



Competitively neutral universal service obligations

Axel Gautier^{a,c}, Xavier Wauthy^{b,c,*}

^a CREPP, HEC-Université de Liège, Bat. B31, Boulevard du Rectorat 7, 4000 Liège, Belgium

^b CEREC, Facultés universitaires Saint-Louis, Boulevard du Jardin Botanique 43, 1000 Brussels, Belgium

^c CORE, Université Catholique de Louvain, Belgium

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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.

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1. Introduction and summary

Universal Service Obligations (USOs) are a standard practice in many industries including telecommunications, energy and postal services. USO can be broadly divided into two categories: quality obligations (e.g. minimum quality standards, ubiquity of service) and price obligations (e.g. uniform and affordable pricing). USO do not attract much attention when the industry is organized as a (possibly regulated) monopoly. Indeed, when the Universal Service Provider (USP) is a monopolist, 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 USO with competition resulting from the current trend in market liberalization 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 a 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 to evaluate the net cost of the universal service to its provider using an appropriate methodology. Based on this cost estimate, the need for a funding mechanism is then assessed and, if necessary, an appropriate funding scheme is chosen and implemented. This is the approach typically 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)

This paper shall set out the argument 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. More specifically, compensating the USP on the basis of an estimated net cost of the USO is likely to be inappropriate whenever the levied tax modifies the behavior of the market participants.

An extreme example of this is provided by the Finnish postal market, which has been fully liberalized since

* Corresponding author at: CEREC, Facultés universitaires Saint-Louis, Boulevard du Jardin Botanique 43, 1000 Brussels, Belgium.

E-mail addresses: agautier@ulg.ac.be (A. Gautier), xwauthy@fusl.ac.be (X. Wauthy).

1994. The regulator has imposed a licensing system, and accordingly any alternative postal service provider operating in densely populated areas only would have to pay a fee. This fee aims to ensure that high quality services are also provided in sparsely populated areas. In practice, this fee is so high that it effectively constitutes an entry barrier to new service providers, and as a result the incumbent Finnish postal operator still enjoys a near monopoly position. Clearly, if this entry fee is based on a USO costing exercise, the estimated and actual costs do not correspond because the costing exercise failed to take into account that the resulting tax is fixed at a deterrent level.

This paper argues that a USO funding mechanism modifies firms' behavior. Such funding schemes tend to partially shelter the incumbent from competition, and consequently the USP collects a higher profit in a funded scenario. A compensation equal to the estimated net cost of the USO therefore leads to an overcompensation of the USP, which is effectively paid twice: first, it is fully compensated for the net service cost by the funding mechanism, and 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), this paper illustrates 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. This study will then demonstrate that a tax level compatible with both competition in the market and competitive neutrality always exists.

The paper is organized as follows. Sections 2 and 3 present the model and introduce four relevant market scenarios: monopoly and USO (*M*), competition without USO (*C*), competition with USO (*U*) and competition with a funded USO (*F*). Section 4 discusses the scope for evaluating the cost of USO ex-ante, i.e. independently of its possible financing; and several possible measures are discussed. Section 5 argues that the ex-ante cost of USO should not serve as a basis for determining the level of compensation, introduces a competitive neutrality criterion to determine the tax level that will ensure adequate compensation; additionally demonstrating that this compensation level exists and is compatible with competition in the market. Finally Section 6 concludes the study.

2. The model

The model used 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, it is assumed 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.

A maximum of two firms are active in each local market. Firms play a two-stage game, first choosing their market coverage and then simultaneously setting prices. 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, the assumption is that the incumbent has a larger coverage that the entrant: $n_e \leq n_i$. It is therefore possible to distinguish between 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, consumer 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 demands are respectively defined as $x_i(p_i, p_e)$ with $\frac{\partial x_i(\cdot)}{\partial p_i} < 0$ and $\frac{\partial x_i(\cdot)}{\partial p_e} > 0$.¹ Demand functions are twice continuously differentiable. Firms produce at a constant marginal cost $c > 0$. $\pi_i^m(p_i)$, $\pi_i^d(p_i, p_e)$ and $\pi_e^d(p_i, p_e)$ denotes the operating profit made by firm $k = i, e$ in a monopoly (subscript 'm') and a duopoly market (subscript 'd'). The assumption is that $\frac{\partial \pi_k^d(\cdot)}{\partial p_k \partial p_l} > 0$, i.e. prices are strategic complements. Finally, the assumption is that there exists a unique, interior, Nash equilibrium in the pricing game taking place in any local market.

