Universal service financing in competitive postal markets: One size does not fit all

Axel Gautier[1]
Dimitri Paolini[2]

March 2010
Preliminary. Do not quote without the authors' permission.

Paper prepared for the 6th conference *"Regulation, Competition and Universal Service in the Postal Sector"*, Toulouse, March 25-26, 2010

Abstract

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 obligations (hereafter USO). Indeed, new postal firms, that are not subject to any universal service constraint will compete in priority 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 experience FMO (and a substantial level of competition): new postal companies target the most profitable products (non-urgent bulk mail) and deliver mail in the most dense 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 finance the same level of (universal) service.

Fulfilling the universal service obligations is usually costly for the firm in charge. The cost of the universal service depends on three groups of factors: the definition of the universal service (and incidentally on its measurement), the postal market characteristics and the country geographical configuration. The 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. The 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 and the contestability of the market have an impact of the competitiveness of the market after FMO and, as market competition erodes the incumbent's profits, on the USP's ability to

[1] Corresponding author, Department of economics, HEC-Management school, University of Liège, BAT B31, Bd du rectorat 7, B4000 Liège, Belgium and CORE, Université Catholique de Louvain, B1348 Louvain-la-Neuve, Belgium. Email: agautier@ulg.ac.be
[2] CRENoS and DEIR, University of Sassari. Email: dpaolini@uniss.it

sustain the USO. Finally, geographical characteristic 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.

All these three factors affect both the direct cost of providing a given service and the extent of competition on the market, as pointed by several studies. 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 competition (access or bypass) adopted by incoming 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 and heterogeneous countries are likely to be in different situations regarding the sustainability of the USO after FMO (PwC, 2006).

The universal service may be non sustainable in a liberalized environment. Moreover, even if the 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 the universal service obligations represent an *unfair financial burden* for its provider, the national regulator may introduce a compensating 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.

Regulator must choose an appropriate tax base to finance the universal service fund. The choice of a tax instrument and a tax level has an impact on the market prices, the profits, the extent of competition and the welfare (Choné *et al.*, 2002, Borsenberger *et al.*, 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 tax on non-covered routes (Pay-or-play). These USO funding mechanisms are not '*competitively neutral*' as they affect the way firms compete on the market. With a USO funding mechanism, the competitors' behavior might be modified in three different ways. It 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 is 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 that were profitable before the imposition of a compensation mechanism may no longer be profitable afterward. 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. Notice that the extent of entry has a second-order effect on the price charged by the firms, especially when a uniform pricing constraint applies. In this case, a 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. This last point is nicely illustrated by

the entry fee imposed in Finland to competitors that do not serve rural areas. Currently, the fee is so high that it is considered as one of the main entry barrier.

The distortions induced by these taxes are not equivalent. Taking into account that different taxes lead to different market outcomes, we consider, in this paper, 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. To make the situations comparable, we set the tax at a level that guarantees that a profit-maximizing incumbent who gets the whole tax revenue breaks even.

As we said, country configurations have an impact on the cost of the USO. In the paper, we consider three configurations 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 and 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 in European postal markets where alternative end-to-end operators have a nationwide coverage in the Netherland but covers only the largest cities in Sweden.

We use a series of calibrated numerical examples in this paper 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, the different taxes lead substantially different market outcomes making the choice of an appropriate tax base sensitive. Second, our numerical simulation aims 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 the USO is likely to be misleading if it fails to recognize the distortionary effect of the tax (Gautier and Wauthy, 2010). For instance, if the cost estimate is based on a market scenario where an entrant covers half of the addresses and, if after imposing a tax the entrant decreases substantially its coverage, the initial cost estimate is likely to be wrong. And a compensation for the USP based on this estimated cost is inappropriate because *the USO costing exercise is endogenous to its funding*. Finally, we would like to shed like on the question of the most appropriate tax instrument. As the title of the paper suggested, 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 repartition 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. The incumbent operator must, as part of the USO, deliver mail

nationwide not less than five working days a week. There are no universal service constraints imposed on the entrant who may then deliver mail at a lower frequency on part of the national territory only. As results, products are not homogenous and firms have a different cost structure.

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

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

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, transport and sorting) and downstream (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 costs of the entrant are variable. Things are different for the incumbent because of the, usually imposed, universal service obligations. If the incumbent must deliver nationwide at a given frequency (five or six times a week) and/or maintain services (delivery, post offices) in remote areas, it 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 return to scale. The structure of the 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, as for the incumbent, the cost of delivery by the entrant 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 scale. The entrant can exhaust the economies of scales by delivering larger volumes at a lower frequency.

