Multi-National Policies for the Universal Service Obligation in the Postal Sector under Entry[1]

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Abstract

In a series of earlier papers, several authors have examined policies concerning the scope and consequences of the Universal Service Obligation (USO) for postal services. This work has been restricted to the design of the USO for a single country. The present paper is concerned with examining the USO across several countries. The assumption is that a multi-national agency can set minimum standards that apply to all the countries in a region, where each country (through regulatory or government policy) must comply with, but may exceed, these standards. The regional and country-specific USOs constrain the operations of an incumbent PO, which is required to fulfill these default service obligations for historical or other reasons. The paper examines the nature of the tradeoff that ensues across countries in designing an efficient USO at the regional level when these postal markets are also simultaneously opened to competitive entry. In particular, the paper examines when "subsidiarty dominates" (in the sense that the regional regulator should leave the determination of the USO entirely in the hands of national regulators) and when some intervention by the regional regulator is desirable.

1. Introduction

This paper examines an aspect of the Universal Service Obligation (USO) that has not previously been the subject of much attention in research on the USO, namely, the

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problem of multi-national regulation of the USO.[4] The multi-national problem arises when a group of countries decide by treaty or other agreement to determine common policies applicable to the entire group of countries. The best current example of this is the European Union (EU). Traditionally, the problem of the (USO) for postal services has been examined only in the context of a single country as in the normative analysis presented in Crew and Kleindorfer (1998, C-K).

C-K pose a single-country model in which entry is allowed, while the incumbent postal operator (PO) is faced with a USO, modeled as the obligation to provide ubiquitous service at a uniform price (and implicitly also subject to service quality constraints) for all services covered by the USO. C-K identify several key tradeoffs in their analysis of the USO. First, pricing uniformity reduces transactions costs for customers, but it also may induce inefficient entry. Second, assuming the PO is to float on its own bottom, without subsidies, the presence of fixed costs and uniform pricing create incentives for cream skimming, which may lead to financial difficulties for the PO.[5] Third, and relatedly, if financing of the USO is accomplished by reserving the exclusive right to provide certain services to the PO (i.e., by retaining the traditional "reserved area"), then the USO financing problem is further confounded with efficiency problems associated with monopoly provision, including the loss of competitive innovation and product portfolio expansion, together with the problem of trying to regulate the prices, profits and production efficiency of the resulting PO. Thus, a whole set of additional tradeoffs may arise in the joint design of the reserved area and the USO. The essence of these tradeoffs is that expanding the reserved area allows for a broader scope of USO to be imposed, while still maintaining financial viability of the PO. However, the reduced transaction costs for consumers associated with an expanded USO, financed by an expanded reserved area, come at the cost of lower benefits of entry. C-K analyze the welfare-optimal design problem, which must balance these costs and benefits.

[4] A national regulator could also face this problem where standards vary on a regional basis and where minimum standard was required.

[5] These financial difficulties were examined in a series of follow-on papers by C-K and others, which examined conditions under which the PO's viability could be assured under entry. The most recent paper in this series is Crew and Kleindorfer (2006a), which the reader can consult for an overview of preceding work in this vein. Other recent work on financial viability includes Cohen et al. (2000, 2004), d'Alcantara and Amerlynck (2006) and De Donder et al. (2002).

They show that the optimal scope of the USO and the reserved area depend on the magnitude of consumer transaction cost savings from the USO, the benefits of differentiated products, the efficiency of potential entrants relative to the PO, and several other cost and demand drivers.

Others have examined the nature of the USO in practice. Ambrosini, Boldron and Roy (2006) describe the varied approaches taken to defining the scope of the USO in 19 countries from around the world. While there are many common elements to the USOs in the POs surveyed by Ambrosini et al., there are also interesting differences, with approaches differing according to the scope of products included, the nature of service quality requirements such as delivery frequency and accessibility to postal counters, and the pricing constraints on affordability and uniformity applied. For example, some countries define the USO for the PO to include very precise and extensive requirements for collection frequency and post office locations, while others have less stringent requirements. Some countries require pricing uniformity quite extensively across product offerings, while others apply uniform pricing on a more limited basis. Access pricing and protocols may or may not belong to the USO, and many other country-specific differences arise when considering the nature of regulation applied to the PO. In general, while the USO remains a central feature of POs around the world, different countries have developed variations on both the definition of the USO as well as regulatory mechanisms to assure compliance with this obligation.

