paid by E (m€)		11.3	16.8	

* Regulated price

The sustainable output tax is set at 0.105€ per mail unit. Its impact on coverage is small but not its impact on prices. The turnover tax leads to a higher incumbent price and a lower coverage and it is welfare dominated by the output tax.

Taxes based on coverage are not feasible in this country configuration. Indeed suppose that the entrant covers only the lowest cost urban region (40% of the addresses). In this case, optimal prices are p_i=0.42€, p_e=0.32€ and the entrant's profit per covered address is equal to 18.8€. Even a tax per covered address equal to that amount would not be sufficient to finance the incumbent's 19.6m€ losses. In the dual country, the tax must distort both the price and the coverage.

With non-uniform pricing, the incumbent's profit is positive but rather small. The regulator has thus little room for decreasing the price in the monopolized region. The lowest possible price-cap must be set at quite a high level (0.67€) and more than a half of the population face a huge price increase after FMO. As a matter of fact, with non-uniform pricing, the price for delivery in the rural region is twice as high as that of the urban zone.

3.3 Welfare comparisons

The different subsidizing schemes we considered have a different impact on prices, the extent of entry, profits and welfare. The choice of an appropriate mechanism depends on the country configuration. In table 9, we have ranked the various solutions for each country according to their welfare level.

	Homogenous	*Monotone*	*Dual*
Entry fee	1	n.a	n.a
Output tax	2	2	1
Revenue tax	3	3	2
Coverage tax	4	1	n.a

Table 9: Taxes ranked according to the welfare

There is no unanimous ranking among countries[20] and the choice of an appropriate tax is sensitive to the geographical characteristics. We have tried to capture this by considering three country configurations that differ according to the importance of cross-subsidies in the pre-FMO situation. From our numerical exercise, it appears that a country where cross-subsidies are more important requires a more distortive tax to sustain the USO in a liberalized market. In the homogenous country, where subsidies are limited, a lump-sum entry fee that has no impact on prices and coverage, is the preferred option. In the monotone country, where cross-subsidies are more important, a neutral entry fee is not feasible and the preferred instrument is a coverage (or profit) tax that does not change the pricing behavior but only the extent of competition. Finally, in the dual country, where cross-subsidies are the most important, only taxes that distort both the pricing and the coverage are feasible.

In this model, we assume a high displacement ratio and a limited price elasticity, two plausible assumptions for the postal sector. They imply that no market expansion is expected after FMO.[21] Moreover, the cost structure is such that the incumbent has a high average cost but a low marginal cost while the entrant has a lower average cost but a higher marginal cost. Hence, each time the entrant captures a fraction of the mail stream, aggregate profits will decrease unless the incumbent is able to compensate with higher prices.

Competitive pressures limit the possible price increases. Higher prices indeed imply lower profit on the contested addresses and larger scale entry. In our estimations, the incumbent's price increase is at most 10% higher than the pre-FMO scenario and it is insufficient to compensate the lost profits due to entry. Having limited possibility for increasing its price, the incumbent's losses are linked to the extent of market cream-skimming by the entrant

When, as in the homogeneous country, cream-skimming is limited, a lump-sum tax can be imposed on the entrant to finance the universal service. But when this phenomenon is more significant, the lump-sum tax is ineffective and the tax must reduce the competitive pressure. The coverage tax lowers the number of challenged routes, quite drastically in the monotone country and the incumbent reduces its losses. Moreover, facing a smaller scale entrant, the incumbent has some freedom to raise its price. But even taking that into account, prices are lower than with the *ad-valorem* and output taxes. Thus the coverage tax is the preferred option. In the dual case, reducing entry with a coverage tax is not enough to sustain USO (unless entry is completely deterred) and the regulator should use a mechanism that has a stronger impact on competition, by modifying

[20] The only unanimous ranking is between the unit and the *ad-valorem* tax, the former dominating the latter (see Anderson *et al.*, 2001 on this point).

[21] Currently, some countries are actually experiencing declines in total mail volume due to e-substitution.

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price and coverage decisions. The *ad-valorem* or the output tax inflates the entrant's price and this leaves some freedom to the incumbent to raise its price too. With both firms charging a higher price, universal service becomes sustainable. Notice that in the dual country, the tax is at a level such that all prices are strictly higher than in the pre-FMO situation.

The choice of an appropriate tax instrument is thus dependent on the country configurations. We have paid particular attention to the asymmetry within a country. More asymmetric countries, that are more prone to selective entry, need more distortive instruments to finance the universal service. The reason is that, in these configurations, distorting the entrant's behavior is a necessary condition for a sustainable USO. The competitive pressures exerted by the entrant must be reduced to have a viable USO. When competition is more damaging to the incumbent, the regulator must use more distortive instruments to finance the USO. As a corollary, prices in a liberalized market substantially differ across countries. The prices (p_i, p_e) corresponding to the preferred USO financing scheme are (0.43€, 0.32€) in the homogeneous country, (0.46€, 0.34€) in the monotone country and (0.51€, 0.41€) in the dual country. These price differences reflect the use of more distortive tax instruments.