Addresses *x* are ranked according to their delivery cost and this cost depends 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 $\partial d_e(x)/\partial x \geq 0$. Latter, we will make a stronger assumption and assume 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 in priority the lowest cost households. 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 in 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 entrant on the n_e contested addresses; the second term is the profit made on the remaining $(N-n_e)$ insulated addresses and the last term is the fixed cost associated with a daily nationwide delivery. Let us call $D_e(n_e) = \int_0^{n_e} d_e(\tau)d\tau$. The entrant's average cost AC_e is equal to $D_e(n_e)/n_e$. The entrant's profit can be expressed as:

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

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.[3] 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.[4] There are thus only two prices, p_i and p_e and none 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.

Let us define the entrant's price best reply function as:

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

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

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

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

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

The equilibrium is unique and prices are strategic complements i.e. an increase in p_e leads to an increase in the incumbent's price. The optimal market coverage n_e^* is such that the entrant realizes a zero profit on the last covered address:[5]

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

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 the 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 the universal service and competition leads to the bankruptcy of the universal service provider and the USO are not sustainable without a subsidizing mechanism.[6]

Different mechanisms can be used to finance the 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 tax applied on the entrant only[7] and third, the tax rate is set at a level that guarantees a nil profit for the incumbent inclusive of the tax proceeds.

We consider the following possible taxes:

- A lump-sum entry fee.
- An output tax on each mailing item handled by the entrant.
- A revenue tax, proportional to the entrant's turnover.
- A coverage tax on each covered address by the entrant.
- A pay-or-play where the entrant pays a fixed amount per address it does not cover.

All these taxes are uniform i.e. independent of the mail destination and apply only on the entrant.

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.

---

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

[6] The third postal directive recommends to compensate the USP whenever the net cost of the USO represents an *unfair* burden. Through this paper, we assume that the USP will be compensated only when the USO are not sustainable.

[7] Or equivalently, we can consider that an identical tax is levied on both the incumbent and the entrant. Since, by assumption, all the money collected is paid to the USP, a tax on the incumbent has no impact on its behavior as long as the tax rate is the same for all market participants.

Taxes are not competitively neutral. The taxes affect the entrant's pricing and coverage behavior, which, in turn, trigger a reaction by the incumbent. For the clarity of the explanation, let us consider 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 ϕ_e and thereby its price. Second, it can modify the number of routes where the entrant has decided to compete in. Table 1 lists and signs the impact on the price p_e 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

The revenue and the turnover taxes shift upward the best reply function ϕ_e 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 on 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 change neither the price nor the coverage but it can eventually modify the decision to compete and deters the firm from entering the market. The above reasoning is valid for a given price p_i and, obviously, the incumbent will react to the tax by changing its price. And, an increase in p_i leads to an increase in p_e and n_e that might mitigate the effects we just mention.

2.3 Comparing the tax instruments

Comparing the different tax instruments is far from obvious[8] because the amount to be financed ($-\Pi_i$) is endogenous to the choice of a tax instrument. In other words, the tax proceeds depend on the choice of a tax instrument. For that reason, our comparisons are mostly based on a numerical exercise. Nevertheless in this section our aim is to draw some general conclusions on the choice of a tax instrument.

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 equals to $-\Pi_i$ is compatible with competition on the market and it does not affect the entrant's behavior who keeps the same price and maintain the same coverage and, when this tax instrument is available, it is likely to be optimal.

When aggregate profits are negative, lump-sum fee equals 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 necessary condition for a sustainable USO is a distortionary tax*. As a matter of fact, a distortionary tax relaxes competition by shifting upward the price best-reply and/or by

[8] See Borsenberger *et al.* (2010) for a comparison between output and revenue taxes.

reducing the extent of coverage by the entrant (cfr. Table 1).[9] Reducing competition by increasing the tax rate has two effects: it decreases the losses made by the USP and it increases the tax proceeds. Hence, the total revenue for the incumbent (profit + tax revenue) increases with the level of the tax. And 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 might not be possible to find a distortionary tax such that aggregate industry profits (before tax) are positives.

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 associated different 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 Doyle and Vickers, 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. 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 equals to 200. Costs and revenues at this price are both equal to 160 millions €. 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 lines with those estimated by Boldron et al. (2006). We consider that the shape of the function $F(x)$ differs across countries. For each country, the total fixed cost is equal to 112 millions € but the repartition 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 equals 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

[9] 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.

112€. Figure 1 represents the fixed cost per household in the three hypothetical countries we consider.