The USO is likely to be of even greater interest in the future, since many countries are following the road to liberalization. Together with technological change and electronic substitution, liberalization policies promoting competitive entry could put the traditional USO at risk. First, technological competition has provided substitutes for and reduced demand for letter mail. This results in a potential increase in a PO's unit costs if it loses some of the benefits of scale economies because of the lower output. Meanwhile, the fixed costs of the USO continue. Second, liberalization implies changes that eliminate or significantly reduce the POs' reserved area, and this means taking away the primary means through which the USO has been funded to date.

In the absence of a reserved area, the feasible options for financing the USO burden in the face of entry consist generally of a combination of greater commercial freedom for

the PO, with the increased commercial operations and competition implied by this, and a reduction in the scope of the USO. Greater commercial orientation can take a number of forms, resulting in increased cost control, more flexible pricing and the ability to adjust the product line with reduced regulatory oversight (see Crew and Kleindorfer (2006a) for details). Reducing the burden of the USO *prima facie* appears to be an effective way of enabling as PO to survive when facing entry, since relaxing the uniformity constraint (in terms of delivery frequency, service quality and/or in pricing) of the USO should allow the PO to remain viable under a broader set of demand, cost and entry scenarios than it could under more stringent uniformity constraints. For example, Haldi and Merewitz (1997), Cohen et al. (2000) and Haldi and Schmidt (2002) discuss the benefits in decreasing the USO burden under entry by making significant changes in the service standards, with high cost areas receiving significantly lower service standards (e.g., three-days a week delivery instead of five or six). The extent of the differences in quality needed to achieve measurable reductions in the USO burden may again differ across countries, of course.

Such considerations have received considerable attention in the literature but the focus has been on single-country markets. However, in the EU this is changing with the postal Directives of 1997 and 2002, and the movement toward full market opening of postal markets in all of the 25 Member States (soon to be 27) by the year 2009.[6] The postal Directives establish for all Member States an EU-wide minimum standard for their USO, where individual countries in the EU have adopted (see Ambrosini et al. (2006)) broader USOs than the EU requirements (which essentially call for 5 day a week deliveries, uniform tariffs[7], and reasonable accessibility and affordability of postal services). The debate on USO policy under the impending liberalization is already heating up, with some voices calling for a continuation of the historical USOs in their respective countries, while others are calling for a significant reduction in the USO after

[6] The European Commission Postal Directive (Directive 97/67/EC as amended by Directive 2002/39/EC) envisages the full opening of the EU postal market to competition by 1 January 2009. Article 7 (3) of the Postal Directive requires the Commission "to submit by 31 December 2006 a report to the European Parliament and the Council accompanied by a proposal confirming, if appropriate, the date of 2009 for the full accomplishment of the postal internal market or determining any other step in the light of the study's conclusions."

[7] It should be noted, however, that the application of a uniform tariff does not exclude the right of the USP to conclude individual agreements on prices with customers.

liberalization, and a good deal of attention being paid to the possible interaction of the European Commission in the definition and harmonization of USOs in Member States after full market opening.[8]

