Competitively Neutral Universal Service Obligations*

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Abstract

Universal service obligations impose specific costs on the universal service provider and the latter may call for an appropriate compensation. Most often, a two-step procedure is put forward to finance the universal service in a competitive environment. Firstly, the cost of the universal service is assessed; secondly, the provider must be compensated for this cost. We argue that this procedure is problematic because the implementation of a compensation scheme affects the behavior of market participants and leads to an overcompensation of the universal service provider. We put forward an alternative approach to this problem that fully acknowledges the distortions that result from the compensation mechanism.

Keywords: Universal service obligations, cost-sharing mechanism, competitive neutrality.
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1 Introduction and summary

Universal service obligations (hereafter USO) have long been imposed in industries like telecommunications, energy or postal services. USO can be broadly divided into two categories: Obligations in terms of quality (minimum quality standards, ubiquity of the service) and in terms of prices (uniform price, affordable price). USO do not retain much attention when the industry is organized as a (possibly regulated) monopoly. As a matter of fact, when the universal service provider (hereafter USP) is a monopolist, the USO are self-financed by internal cross-subsidies: The profits realized on the profitable market segments finance the losses made on the loss-making segments that the USP must serve as part of the USO. However, the coexistence of competition, as resulting from the current trend in market liberalization, and USO is more problematic. Competition erodes the USP's profit and, eventually, threatens the financial viability of the USP who might not be able to sustain the same standard of service in a liberalized market as under monopoly.

In order to maintain the universal service in a competitive environment, the design of an appropriate USO funding mechanism may be necessary. A standard approach to the financing issue is the following: First, using an appropriate methodology, the *net cost of the universal service* for its provider is evaluated. Second, based on this cost estimate, the need for a funding mechanism is assessed and, if necessary, an appropriate funding scheme is chosen and implemented. Typically, this approach is followed by the European Commission for the postal sector.

> "Where a Member State determines that the universal service obligations 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." (Third postal directive (2008/6/EC), Article 7, §3)

In this paper, we shall argue that, whenever option (b) is retained, this two-step approach is misleading because it fails to recognize the distortions induced by any sharing mechanism of this kind. That is, compensating the USP on the basis of an estimated net cost of the USO is likely to be inappropriate whenever the tax modifies the behavior of the market participants.

An extreme example is provided by the Finnish postal market. The Finnish postal market has been fully liberalized since 1994. The regulator has imposed a licensing system and, accordingly, an alternative postal operator that would operate only in densely populated areas would have to pay a fee. This fee aims at ensuring that high quality services are provided also in sparsely populated areas. Actually, this fee is so high that it constitutes an entry barrier. As a result, the incumbent Finnish postal operator still enjoys a near monopoly position. Clearly enough, if this entry fee is based on a USO costing exercise, the estimated cost does not correspond to the actual cost because the costing exercise failed to take into account that the resulting tax is fixed at a deterrent level.

In this paper, we argue that a USO funding mechanism modifies firms' behavior. The resulting market outcome is such that the incumbent is partially sheltered from competition when the funding scheme applies. Thus, the USP collects a higher profit in the funded scenario. A compensation that would be equal to the estimated net cost of the USO therefore leads to an overcompensation of the USP that is ultimately paid twice. First, it is fully compensated for the net cost by the funding mechanism. Second, it is sheltered from competition and thereby able to collect additional profits. The additional profits made by the USP should be accounted for as part of the USO funding mechanism. Accordingly, the tax collected should be inferior to the estimated cost of the USO. In other words, the USO costing exercise cannot be separated from its funding.

Using the profitability cost approach to estimate the net cost of the USO (Panzar, 2000 and Cremer *et al.*, 2000), we show that the cost of the USO is endogenous to its funding and, incidentally, smaller in the presence of a cost-sharing mechanism. Taking this into account, an appropriate compensation for the true cost of the USO is equivalent to the adoption of a competitive neutrality criterion where the profits of the USP in a funded USO scenario are equal to some benchmark level computed in an *unsubsidized market scenario* (Panzar, 2000) with competition but without USO. We show then that there always exists a tax level that is compatible with both competition in the market and competitive neutrality.

The paper is organized as follows. In sections 2 and 3, we present the model and introduce our four relevant market scenarios: Monopoly and USO (M), competition without USO (C), competition with USO (U) and competition with a funded USO (F). In section 4, we discuss the scope for evaluating the cost of USO ex-ante, i.e. independently of its possible financing. Several possible measures are discussed. In section 5, we argue that the ex-ante cost of USO should not serve as a basis for determining the

level of compensation and we introduce a competitive neutrality criterion to determine the tax level that will ensure adequate compensation. We show that this compensation exists and is compatible with competition in the market. Finally section 6 concludes.