USO, if any, are imposed on firm *I* exclusively. USO are defined here as comprising two distinct elements: a uniform 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 an obligation to serve all markets in $[0, \bar{n}]$. It is therefore noteworthy that while local markets are independent from each other without USO (since marginal costs are constant), this no longer holds true under USO because of the uniform pricing rule. This strategic link between markets under USO may lead to the nonexistence 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). The focus of the present paper is confined to the original analysis proposed by Valletti et al. (2002), focusing 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 a scenario in which a mixed strategy equilibrium prevails) largely confirm those of Valletti et al. (2002).

3. Four market scenarios

In the following section, we will consider four different market scenarios:

¹ Without loss of generality, the assumption is that $\forall p, x_i^m(p) \geq x_i^d(p, p_e)$

² For the economic foundations of the USO see Cremer et al. (2001).

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 provider would be relieved from the universal service constraints while being exposed to competition. This theoretical scenario is often used to gauge the financial burden of the USO in a real-world situation.

Scenario *U* describes a liberalized market where the universal service is maintained and competition simultaneously takes place. The competitor enters only in the most profitable local markets, leaving the markets with high connection costs to the USP. The universal service consequently entails a net cost that requires accurate measurement. Furthermore, if this cost represents an *unfair burden*, the regulator may introduce a compensation mechanism. In order to finance the USO, regulators face two basic options: use of public funds or cost-sharing mechanisms. In this paper, we focus on the latter option only. The principle is as follows: the regulator creates a universal service fund, 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*

This scenario is based on the premise 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:

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

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, the scenario assumes 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:

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

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

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:

$$\pi_e^d(p_i^C, p_e^C) = g(n_e^C), \tag{5}$$

$$\pi_i^m(p_i^m) = g(n_i^C). \tag{6}$$

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

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

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

3.3. Scenario *U*

Under USO, UP and CC constraints are imposed on the incumbent provider. The USP must serve each local market, and cannot price discriminate across them. As a result, a local Nash equilibrium in each market cannot be determined separately, because the optimal behavior of the incumbent in the duopoly markets cannot be separated from that applying to the monopolized markets.

Taking the following first order condition, computed on the global profit function of the incumbent:

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

The solution to this equation can be denoted by $\phi_i^U(\cdot)$. Assuming that this solution is unique, and furthermore that it defines the true best response function in the relevant range³, $\phi_i^U(\cdot)$ characterizes the incumbent's best response function. Firm *E*'s best response function is not affected by USO, and therefore $\phi_e^C(\cdot)$ still defines the optimal entrant behavior.

The Nash equilibrium resulting from the combination of $\phi_i^U(\cdot)$ and $\phi_e^C(\cdot)$ can be denoted by (p_i^U, p_e^U). 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:

$$p_i^C < p_i^U < p_i^m, \\ p_e^C < p_e^U.$$

Furthermore, from (9), the incumbent's best price 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 mar-

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

ket decrease with the entrant’s coverage. When the entrant extends its market coverage, it faces a tougher incumbent at the price setting stage. For this reason, the entrant has a strategic incentive to limit its market coverage. Optimal coverage is thus the solution of:

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

Note 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 increase, enabling profitable entry in a larger number of markets. However, the entrant must control 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:

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

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

3.4. Scenario F

Being the USP is usually costly, and consequently the USP may be compensated for the net cost of the USO. The following section will explore ways in which 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 USP. Criteria used to evaluate the unfairness of the burden vary across sectors and countries and may not be well defined.⁴ The scenario below considers a market 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 $T(\tau) \geq 0$ paid to the incumbent as a compensation for being the USP. In this funded scenario, the regulator must choose the tax base (entry fee, output, turnover, etc.)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 model, where any operator that provides the universal service is exempt from the tax. If a compensation fund is selected, the USP must itself partially compensate the net cost of the USO. For the purposes of this study (unless specified otherwise), a pay-or-play system will be studied.