Against this background, we propose to analyze a simple model of a multi-national USO, which is a stylized version of the EU situation, in which a multi-national agency sets minimum policy for the USO, with countries in the region then free to set a "higher" level of USO. We analyze the case in which there is some historical or other reason such that each country is committed to a certain level of USO. In section 2, following an extension of the model of Crew and Kleindorfer (2000), we consider a model of the USO in a particular national market, and we note the details of how entry and the choice of the USO will interact in a liberalized market to influence profits of the Universal Service Provider (assumed to be the incumbent PO) and welfare in any specific national market. The entry considered is potentially from other POs in the region, as well as from new entrants. Motivated by these single-results, we then consider in section 3 the aggregate profit and welfare consequences for the region of setting minimum standards for the USO. We derive some results for this general case, showing when the regional regulator should set a constraint that is binding on at least one of the countries (i.e., for at least one of the countries in the region, when the regional standard should be set to exceed that which the country would choose if not subject to regional regulation). Section 4 discusses some of the possible conclusions from this analysis. As with other policy issues related to the USO, robust conclusions concerning optimal regional policies are not available from theory alone. Rather, efficient regional USO policies depend on country characteristics in the region, so that an empirical assessment will be required to inform the design of regional USO policies. The nature of the regional assessment required will be briefly discussed in concluding the paper.

For the reader not interested in technical details, here is a summary of what we show in the next two sections. First, we consider a model in which entrants can capture market share from a hitherto monopoly incumbent in a single liberalized postal market. The

[8] See Finger et al. (2005) for a discussion of the current EU requirements for the USO and for some of the reasons for reconsidering and reducing the scope of the USO as liberalization approaches. It should be noted, of course, that there are many other issues beyond the USO policy that must also be determined as the EU moves to liberalization, including critical issues relating to regulation and to access policies.

Incumbent faces a USO that consists of affordability constraints, uniform pricing and requirements for establishing a network with a certain density of postal counters. The scope of these USO requirements is the subject of the economic design problem analyzed. We derive first-best and Ramsey (breakeven constrained) benchmarks for the optimal scope of USO, and show how this scope depends on the tradeoffs between the transactions cost savings of customers who benefit from the USO and the costs and benefits of entry under the constrained USO design. In the following section, we then show the conditions under which it is efficient to set minimal standards at a multi national level, allowing countries to determine their own scope of USO. It should be noted that the primary driver of the outcome that "subsidiarty is efficient" is the presumption (which we dress up in proper raiment of an economic model) that the incumbent PO in each national state covered by the multi-national USO regulation would like to see only minimal USO requirements. The rationale provided in the modeling framework adopted is that the incumbent PO is a for-profit organization, which therefore would foresee constraints on its operational and pricing decisions (whether from the USO or otherwise) as an unwanted intrusion on its commercial freedom. Since there are several other models and motivations that might be considered realistic for national POs vis-à-vis USO policy, we consider some of the possible variations on this theme in the final section of the paper.

2. USO Policy and Welfare for a Single Country

Consider a region consisting of N = {1, …, n} countries. Each country has a national PO, which is simultaneously the Universal Service Provider (USP). In this section, we consider one of the national markets and analyze the consequences for welfare and financial viability of the USO imposed in the country, whether the USO arises from a multi-national regulator or from the country's national regulator. We will consider only a single product ("letters") and a situation in which the USP is required to service all regions of the country.

To capture the essence of the USO we consider three typical constraints embodied in the USO: 1) a uniform price for all delivery zones; 2) a requirement for locating post office outlets according to population density in each zone; and 3) an affordability

constraint, taken here to be a zero-profit constraint on prices of USO products.[9] The intent here is to capture the spirit of the USO as a constraint on USP services that may make it more difficult for the USP to compete (especially for high-margin products in the low-cost delivery areas), but which may, nonetheless, be valuable for customers in terms of reduced transactions costs, ubiquity of coverage or other potentially valued service attributes.

To avoid uninformative complications, only the case of inelastic demand is assumed, with demand for zone $t \in [0, T] \subset \Re$ given by D(t). In keeping with the notion of full market opening, we assume no reserved area for the incumbent and Bertrand competition between the USP and a set of entrants, treated here as a competitive fringe, some of which may be POs from other countries. We assume that entrants are sufficiently numerous and homogeneous that we will, in fact, treat them as a competitive fringe in each country.