2 The Model

Our model is standard and similar to Valletti *et. al* (2002). There are two firms: the incumbent, firm I and the entrant, firm E potentially selling differentiated products or services to a continuum $[0, N]$ of independent local markets. To serve consumers in any local market $n \in [0, N]$, a firm must incur a sunk connection cost $g(n)$ and markets are ordered by increasing connection costs. Furthermore, we assume that $g(0) \geq 0$ and $\frac{\partial g(\cdot)}{\partial n} > 0$ for all $n \in [0, N]$. Except for this fixed connection cost, all local markets are identical.

At most two firms are active on each local market. Firms play a two-stage game where they first choose their market coverage and then they simultaneously set prices. We assume that firms cover a closed subset of the local markets starting from the cheapest location. Coverage decisions are represented by n_i and n_e where n_k is the index of the last market covered by firm k. Without loss of generality, we assume that the incumbent has a larger coverage that the entrant: $n_e \leq n_i$. We can therefore distinguish three kinds of local markets: duopoly markets in $[0, n_e]$, monopolized markets in $[n_e, n_i]$ and non-covered markets in $[n_i, N]$.

In a monopolized market, the demand is defined by $x_i^m(p_i)$ with $\frac{\partial x_i^m(\cdot)}{\partial p_i} < 0$. In a duopoly market, firms sell differentiated products so that demands are respectively defined as $x_j(p_j, p_k)$ with $\frac{\partial x_j(\cdot)}{\partial p_j} < 0$ and $\frac{\partial x_j(\cdot)}{\partial p_k} > 0$.[1] Demand functions are twice continuously differentiable. Firms produce at a constant marginal cost $c > 0$. Let us denote by $\pi_i^m(p_i)$, $\pi_i^d(p_i, p_e)$ and $\pi_e^d(p_i, p_e)$, the operating profit made by firm $k = i, e$ in a monopoly (subscript 'm') and a duopoly market (subscript 'd'). We assume $\frac{\partial^2 \pi_k^d(\cdot)}{\partial p_k \partial p_l} > 0$, i.e. prices are strategic complements. Finally, we assume that there exists a unique, interior, Nash equilibrium in the pricing game taking place in any local market.

Universal service obligations, if any, are imposed on firm I exclusively. We define universal service obligations along two dimensions: A uniform

[1] Without loss of generality, we assume that $\forall p$, $x_i^m(p) \geq x_i^d(p, p_e)$

price constraint (UP) and a coverage constraint (CC).[2] The UP is a ban on price discrimination between local markets. The CC constraint, defined by an upper limit $\bar{n} \leq N$ on coverage, imposes to serve all markets in $[0, \bar{n}]$. Notice therefore that while local markets are independent from each other without USO (since marginal costs are constant), this is not true anymore under USO because of the uniform pricing rule. This strategic link between markets under USO may lead to the non-existence of a pure strategy equilibrium in the price game, especially if products are not differentiated enough (see Gautier and Wauthy (2010) for a complete analysis of the implications of USO on equilibrium outcomes). In the present paper, we stick to the original analysis proposed by Valletti *et al.* (2002) and we focus on those instances where a pure strategy equilibrium exists. This is done without loss of generality as the results established by Gautier and Wauthy (2010) for the case where a mixed strategy equilibrium prevails largely confirm those of Valletti *et al.* (2002).

3 Four market scenarios

In the sequel, we shall consider four different market scenarios:

1. Monopoly and USO (referred to as M hereafter)
2. Competition without USO (referred to as C hereafter).
3. Competition with an unfunded USO (referred to as U hereafter)
4. Competition with a funded USO (referred to as F hereafter)

Scenarios M and C are two useful benchmarks, one without competition, the other without USO. The M scenario corresponds to the old-fashioned organization of the universal service where the service provider is granted a monopoly right to cover the cost of the USO. The C scenario corresponds to a market situation where the incumbent would be relieved from the universal service constraints while being exposed to competition. This counterfactual is often used to measure the financial burden of the USO.