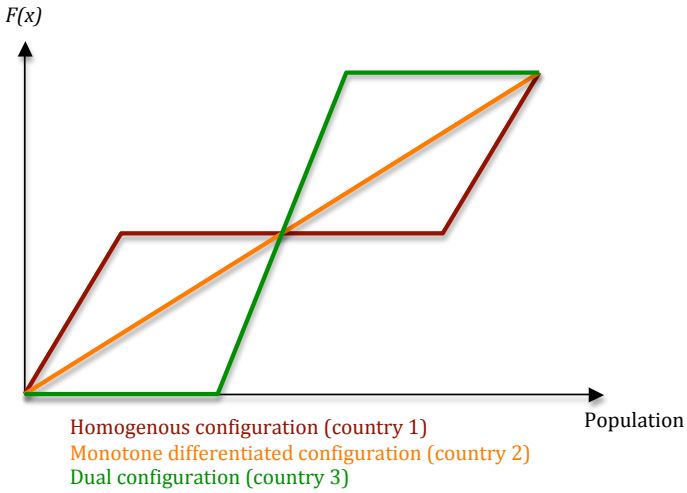

Figure 1: the three country configurations

The total fixed cost is identical for all three configurations and only its repartition 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 accounts for a deficit of XX, 23.3m and 33.5m in the homogenous, monotone and dual configuration compensated by an equivalent profit realized on the profitable addresses. Or putted differently, the profit-maximizing outcome of a monopolist that is not subject to any USO differs across countries. This is illustrated in table 2. When the incumbent is relieved from the USO, it serves only the profitable addresses at the monopoly price of 0.76€. In the monotone configuration, 78% of the addresses are profitable at the monopoly prices. In the dual configuration, this proportion drops to 57% but profits are higher.

	Homogenous	*Monotone*	*Dual*
Coverage		78%	57%
Profit		56.1m	61.3m
Welfare			

Table 2: Monopoly outcome without USO

Last, we must parameterize the entrant's cost function. We assume that the entrant's unit cost of handling a mail to x is 30% lower than the average unit cost of an incumbent monopolist. That is $c_e+d_e(x)=0.7[c_i+d_i+F(x)/200]$. The function $d_e(x)$ has the same shape than $F(x)$, represented on figure 1.

3.2 Calibrated results

In this section, we present our numerical simulations. For each country, our starting point is an unsubsidized market scenario where uniform price and universal coverage constraints are imposed on the incumbent and the entrant is not bounded by universal

coverage. The entrant's cost advantage is such that in the three country configurations, the incumbent cannot sustain the universal service without a subsidizing scheme and we present the simulated results for the five different taxes we consider. We also detail a sixth alternative where the uniform price constraint imposed on the incumbent is removed. In this case, the incumbent sets two prices: one for the contested addresses, one for the monopolized addresses. Eventually, we consider that the monopoly price is regulated and set at its lowest possible level.

3.2.1: the 'homogenous' country

In the homogenous country, 60% of the households are located in a fairly urbanized region. In the unsubsidized scenario, the incumbent deters the entrant from competing for delivery in these households by setting a limit price of 0.39€. At that price, the entrant covers only 20% of the addresses. Despite this limited coverage, the incumbent is making a 10.4m losses while the entrant has a positive profit equals to 12.5m. In this case, an entry fee set at the level 10.4m would be compatible with both competition and a sustainable USO. And other taxes that distort the price and/or the coverage are dominated by this lump-sum fee. See table 3 for detailed comparisons.

Add table 3 here [coming soon]

3.2.2: the 'monotone differentiated' country

In table 4, we present the results for the monotone differentiated configuration. In the unsubsidized scenario, the entrant covers 65% of the country and the price differential is such that it captures the largest fraction of the mail stream (54%) in the contested routes. Without subsidies, the incumbent is no longer able to break-even and the USO are not sustainable. Moreover, it is not possible to set an entry fee that would be compatible with a sustainable USO and the entry of an alternative operator on the market. Indeed, the losses made by the universal service provider exceed the benefits made by the entrant. Lump-sum transfers are thus incompatible with competition on the market i.e. either the entry fee deters entry or it is not enough to finance the USO. To put it in numbers, the incumbent losses 31.6m after FMO while the benefits of the entrant are equal to 13.3m. Aggregate profits are thus negative and the regulator must use a distortive tax to subsidize the USP. The mechanism by which a distortive tax finances the USO is twofold: first, the tax is an additional source of income for the USP. Second, the tax reduces competition on the market: price competition is less fierce and/or the entrant has a lower coverage.