Figure 1 (at the end of the paper) illustrates the problem, following C-K (2000). The horizontal axis represents the region of the country, arranged in increasing order of entrant's unit costs (as just noted, we show only the minimum such cost across all entrants, as this is the only cost that matters in determining market shares). The vertical axis is price (or unit cost). The unit costs of entrants is the curve $C_E(t)$, while for the incumbent it is $C_I(t)$, both of which are assumed continuous and strictly increasing on [0, T]. To make matters interesting, it is assumed that $C_E(0) < C_I(0)$, so that entrants enjoy a cost advantage in some of the low-cost areas. Price is uniform at P_I for all delivery zones under the USO. Since delivery zones are indexed in increasing order of $C_E(t)$, the intersection (if there is one) between the uniform price $P = P_I$ and CE(t) defines the point $t_I(P)$, to the left of which entrants will capture all mail and to the right of which the incumbent USP will be the supplier.[10]

[9] There have been several calls recently to relax the uniform pricing constraint (especially on letters) of the traditional USO (e.g., Crew and Kleindorfer (2006b) and Biasi et al. (2006)). In addition, proposals (e.g., Felisberto et al. (2006)) to charge for "the final mile" (rather than to a more accessible centralized mailbox location) are also a move away from strict uniform pricing. As noted earlier in this paper, most of the earlier discussion on varying the scope of the USO focused on relaxing service quality for high-cost delivery areas.

[10] More complex models have been developed after C-K (2000) which show outcomes that have the incumbent and entrants sharing delivery of mail on routes, rather than the simpler model here that shows an all or none outcome in which either a delivery zone is fully supplied by entrants or fully supplied by the

The USO requirement that post offices be located in reasonable proximity to the population is assumed to give rise to (say, annual) fixed costs of:

$$F(u) = u\int_{0}^{T} D(t)dt \qquad (1)$$

where u ε $\Re^+$ is density of post office coverage. It is one element defining the scope of the USO, the other elements being uniformity of price and affordability. The affordability constraint for the USO id understood here to be the least price (if one exists) that assures breakeven operations for the incumbent while meeting pricing uniformity and the specified USO represented by u in (1).[11] Our assumptions give rise to the following two identities characterizing price P and USP profits Π(P, u):

$$C_E(t_I) = P \Rightarrow t_I(P) = C_E^{-1}(P) \qquad (2)$$

$$\Pi(P,u) = \int_{t_I(P)}^{T} \big(P - C_I(t)\big)D(t)\,dt - F(u) = 0 \qquad (3)$$

We do not explore here issues of the Graveyard Spiral (Crew and Kleindorfer, 2000), and so we assume that the required u ε $\Re^+$ is not so onerous as to preclude a solution to (3), and, moreover, that this solution occurs while gross profits Π(P, u) are increasing in P (i.e., a price P(u) less than the profit-maximizing price solves (3)). Given this, it is easily established under some regularity conditions stated below that the solution P(u) to (3) is unique and monotonic increasing in u (see Lemma 1, Appendix).

Assume the reservation price/value per letter is v. To capture the benefits of the USO, we assume that consumer transactions costs in accessing the postal network are proportional to the average distance to a post office,[12] which in our linear market is then inversely related to the number of such post offices. Thus, if F(u) is proportional to the

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incumbent. These richer models take a customer-specific focus or introduce imperfect product differentiation. See Crew and Kleindorfer (2001, 2006) for a discussion.

[11] We will see below that imposing the less constraining requirement that Π(P, u) $\geq$ 0 leads at the Ramsey optimal solution to (3). Thus, in the context of the present model, assuming (3) holds as an equality is without loss of generality from a welfare perspective.