Scenario U describes a liberalized market where the universal service is maintained and competition takes place. The competitor enters only in the most profitable local markets, leaving the markets with high connection costs to the universal service provider. Being the universal service provider thus entails a net cost that needs to be properly measured. And, if this cost

[2]For the economic foundations of the USO see Cremer *et. al*, (2001).

represents an *unfair burden*, the regulator may introduce a compensation mechanism. In order to finance the USO, regulators face two basic options: public funds and cost-sharing mechanisms. In this paper, we focus only on the latter option. The principle is the following: the regulator creates a universal service fund; the fund is financed by taxes levied on market participants and receipts are used to compensate the incumbent for the net cost of the USO. Scenario F describes the market outcome in the presence of such a tax.

3.1 Scenario M

Suppose that the market is not opened to competition yet . The incumbent firm is the sole service provider and services are offered at the monopoly price p_i^m defined as:

$$p_i^m \equiv \underset{p_i}{\operatorname{argmax}}\, \pi_i^m. \tag{1}$$

The total profit of the incumbent monopolist is equal to:

$$\Pi_i^M = \bar{n}\pi_i^m(p_i^m) - \int_0^{\bar{n}} g(n)dn. \tag{2}$$

Regarding the USO, we shall assume that (1) there is a non-empty subset of markets for which the connection cost exceeds the operating profit, that is $\pi_i^m(p_i^m) < g(\bar{n})$ and (2) a monopolist is able to self-finance the USO, $\Pi_i^M \geq 0$. In the scenario M, loss-making markets that the incumbent must serve as part of the USO are cross-subsidized by profits realized in the markets with low connection costs.

3.2 Scenario C

Under scenario C, firms compete freely and the incumbent can price discriminate between the monopolized markets, where it charges the monopoly price p_i^m, and the duopoly markets. In the latter, the best response functions in prices are defined as:

$$\phi_i^C(p_e) \equiv \underset{p_i}{\operatorname{argmax}}\, \pi_i^d, \tag{3}$$

$$\phi_e^C(p_i) \equiv \underset{p_e}{\operatorname{argmax}}\, \pi_e^d. \tag{4}$$

The equilibrium prices in the duopoly markets (p_i^C, p_e^C) are given by the intersection of the best response functions defined in (3) and (4). Firms

cover local markets as long as the equilibrium operating profits cover the connection cost. Equilibrium coverages (n_i^C, n_e^C) are thus given by:

$$\pi_e^d(p_i^C, p_e^C) = g(n_e^C), \quad (5)$$
$$\pi_i^m(p_i^m) = g(n_i^C). \quad (6)$$

The equilibrium industry structure is characterized by the following 5-tuple of endogenous variables $(n_i^C, n_e^C, p_i^m, p_i^C, p_e^C)$. Our assumptions immediately yield $n_e^C < n_I^C < \bar{n}$. Finally, the total profits of the firms are given by:

$$\Pi_i^C = n_e^C \pi_i^d(p_i^C, p_e^C) + (n_i^C - n_e^C)\pi_i^m(p_i^m) - \int_0^{n_i^C} g(n)dn, \quad (7)$$

$$\Pi_e^C = n_e^C \pi_e^d(p_i^C, p_e^C) - \int_0^{n_e^C} g(n)dn. \quad (8)$$

3.3 Scenario U

Under USO, the constraints UP and CC are imposed on the incumbent. The USP must serve each local market, and it cannot price discriminate across them. As a result, we cannot solve for a local Nash equilibrium in each market separately because the optimal behavior of the incumbent in the duopoly markets cannot be separated from that applying in the monopolized ones. In order to characterize the incumbent's best response function, we solve the following first order condition, computed on the global profit function of the incumbent:

$$\frac{\partial \Pi_i(\cdot)}{\partial p_i} = n_e^U \frac{\partial \pi_i^d}{\partial p_i} + (\bar{n} - n_e^U)\frac{\partial \pi_i^m}{\partial p_i} = 0. \quad (9)$$

Let us denote the solution to this equation by $\phi_i^U(\cdot)$. We assume that this solution is unique and furthermore that it defines the true best response function in the relevant range.[3] Firm E's best response function is not affected by USO so that $\phi_e^C(\cdot)$ still defines the entrant optimal behavior.