To check the robustness of our welfare ranking, we have conducted alternative estimations with a modified cost effectiveness for the entrant. We considered an entrant with a unit cost 10% or 30% lower than the incumbent monopolist's (the results presented in this section are based on a 20% cost advantage). With these modified cost parameters, the preferred tax in the homogeneous country may no longer be the entry fee. Indeed, with a 30% cost advantage, aggregate profits are negative and the lump-sum fee cannot be used for USO financing. With a 10% cost advantage, both firms have positive profits and there is no need to impose a tax to finance the USO. Except for that, the tax ranking is identical.

3.4 Reforming USO

An alternative to the tax is to reduce the possibility of cream-skimming by having prices that reflect more closely the (average) costs. Indeed, selective entry in the more profitable regions is exacerbated by the uniform price constraint that makes the low cost regions artificially profitable. Without the uniform price constraint, the incumbent is able to sustain the USO without taxes but consumers that are not covered by the entrant face the monopoly price. For that reason, the non-uniform price solution leads to a considerably lower welfare, unless some form of price regulation accompanies it. With an appropriate price cap, the removal of the uniform price constraint is the solution that leads to the highest welfare in the three countries.

Market liberalization changes universal service financing. The 'old fashioned' financing under monopoly uses internal cross-subsidies: profitable services that are sheltered from competition finance the loss-making services. In a liberalized world, these internal cross-subsidies are no longer possible because the competitors focus only on the profit-making services leaving the unprofitable ones to the USP. A universal service fund can be used to re-organize cross-subsidies within the industry but such a fund modifies the way firms compete. Universal service is financed differently in a liberalized environment and the financing mechanism is not competitively neutral. Pushing this logic to its end, a reform of the universal service financing should be accompanied by a reform in the definition of the universal service itself. It may well be that, given the cost of the USO in a liberalized environment, the regulator wishes to modify the scope of the universal service. As we have shown, relaxing the pricing constraint might be an appropriate alternative to the universal service fund. Other reforms, such as for example a lower delivery frequency, might well be welfare improving given the cost of such a service in a competitive environment. But this interesting issue is outside of the scope of this paper.

4. Concluding remarks

In this paper, we have shown that the choice of an appropriate USO funding scheme depends on the countries' geographical characteristics with more asymmetric countries requiring more distortive tax instruments. From our calibrations, it appears that none of our country configurations is able to finance the universal service without a compensation fund. This quite dark picture of the postal sector could be partially explained by the calibration hypothesis we made. Though we believe that the parameters chosen are plausible, we made assumptions that are quite unfavorable to the USP. Especially, we considered an average mail volume per inhabitant, a low cost elasticity for the USP and a large cost advantage for the entrant. It is indeed in those circumstances that USO funding will be the more problematic, and even more if the country is asymmetric. Whether European countries will be in such a worst-case scenario after FMO is still a debatable question since competition is still at its infancy and postal markets are ahead of major changes. The future of the universal service and its financing are in the agenda of many European countries. In the UK for instance, the Hooper report (2008) reviews the option for maintaining the universal service in posts. Compensation fund, public subsidies and a reform of the USO are all envisioned (but the report recommends a modernization of the USP as a precondition before any reform). Some countries have already decided to install a compensation fund and, interestingly, they have adopted a different tax base. Currently, most of the universal service funds exist only on paper and, to

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our knowledge, only Italy and Estonia have activated the compensation fund. In Estonia, the contribution is proportional to the mail volume. In Italy, the entrants' contribution to the USO financing is proportional to their turnover. The maximum rate is 10% and the current rate is 3%. The Italian compensation fund is notably under funded and it does not cover the burden of the USO supported by the USP. In France, the new postal law specifies that the contribution to the fund will be proportional to the number of postal items within the scope of the USO. The Finish system is a pay-or-play: the licensing requirements impose either a large coverage, close to nationwide, or the payment of a tax proportional to the turnover. The tax rate depends on the density of the regions served with a maximal percentage of 20% for the operators that serve only the capital. Other countries, for instance Norway, have decided to rely on public subsidies to finance the USO. Finally, in Sweden, the pioneer country in postal market liberalization, the historical operator has managed to maintain and finance the universal service in a liberalized environment without any sort of compensating mechanism. But, competition in the bulk mail segment has been accompanied by a sharp increase in the single-piece letter price for which the historical operator remains *de facto* as a monopolist. Clearly enough, there are multiple solutions to maintain a universal service in a liberalized environment. In this paper, we have modestly contributed to the debate and we have paid a particular attention to the countries' geographical configuration that indeed, play an important role in the choice of an appropriate funding scheme.

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