In the market scenario F, the regulator decides on the tax level τ before the entrant decides on its coverage and firms begin to compete on price. 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 in-

stance at a level τ , such that the revenue $T(\tau)$ is equal to ΔUSO .

The following argument will consider the case of an output tax paid by the entrant to the incumbent. This argument can be replicated for any other tax base and the special case of the lump-sum entry fee will be specifically addressed in Section 5. In the funded scenario, when an output tax $\tau \geq 0$ applies, the entrant’s optimal pricing behavior is defined as:

$$\operatorname{argmax}_{p_e} \pi_e^d = (p_e - c - \tau) \chi_e^d. \quad (13)$$

$\phi_e^F(\cdot)$ denotes the best response function, corresponding to the solution of Eq. (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 $\Pi_i^F + T(\tau) = \Pi_i^F + n_e \tau \chi_e^d$, the sum of the operating profits and the net tax proceeds.⁶ Consequently, the first order condition of the maximization problem is:

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

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 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: $\phi_i^F(\cdot) \geq \phi_i^U(\cdot)$.

In summary:

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 costs, 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 stage, the presence of the unit tax unambiguously relaxes price 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.

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

⁶ For a given tax level τ , the incumbent’s objective remains unaltered regardless of whether the system is pay-or-play or compensation fund based, as in the case of a compensation fund the incumbent pays the tax to itself. The qualitative results derived here are consequently independent of the mechanism chosen, although the tax level will obviously 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 a 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.

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

⁵ The choice of a tax base is, in practice, a highly complex question; see the discussion and examples in Oxera (2007), Borsenberger et al. (2010) and Gautier and Paolini (2011).

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 scenario F in comparison with scenario 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:

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

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

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

Combining the two previous equations requires:

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

Which after simplification reads:

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

Since

$$\frac{\partial \mathcal{X}_e(\cdot)}{\partial p_i} < \frac{-\partial \mathcal{X}_e(\cdot)}{\partial p_e},$$

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

There are therefore two channels through which τ could induce the incumbent to be less aggressive: the strategic effect resulting from the collected tax, and the market coverage effect. The following is based on the premise that the total effect is such that Lemma 2 holds true; and consequently $\frac{\partial \pi_e^*(\cdot)}{\partial \tau} < 0$. Note that therefore even if $\frac{\partial p_i^F}{\partial \tau} > 1$, the entrant's payoff may decrease with the level of τ ; this is increasingly likely the more differentiated the products are.⁸

4. Measuring the net cost of the USO

In this model, complying with the USO is costly for the incumbent because the additional costs imposed by the USO exceed the additional revenues⁹. 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; Cremer et al., 2000) are the most popular methodologies.¹⁰ Clearly, the cost of the USO depends on the way it is measured.

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 USP.

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.

The NAC is an accounting exercise based on scenario M , and consists of identifying the unprofitable submarkets for which the incremental cost exceeds the incremental revenue.¹¹ The NAC of the USO is then the additional profit that the USP would be able to achieve if it were relieved from the USO and was allowed to withdraw from the unprofitable submarkets. The NAC of the USO is equal to:

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

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 market structure. The other methods consider the issue of market structure 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:

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

Finally, 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:

$$\Delta USO_\pi = \Pi_i^C - \Pi_i^U. \quad (17)$$

This methodology estimates the loss in profits incurred by the USP specifically due to the USO, independent of the liberalization process, since in both scenarios the USP faces competition.¹³

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, and consequently the USP is eligible for compensation. The two-step procedure for funding USO consists of firstly identifying the cost of complying with the USO (using one of the methods described above), and secondly imposing a tax, τ , on

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).

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) deconstruct the transition from a monopolized to a liberalized market as a profitability cost of liberalization. This is 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 .

market participants. The tax is set at a level that guarantees the tax proceeds to be equal to the estimated cost of the USO. The compensation paid to the USP is equal to the estimated net cost of the USO.