Let us denote by (p_i^U, p_e^U) the Nash equilibrium resulting from the combination of $\phi_i^U(\cdot)$ and $\phi_e^C(\cdot)$. The imposition of a uniform pricing rule relaxes price competition in the duopoly markets since $\phi_i^U(\cdot) > \phi_i^C(\cdot)$. The following orderings can be established:

$$p_i^C < p_i^U < p_i^m,$$

[3] See Gautier and Wauthy (2010) and Valletti *et al.* (2002).

$$p_e^C < p_e^U.$$

Furthermore, from (9), it can be shown that the incumbent's price best response function $\phi_i^U(\cdot)$ shifts downward when the entrant extends its market coverage: $d\phi_i^U/dn_e < 0$. This implies that the equilibrium prices and the profit of firm E in any local market are decreasing with the entrant's coverage. When the entrant extends its market coverage, it faces a tougher incumbent at the price setting stage. For that reason, the entrant has strategic reasons to limit its market coverage. Optimal coverage is thus the solution of:

$$\pi_e^d(p_i^U, p_e^U) + \frac{d\pi_e^d}{dp_i^U}\frac{dp_i^U}{dn_e} = g(n_e^U). \tag{10}$$

Notice that the effect of USO on n_e is ambiguous. Indeed, since price competition is weaker ($\phi_i^U > \phi_i^C$), local profits for the entrant are larger so that profitable entry can take place in a larger number of markets. However, the entrant controls for the incumbent's aggressiveness by limiting the number of contested markets. Thus the entrant's coverage may be higher or lower compared to scenario C.

Industry structure under this scenario is summarized by the 4-tuple $(p_i^U, p_e^U, \bar{n}, n_e^U)$ and the total profits of the firms are given by:

$$\Pi_i^U = n_e^U \pi_i^d(p_i^U, p_e^U) + (\bar{n} - n_e^U)\pi_i^m(p_i^U) - \int_0^{\bar{n}} g(n)dn, \tag{11}$$

$$\Pi_e^U = n_e^U \pi_e^d(p_i^U, p_e^U) - \int_0^{n_e^U} g(n)dn. \tag{12}$$

3.4 Scenario F

Being the universal service provider is usually costly and the USP may be compensated for the *net cost of the USO*. In the next section, we will see how this cost can be measured. For now, consider that complying with the constraints UP and CC induces a net cost $\Delta USO > 0$. In practice, regulators agree to compensate the USP for the net cost of the USO when it represents an *unfair burden* for the universal service provider. Criteria to evaluate the unfairness of the burden vary across sectors and countries and may not be well defined.[4] Let us now consider a market scenario where the USP will be compensated for the net cost ΔUSO.

In this scenario, the regulator sets a tax $\tau > 0$ and collects an amount $T(\tau) \geq 0$ that is paid to the incumbent as a compensation for being the universal service provider. In this funded scenario, the regulator must choose

[4]See Boldron *et al.* (2009) and Jaag (2011).

the tax base (entry fee, output, turnover...)[5] and the appropriate tax level. Furthermore, the regulator has the choice between a *compensation fund* where all the market participants, including the USP, pay the tax and a *pay-or-play* where any operator that provides the universal service is exempted from the tax. With a compensation fund, the USP has to partially compensate the net cost of the USO itself. From now on, unless specified otherwise, we will consider that the system is a pay-or-play.

In the market scenario F, the regulator decides on the tax level τ before the entrant decides on its coverage and firms compete in prices. The regulator anticipates all the consequences of the tax and it is therefore able to fine-tune the tax and to set it at the desired level, for instance at a level τ such that the revenue $T(\tau)$ is equal to ΔUSO.

To make our arguments, we will consider the case of an output tax paid by the entrant to the incumbent. The argument can be replicated for any other tax base and we will treat the special case of the lump-sum entry fee in section 5. In the funded scenario, when an output tax $\tau \geq 0$ applies, the entrant's optimal pricing behavior is defined as:

$$\underset{p_e}{\operatorname{argmax}}\, \pi_e^d = (p_e - c - \tau)x_e^d. \tag{13}$$

Let us denote by $\phi_e^F(\cdot)$ the best response function corresponding to the solution of equation (13). This function unambiguously shifts upward relative to scenario U: $\phi_e^F(\cdot) \geq \phi_e^C(\cdot)$ with a strict inequality for $\tau > 0$.

In the funded scenario, the incumbent maximizes $\Pi_i^F + T(\tau) = \Pi_i^F + n_e \tau x_e^d$ the sum of the operating profits and the net tax proceeds.[6] Consequently, the first order condition of the maximization problem is:

$$\frac{\partial \Pi_i(\cdot)}{\partial p_i} = n_e^U \frac{\partial \pi_i^d}{\partial p_i} + (\bar{n} - n_e^U)\frac{\partial \pi_i^m}{\partial p_i} + \tau n_e \frac{\partial x_e^d}{\partial p_i} = 0. \tag{14}$$

The last term in (14) captures the impact of a price increase on the tax proceeds.[7] This positive impact makes the USP less aggressive at the price

[5]The choice of an tax base is a very complex question in practice; See the discussion and the examples in Oxera (2007), Borsenberger *et al.* (2009) and Gautier and Paolini (2011).