The USO become sustainable with an appropriate output, revenue or coverage tax but the market outcome is substantially different with these three different options. A sustainable output tax must be equal to 0.11€ per mail handled by the entrant and the total tax revenue accounts for 10.4m. With an output taxes both prices increase substantially: p_i increases by 20%, from 0.40€ to 0.48€ and p_e by 0.09€, less than the amount of the tax. The market coverage is affected by the subsidizing scheme. Despite higher prices, the entrant's revenue from each covered address decreases and consequently, the entrant decreases slightly its market coverage.

	Unsubsidized scenario	*Output tax*	*Revenue tax*	*Coverage tax*	*Non-uniform price*
Market coverage	65%	58%	52%	27%	43%
(10^3 of address)	(1.308)	(1.159)	(1.038)	(546)	(847)
Prices					
p_I	0.40	0.48	0.5	0.45	0.27-0.76 (0.62*)
P_E	0.33	0.42	0.41	0.32	0.25
Mail volume (per address)					
q_I^M	200	183	180	189	128
q_I^D	114	107	83	58	170
q_E	95	84	108	146	62
Profits (m€)					
π_I	-31.6	0	0	0	4.4
π_E	13.3	9.23	9.48	3.55	3.6
Welfare (m€)	188	182	178	188	164 (183*)
Tax rate	/	0.11€	29.7%	17.3€	/
Tax proceeds		10.7m	10.4m	9.44m	

* Regulated price

Table 4: monotone differentiated country

With a turnover tax, the contribution of the entrant to the USO financing accounts for nearly 30% of its revenue. Prices and revenue taxes are similar with the turnover and the output tax but coverage and welfare are higher with the latter.

The third option for the regulator is a uniform tax on covered addresses. In our estimation, for each covered household, the entrant must pay 17.3€. This tax has no first order impact on prices i.e. the same prices would apply without for an equivalent coverage, but it has a strong impact on coverage that shrinks to 27%. A lower coverage relaxes price competition leading to a higher price by the incumbent. For the entrant, this effect is compensated by a cost reduction (only lower cost households are covered) and its stamp price is similar to the unsubsidized scenario. A tax on non-covered routes would induce market expansion compared to the unsubsidized scenario and further losses for the incumbent that the tax could not compensate.

Finally, an alternative to the universal service fund is to relax the universal service constraints. In particular, the regulator may 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 unique provider and another (=0.25€) for the lower cost addresses challenged by the entrant. With non-uniform price, firms compete for 43% of the delivery routes and both firms have positive profits. The incumbent price nearly doubles 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 0.62€. If competition on the contested routes and regulation on the monopolized routes are mixed, the welfare is equal to 1.83m and it is actually higher than with the output and the revenue taxes.

3.2.3: 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 on the most profitable routes only is likely to have adverse consequences on the incumbent's profit. As a matter of fact, the entrant has a smaller operating scale than in the monotone case (12% of the population are no longer covered in the unsubsidized scenario) but higher profits (a 8.4m increase). Without a universal service fund, the entrant delivers to a bit more than half of the population and collect considerable profits. Despite that, the incumbent's losses cannot be financed by a lump-sum entry fee.

	Unsubsidized scenario	*Output tax*	*Revenue tax*	*Non-uniform price*
Market coverage	53%	47%	43%	48%
(10^3 of address)	(1.059)	(944)	(867)	(961)
Prices				
p_I	0.43	0.50	0.51	0.30-0.76
P_E	0.32	0.44	0.44	0.26
Mail volume (per address)				
q_I^M	193	180	178	128
q_I^D	74	110	100	141
q_E	133	78	86	86
Profits (10^6€)				
π_I	-30.6	0	0	-1.9
π_E	21.7	6.4	3.2	8.1
Welfare (10^6€)	182	184	1.83	166
Tax rate	/	0.20€	56%	/
Tax proceeds		14.7m	18.4m	

Table 5: dual country

Higher taxes in the dual country are necessary to distort the incumbent's behavior and to restrict competition. These taxes push the prices upward and the coverage downward and lower competitive pressures make, with the tax revenue, USO sustainable.

The sustainable output tax is set at 0.20€ per mail. Its impact on coverage is rather limited but not its impact on prices. The incumbent's price increases by 0.07€ and the entrant's price by 0.13€, again less than the tax. Prices are higher and the price differential is smaller. These induced distortions decrease by more than a half the incumbent's losses and, with the 14.7m tax revenue, the USO is sustainable. The turnover tax leads to higher prices, lower coverage and lower entrant's profit and consequently, 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, the entrant's per covered address is equal to 8.8€ and, even a tax per covered address equal to that amount would not be sufficient to finance the incumbent's 40m losses. In the dual country, the tax must distort both the price and the coverage.