The following paragraphs set out the argument that whenever the funding of the USO is based on its estimated cost, be it ΔUSO_{NAC} , ΔUSO_{ep} or ΔUSO_{τ} , the USP receives a total compensation above the estimated net cost of the USO. In other words, a funding exercise based on a prior estimate of the cost of the USO is inappropriate, overcompensating the USP. As a result, the USO costing exercise cannot be separated from USO funding exercise, because the cost of USO compliance is inextricably affected by its funding.

Comparing scenarios U and F has demonstrated that the imposition of a tax relaxes price competition, with the two firms behaving less aggressively 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 combine 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 in comparison with the unfunded USO scenario. However, the incumbent additionally 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 is also partially sheltered from competition. The incumbent is clearly over-compensated: the total benefit received by the incumbent exceeds the cost of providing the USO (whichever way it is measured). Formally, the total compensation received by the USP is $\Pi_i^F - \Pi_i^U + \Delta USO$, 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 therefore 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 therefore be adjusted downward to take into account the fact that the funding relaxes the competitive pressures faced by the incumbent.

The argument outlined above is based on the imposition of a distortionary tax that modifies the pricing behavior of the firms.¹⁴ This section will now 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

¹⁴ In the European telecommunication sector, most countries with a mechanism to share the burden of the USO use the turnover or the revenue to determine the contribution to the fund.

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 that fully compensates the incumbent for the ex-ante cost of USO, $T = \Delta USO$, deters entry. Thus the regulator must use a distortionary tax to finance the USO, or otherwise simply accepts that no competition effectively takes place.¹⁵ Finally, notice that if the profitability cost approach is used 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.

5.2. Competitive neutrality

This section highlights the analogy between the above approach to USO financing and the concept of competitive neutrality. *Competitive neutrality* has often been proposed as a qualifying criterion for the universal service and its supporting mechanism, especially in 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*. Broadly speaking, the universal service and its financing are competitively neutral if they do not create a competitive advantage or disadvantage for either the provider or the competitors. One possible way to interpret this requirement (adopted for instance by Choné et al., 2002) is to require that the profit of the designated provider is at least as big as the profit it would collect if it were relieved from the USO (in the scenario C).

Adopting the profitability cost approach to measure the USO, the condition of Proposition 1 for an appropriate USO financing can be written as follows:

$$\Pi_i^F + T(\tau) = \Pi_i^C. \quad (18)$$

The tax must be set at a level that guarantees to the incumbent a payoff equaling the 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 latter being estimated on the basis of the relevant market scenario F with funding, rather than on an hypothetical scenario U without funding. 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 .

¹⁵ When the two types of taxes are possible, it is not necessarily obvious that the lump-sum tax is the preferred option. The USO may place the USP 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 USO (see 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.

Notwithstanding the above, there always exists a tax that is compatible with competitive neutrality (as defined above) and that induces a positive amount of entry, as demonstrated below:

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:

$$\Pi_i^U + \Pi_e^U \leq \Pi_i^M, \quad (19)$$

$$\Pi_e^U \geq T(\tau). \quad (20)$$

Combining the two results in $\Pi_i^F + T(\tau) \leq \Pi_i^M$.

- (2) Using Lemma 2 and the envelope theorem, we have $\frac{\partial \Pi_i^F}{\partial \tau} > 0$, with $\lim_{\tau \rightarrow 0} \Pi_i^F = \Pi_i^U$ and with $\lim_{\tau \rightarrow \bar{\tau}} \Pi_i^F = \Pi_i^M$, 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 $[\Pi_i^U, \Pi_i^M]$. Consequently, whenever $\Pi_i^U < \Pi_i^C \leq \Pi_i^M$, there exists a tax rate τ that satisfies competitive neutrality and leads to a positive coverage by the entrant. \square

This study has demonstrated that by utilizing 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 a reduction in competitive pressures and the funding levied on the industry participants.

5.3. Implications for USO design

This study has additionally demonstrated that the funding of the USO creates additional distortions as prices increase and the entrant covers fewer markets; in other words, funding incurs 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 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 show that it is optimal to reduce the scope of the USO in a competitive environment compared to a monopoly situation.

6. Concluding remarks

Furthermore, this study has demonstrated 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 result in over-compensation and would not be competitively neutral. The benchmark model proposed in this paper has 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. However, this 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, this study has sought to contribute to the wider debate by pointing out that the cost of the USO is endogenous to its funding.

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