[6]For a given tax level τ, the incumbent's objective is the same with a pay-or-play system than with a compensation fund as in the compensation fund the incumbent pays the tax to itself. The qualitative results we derive are thus independent of the mechanism chosen, though, obviously the tax level will not be the same.

[7]This term may be locally equal to zero if the regulator agrees to transfer all the tax proceeds up to some pre-specified limit, for instance an estimated net cost of the USO. Beyond this limit, increasing the entrant's market share would not lead to a higher revenue for the USP.

setting stage and for any given n_e, the best response function $\phi_i^F(\cdot)$ defined by (14) shifts upward compared to scenario U: $\phi_i^F(\cdot) \geq \phi_i^U(\cdot)$.

Summarizing, we have:

Lemma 1 *Given n_e, funding USO with $\tau > 0$ yields $\phi_e^F(\cdot) \geq \phi_e^C(\cdot)$ and $\phi_i^F(\cdot) \geq \phi_i^C(\cdot)$.*

The intuition for Lemma 1 is straightforward. Firm E tends to set higher prices because of its higher cost whereas firm I tends to set higher prices because part of the revenues that are lost by consumers' displacement are recovered through the taxes collected on firm E's sales. At this step, the presence of the unit tax unambiguously relaxes prices competition. One may expect that the entrant's profit decreases because of the tax but this is not immediately obvious, precisely because the presence of the tax induces an upward shift in $\phi_i(\cdot)$. Moreover, Gautier and Wauthy (2010) show that $\frac{\partial \phi_i(\cdot)}{\partial n_e} < 0$. As a result, the first order effect materialized by the shift of $\phi_e(\cdot)$ in Lemma 1 is reinforced by an upward shift of $\phi_i(\cdot)$ if the extent of market coverage decreases.

Let us denote by (p_i^F, p_e^F), the equilibrium prices defined by the combination of $\phi_i^F(\cdot)$ and $\phi_e^F(\cdot)$. The incumbent's coverage is $n_i^F = \bar{n}$ and the entrant's coverage is given by (10).

In the next Lemma we establish the condition under which the equilibrium profit of firm E in any local market, $\pi_e^* = \pi_e^d(p_i^F, p_e^F)$, decreases with τ. This condition implies that the entrant's coverage is lower in the scenario F as compared to U.

Lemma 2 *A sufficient condition for $\frac{\partial \pi_e^*(\cdot)}{\partial \tau} < 0$ is $\frac{\partial p_i^F}{\partial \tau} \leq 1$.*

Proof: Relying on the expression of the first order condition for firm E, we know that in equilibrium the following relation is satisfied:

$$(p_e - c - \tau)\frac{-\partial x_e(\cdot)}{\partial p_e} = x_e.$$

Developing the condition $\frac{\partial \pi_e^*(\cdot)}{\partial \tau} < 0$, we have:

$$-x_e + (p_e - c - \tau)\frac{\partial x_e(\cdot)}{\partial p_i}\frac{\partial p_i}{\partial \tau} < 0.$$

Combining the two previous equations we need:

$$(p_e - c - \tau)\frac{-\partial x_e(\cdot)}{\partial p_e} > (p_e - c - \tau)\frac{\partial x_e(\cdot)}{\partial p_i}\frac{\partial p_i}{\partial \tau}.$$

Which after simplification reads:

$$\frac{\frac{\partial x_e(\cdot)}{\partial p_i}}{\frac{-\partial x_e(\cdot)}{\partial p_e}} \frac{\partial p_i}{\partial \tau} < 1.$$

Since

$$\frac{\partial x_e(\cdot)}{\partial p_i} < \frac{-\partial x_e(\cdot)}{\partial p_e},$$

we have that $\frac{\partial p_i}{\partial \tau} < 1$ is sufficient to ensure that $\frac{\partial \pi_e^*(\cdot)}{\partial \tau} < 0$ is satisfied. ■

There are thus two channels through which τ could induce the incumbent to be less aggressive: the strategic effect that results from the collected tax and the market coverage effect. We shall assume hereafter that the total effect is such that Lemma 2 holds. In this case, we have $\frac{\partial n_e^F}{\partial \tau} < 0$. Notice thus that even if $\frac{\partial p_i^F(\cdot)}{\partial \tau} > 1$ we may have that the entrant's payoff decreases with the level of τ, and this is the more likely the more differentiated the products are.[8]

4 Measuring the net cost of the USO

In our model, complying with the universal service obligations is costly for the incumbent as the additional costs imposed by the USO exceed the additional revenues[9]. The net cost of the USO may thus be broadly defined as the cost of conforming to these obligations. To measure this cost, several methodologies have been proposed. The net avoided cost (NAC), the entry pricing (Rodriguez and Storer, 2000) and the profitability cost (Panzar, 2000 and Cremer *et al.*, 2000) are the most popular ones.[10] And, obviously, the cost of the USO depends on the way it is measured.