Notice also that with non-uniform price, the incumbent is still making losses and thus relaxing USO constraints alone is not feasible. But non-uniform prices and an appropriate entry fee are compatible with competition and universal service but the welfare is clearly the lowest.

4. Conclusions

To conclude, we have shown that different subsidizing schemes have a different impact on prices, the extent of entry, the profits and the welfare and the choice of an appropriate mechanism depends on the country configuration. In the following table, 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		3	1
Revenue tax		4	2
Coverage tax		1	n.a
Pay-or-play		n.a	n.a
2 prices		2	3

Table 6: taxes ranked according to the welfare

Clearly, there is no unanimous ranking and the choice of an appropriate tax is sensitive to the country 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. Indeed, 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, the optimal tax is a tax on coverage that does not distort the prices but only the extent of competition. Finally, in the dual country, where cross-subsidies are the most important, only taxes that distort both the price and the coverage are feasible. This "result" is based on a

numerical exercise and its (possible?) generalization is an interesting avenue for further research.

5. References

d'Alcantara G. and A. Gautier (2008). "National Postal Strategies after a Full Postal Market Opening," in Crew, M. and P. Kleindorfer (eds) *Competition and Regulation in the Postal and Delivery Sector*, Edward Elgar, Cheltenham, UK.

Ambrosini, X., F. Boldron et B. Roy (2006) "Universal Service Obligations in the Postal Sector: Economics Learnings from Cross-Country Comparisons" in M. A. Crew a P. R. Kleindorfer (eds), *Progress toward Liberalization of the Postal and Delivery Sector*, Springer.

Bloch, F. and A. Gautier (2008) "Access Pricing and Entry in the Postal Sector," *The Review of Network Economics*, 7(2), 207 – 230.

Boldron F., Joram D., Martin L. and Roy B., (2006). From Size of the Box to the Costs of Universal Service Obligation: A Cross-Country Comparison, in M. A. Crew a P. R. Kleindorfer (eds), *Liberalization of the Postal and Delivery Sector*, Edward Elgar, Cheltenham, UK.

Boldron F., Borsenberger C., Joram D., Lecou S., and B. Roy (2009). "A Dynamic and Endogenous Approach to Financing the USO in a Liberalized Environment," in Crew, M. and P. Kleindorfer (eds) *Progress in the Competitive Agenda in the Postal and Delivery Sector*, Edward Elgar, Cheltenham, UK.

Borsenberger, C., Cremer, H., De Donder, P., Joram, D., and B. Roy (2010). "Funding the Cost of Universal Service in a Liberalized Postal Sector," in Crew, M. and P. Kleindorfer (eds) *Hightening Competition in the Postal and Delivery Sector*, Edward Elgar, Cheltenham, UK.

Choné, P., Flochel, L., and A. Perrot (2002). "Allocating and Funding Universal Service Obligations in a Competitive Market," *International Journal of Industrial Organization*, 20(9), 1247-1276.

de Bijl, P., van Damme, E. and P. Larouche (2006). "Regulating Access to Stimulate Competition in Postal Markets?," in M. A. Crew a P. R. Kleindorfer (eds), *Progress toward Liberalization of the Postal and Delivery Sector*, Springer.

Gautier, A. and X. Wauthy (2009). "Price Competition under Universal Service Obligations," CORE DP 2009/32.

Gautier, A. and X. Wauthy (2010). "How to Finance Universal Service Obligations under Competition?," CORE DP *forthcoming.*

Hoernig, S. (2006). "Should Uniform Pricing Constraints be Imposed on Entrants?," *Journal of Regulatory Economics*, 30(2), 199-216.

Oxera (2007). “Funding Universal Service Obligations in the Postal Sector”.

Panzar, J. (1991). “Is Postal Service a Natural Monopoly?,” in M. A. Crew a P. R. Kleindorfer (eds), *Competition and Innovation in Postal Services*, Kluwer Academic Press.

PricewaterhouseCoopers (2006). "The Impact on the Universal Service of the Full Market Accomplishment of the Postal Internal Market in 2009,” Final report to the European Commission

Roy, B. (1999). “Technico-Economic Analysis of the Costs of Outtside Work in Postal Delivery,” in M. A. Crew a P. R. Kleindorfer (eds), *Emerging Competition in the Postal and Delivery Services*, Kluwer Academic Press.

Valletti, T., Hoernig, S. and P. Barros (2002). “Universal Service and Entry: The Role of Uniform Pricing and Coverage Constraints,” *Journal of Regulatory Economics*, 21(2), 169-190.