The NAC is an accounting exercise based on scenario M that consists in identifying the unprofitable submarkets for which the incremental cost exceeds the incremental revenue.[11] The NAC cost of the USO is then the additional profit that the USP would be able to achieve if it were relieved

[8] See Anderson *et al.* (2001) for a detailed analysis of the conditions on demand primitives such that the presence of a uniform tax may induce a profit increase.

[9] Including the possible intangible revenues of being recognized as the universal service provider.

[10] In all these approaches, it is assumed that the USP is an efficient operator i.e. costs are best practice costs. Thus, in principle, the net cost of the USO does not include any cost due to productive inefficiency.

[11] Distinguishing profitable and unprofitable products is far from obvious when there are common costs that must be allocated (see Pearsall, 2009 for a recent contribution).

from the USO and was allowed to withdraw from the unprofitable submarkets. The net avoided cost of the USO is equal to:

$$\Delta USO_{NAC} = \int_{\tilde{n}}^{\bar{n}} g(n)dn - (\bar{n} - \tilde{n})\pi_i^m(p_i^m), \tag{15}$$

where $\tilde{n} < \bar{n}$ is defined as $\pi_i^m(p_i^m) = g(\tilde{n})$. The NAC has been criticized on the grounds that it is essentially a static approach that fails to take into account possible changes in the market structure. The other methods consider that issue explicitly as they are both based on the comparisons of two different market scenarios.

The *entry pricing approach* compares the scenarios M and U. The entry cost of the USO is equal to the lost revenues for the incumbent on the n_e^U contested markets where entry occurs minus the impact of entry on the incumbent's total cost. Including the variation in the total cost after entry is particularly relevant when there are economies of scale. Formally, the entry pricing cost of the USO is defined as:

$$\Delta USO_{ep} = n_e^U[\pi_i^m(p_i^m) - \pi_i^d(p_i^U, p_e^U)] - (\bar{n} - n_e^U)c[x_i^m(p_i^m) - x_i^m(pi^U)]. \tag{16}$$

The *profitability cost approach* is based on a comparison of the incumbent's profit in the scenarios U and C.[12] The resulting profit for the incumbent USP, Π_i^C, is then compared with its actual profit in a liberalized market with USO, Π_i^U. The profitability cost of the USO (ΔUSO_π) is the difference between these two profit levels:

$$\Delta USO_\pi = \Pi_i^C - \Pi_i^U. \tag{17}$$

It estimates the losses in profits incurred by the USP that are specifically due to the USO, independently of the liberalization process since in both scenarios the USP faces competition.[13]

[12] A similar approach is recommended by the European Commission in the third postal directive (2008/6/EC, Annex I).

[13] The profitability cost approach does not make any reference to the regulated monopoly situation (scenario M). Cremer *et al.* (2000) decompose the transition from a monopolized market to a liberalized market into a profitability cost of liberalization measured as the difference between Π_i^M and Π_i^C and a profitability cost of the USO measured as the difference between Π_i^C and Π_i^U.

5 Funding USO

5.1 The two-step procedure

A positive net cost of the USO means that complying with the USO is costly for the service provider. Consequently, the universal service provider is eligible for a compensation. The two-step procedure for funding USO consists in a first step, to identify the cost of complying with the USO, using one of the methods described above, and, in a second step, to impose a tax τ on market participants. The tax is set at a level that guarantees that the tax proceeds are equal to the estimated cost of the USO. The compensation paid to the universal service provider is equal to the estimated net cost of the USO.

Now we shall argue that, whenever the funding of the USO is based on an estimated cost of the USO, be it ΔUSO_{NAC}, ΔUSO_{ep} or ΔUSO_{π}, the universal service provider receives a total compensation above the estimated net cost of the USO. In other words, a funding exercise that would be based on a prior estimate of the cost of the USO is inappropriate as it results in a too large compensation for the universal service provider. As a result, the USO costing exercise cannot be separated from the USO funding one because funding the USO affects the cost of complying with the USO.

In our comparisons of the scenarios U and F, we have shown that the imposition of a tax relaxes price competition, with the two firms being softer at the price-setting stage: $\phi_i^F(\cdot) \geq \phi_i^U(\cdot)$ and $\phi_e^F(\cdot) > \phi_e^U(\cdot)$. Furthermore, the entrant competes on a reduced number of markets $n_e^F < n_e^U$. These effects clearly concur to increase the incumbent's total profits. We thus have:

Lemma 3 *For any* $\tau > 0$, $\Pi_i^F(\cdot) > \Pi_i^U(\cdot)$.

In a funded USO scenario, the competitive pressures faced by the incumbent are lower and, consequently, its profit increases, as compared to the unfunded USO scenario. But, in addition, the incumbent receives a compensation that matches the estimated net cost of the USO. The incumbent is thus funded twice for its universal service provision: It receives a compensation from the universal service fund and it is partially sheltered from competition. The incumbent is clearly over-compensated: The total benefit received by the incumbent exceeds the cost of providing the USO (whatever the way it is measured). Formally, the total compensation received by the universal service provider is $\Pi_i^F - \Pi_i^U + \Delta USO$ and it is clearly above the estimated cost of the USO.

Proposition 1 *To compensate for the net cost of the USO, the tax τ must satisfy $\Pi_i^F - \Pi_i^U + T(\tau) = \Delta USO$ and it is immediate that $T(\tau) < \Delta USO$.*

The two-step procedure is misleading as it fails to account for the fact that tax proceeds are not the only source of funding. USO funding results from both the compensation fund and the sheltering of competition. Taxes should be adjusted downward to take into account the fact that the funding relaxes the competitive pressures faced by the incumbent.

Our previous argument is based on the imposition of a distortionary tax that modifies the pricing behavior of the firms.[14] Let us then consider the case of a fixed entry fee T set at the level of the estimated net cost of the USO. In this case, the firms' behavior in scenarios U and F are identical and the (after-tax) profits of the incumbent and the entrant are respectively $\Pi_i^U + \Delta USO$ and $\Pi_e^U - \Delta USO$. With a lump-sum entry fee, the tax proceeds are equal to the estimated cost of the USO and the USP is not overcompensated. This argument holds true as long as the entry fee is not set at an entry deterring level. Indeed, if $\Delta USO > \Pi_e^U$, the entrant is better off staying out of the market and the relevant scenario that applies is no longer F or U but M. When this condition is not satisfied, the entry fee $T = \Delta USO$ that fully compensates the incumbent for the ex-ante cost of USO deters entry. Thus the regulator must use a distortionary tax to finance the USO (or it accepts that no competition effectively takes place).[15] Finally, notice that if we use the profitability cost approach to calculate the net cost of the USO, the condition for entry can be expressed as $\Pi_i^C - \Pi_i^U > \Pi_e^U$, that is, the aggregate profit under USO is higher than the incumbent's profit in the unregulated case.

[14] In the european telecommunication sector, most of the countries that have a mechanism to share the burden of the USO use the turnover or the revenue to determine the contribution to the fund.

[15] When the two types of taxes are possible, it is not necessarily obvious that the lump-sum tax is the preferred option. The universal service obligations may place the universal service provider at a competitive disadvantage, for example when some form of uniform pricing is required. A distortive universal service tax may then be used to countervail the impact of the universal service obligations (see for instance the examples in Armstrong, 2001 and Mirabel *et al.*, 2009). For that reason, even if a lump-sum tax is feasible, the regulator may eventually prefer a distortive tax to place all the competitors on a level playing field. The choice then depends on the distortive impact of both the set of universal service constraints and the associated financing.

5.2 Competitive neutrality

Next, we would like to point the analogy between the above approach to USO financing and the concept of competitive neutrality. The criterion of *competitive neutrality* has often been put forward for qualifying the universal service and its supporting mechanism, especially in the telecommunications. In the US, the FCC requires that *the universal service support mechanisms and rules should be competitively neutral. In this context, competitive neutrality means that universal service support mechanisms and rules neither unfairly advantage nor disadvantage one provider over another.* Roughly speaking, the universal service and its financing are competitively neutral if they do not create a competitive advantage or disadvantage for the provider or the competitors. A possible way to interpret this requirement (adopted for instance by Choné *et al.*, 2002) is to impose that the profit of the designated provider is at least as big as the profit it would collect if it were relieved from the universal service obligations (in the scenario C).

If we adopt the profitability cost approach to measure the USO, the condition of proposition 1 for an appropriate USO financing can be written as follows:

$$\Pi_i^F + T(\tau) = \Pi_i^C. \tag{18}$$

The tax must be set at a level that guarantees to the incumbent a payoff that equals his payoff in scenario C, with competition but without USO. In other words, the funding should satisfy the competitive neutrality criterion.

Alternatively, condition (18) could be reinterpreted as follows: The compensation paid by the fund must be equal to the true profitability cost of the USO, the later being estimated on the basis of the relevant market scenario F with a funding and not on an hypothetical scenario U without funding. The tax proceeds can be set to equalize the estimated net cost of the USO when it is recognized that the cost of USO is endogenous to its funding i.e. computed on the basis of F.

Having said that, we now demonstrate that there always exists a tax that is compatible with competitive neutrality (as defined above) and that induces a positive amount of entry.

Proposition 2 *Whenever $\Pi_i^M > \Pi_i^C$, there exists a $\tau > 0$ such that (i) competitive neutrality can be achieved: $\Pi_i^F + T(\tau) = \Pi_i^C$ and (ii) entry takes place in the market: $n_e^F > 0$.*

Proof:(1) Total profits in F never exceeds those of the incumbent in M and

the tax proceeds T cannot exceed the entrant's profit:

$$\Pi_i^U + \Pi_e^U \leq \Pi_i^M, \tag{19}$$

$$\Pi_e^U \geq T(\tau). \tag{20}$$

Combining the two, we have that $\Pi_i^F + T(\tau) \leq \Pi_i^M$.

(2) Using lemma 2 and the envelope theorem, we have $\frac{\partial \Pi_i^F}{\partial \tau} > 0$, with $\lim_{\tau \to 0} \Pi_i^F = \Pi_i^U$ and with $\lim_{\tau \to \bar{\tau}} \Pi_i^F = \Pi_i^M$, where $\bar{\tau}$ is the tax rate that completely deters entry.

(3) The tax proceeds are non-negative $T(\tau) \geq 0$ and continuous in τ.

Combining these three facts, it must be that $\Pi_i^F + T(\tau)$ is continuous in τ and belongs to the closed interval $[\Pi_i^U, \Pi_i^M]$. Thus, whenever $\Pi_i^U < \Pi_i^C \leq \Pi_i^M$, there exists a tax rate τ that satisfies competitive neutrality and that leads to a positive coverage by the entrant. ■

We have demonstrated that, with distortive taxes, the regulator is always able to finance the true net cost of the USO and maintain competition in the market. This mechanism combines the reduction in competitive pressures and the funding levied on the industry participants.

5.3 Implications for USO design

We have shown that the funding of the USO creates additional distortions as prices are going up and the entrant covers fewer markets. In other words, the funding has some extra costs in terms of consumer surplus and welfare. Thus, if one considers the problem of designing the universal service, a question that is beyond the scope of this paper[16], it is clear that, due to the additional welfare losses specifically created by the funding mechanism, the scope of the USO will certainly not be extended when a cost-sharing mechanism is implemented. More specifically, if one considers that the CC constraint $\bar{n}$ that applies in scenario U has been designed in order to maximize the welfare, the regulator is likely to relax the constraint in scenario F as it entails additional costs. Reducing the scope of the universal service and thus reducing the net cost of the USO is an additional measure that could be combined with the cost-sharing mechanism and the associated sheltering of competition effect to sustain the universal service in a competitive environment.

[16] Crew and Kleindorfer (2006) focus on the accessibility of contact points and they show that its optimal to reduce the scope of the USO in a competitive environment compared to a monopoly situation.

6 Concluding remarks

We have shown that an estimated cost of the USO should be used carefully in any USO policy. In particular, it cannot be used to determine the size of the universal service fund because, whenever funding USO requires the use of a tax mechanism, the presence of this tax partly shields the USP from competition and, as such already yields a partial compensation for universal service provision. As a result, compensating the provider to the level of the ex-ante measured cost would induce over-compensation and would not be competitively neutral. In the benchmark model we proposed in the paper, we have nevertheless shown that there always exists a tax level that ensures the funding of USO according to the competitive neutrality criterion and this funding is compatible with competition in the market. With an appropriate distortive tax, it is thus possible to sustain the same standard of universal service in a competitive market. Having said that, it does not mean that the universal service should be fixed once and for all. Market liberalization ultimately changes the USO funding from internal cross-subsidies in scenario M to explicit inter-industry transfers in scenario F with both mechanism having their own welfare cost. For that reason, market liberalization may call for a redefinition of the universal service that takes into account the true cost of the USO and its funding. In this last respect, we have contributed to the debate by pointing out that the cost of the USO is endogenous to its funding.

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