[12] In Crew and Kleindorfer (1998), we also considered transactions cost savings arising from uniform pricing by the PO. These are neglected here.

number N of post offices required for a given USO for a given location density requirement u ε U, then we can assume access transactions costs to be given by

$$A(u) = \frac{K}{u\int_0^T D(t)dt} \qquad (4)$$

where K is a proportionality factor measuring the value of time and inconvenience of accessing a post office. Then, from (1)-(4), we can express the welfare associated with a given USO policy in the traditional form of the (unweighted) sum of consumer and producer surpluses:

$$W(P,u) = v\int_0^T D(t)\,dt - \int_0^{t_I(P)} C_E(t)\,D(t)\,dt - \int_{t_I(P)}^T C_I(t)\,D(t)\,dt - F(u) - A(u) \qquad (5)$$

Before proceeding, we need some regularity conditions on costs and demands, which amount to assuming that the Incumbent is disadvantaged in the low-cost areas, but has cost advantages in the high-cost delivery zones, and that demand declines sufficiently quickly as one moves from low-cost to high-cost zones. Specifically, we assume:

Regularity Conditions (RC)

RC(i): $C_E(t)$ and $C_I(t)$ are differentiable and strictly increasing on [0, T], with $C_I(0) > C_E(0)$ and $C_I(T) < C_E(T)$, and with a unique $t = t^* \varepsilon [0, T]$ such that $C_I(t^*) = C_E(t^*)$;

RC(ii): D(t) is positive on [0, T];

RC(iii): $[C_I(t) - C_E(t)]D(t) + \frac{dC_E(t)}{dt}\int_t^T D(\tau)d\tau$ is strictly decreasing on [t*, T], where t* is the unique crossover point specified in condition RC(i)).

Given RC, the solution (P^W, u^W) to the first-best problem of maximizing (5) over non-negative prices P and scope of USO u is obtained directly from the relevant FOCs as:

$$t_I(P^W) = t^* \text{ so that } C_E(t_I(P^W)) = C_I(t_I(P^W)); \quad u^W = \frac{\sqrt{K}}{V} \qquad (6)$$

where total (say, annual) volume V is defined as

$$V = \int_0^T D(t)dt \tag{7}$$

Intuitively, the first-best price is set to ensure that Entrants serve the low-cost zones $t < t_I(P^W) = t^*$, where $C_E(t) < C_I(t)$, and the Incumbent serves all those zones $t \geq t_I(P^W)$ for which it has the cost advantage (note that there is a single cross-over point $t^* = t_I(P^W)$ by RC(i)). Given the separability of W(P, u) in P and u, the first-best solution for u is easily obtained as the solution u^W shown in (6) which minimizes the sum of USO fixed costs F(u) and transactions costs A(u). From (6) and RC, it should be clear that the first-best solution entails losses for the incumbent, since setting price according to (6) will ensure that the Incumbent makes losses on every zone it serves (i.e., for every $t \geq t_I(P^W)$). As this is not a sustainable arrangement without subsidies, we turn to the Ramsey problem, namely the maximization of W in (5) subject to breakeven operations for the USP. Some of the properties of the Ramsey solution are stated in Proposition 1.

Proposition 1: Consider the Ramsey problem:

$$\text{Max}\left\langle W(P,u) \;\middle|\; \Pi(P,u) \geq 0, P \geq 0, u \geq 0 \right\rangle \tag{8}$$

Define $\bar{u} = \Pi^* / V$, where $\Pi^* = \text{Max}\left\langle \Pi(P,0) \middle| P \geq 0 \right\rangle$ and V is total volume, and assume that $\Pi^* > 0$. Then W(P, u) is well defined and continuous on $U = [0, \bar{u}]$. Moreover, a solution (P*, u*) to (8) exists and satisfies:

$$u \in U,\ u^* \leq \text{Min}\left[\frac{\sqrt{K}}{V}, \frac{\Pi^*}{V}\right] \leq u^W;\ \Pi(P^*,u^*) = 0;\ P^* > P^W; \tag{9}$$

Proposition 1 is proved in the Appendix. Note that, as expected, the Ramsey solution entails a smaller USO and a higher price than in the first-best solution. Assuming RC, the first three terms in (5) can be shown to be decreasing as the scope of the USO increases, while the (negative of the) final two terms (reflecting the fixed cost of the USO and the transactions costs of customers in accessing USO services) first decrease and then increase, so that a tradeoff ensues between the cost of financing the USO and its benefits. The bounds in (9) reflect these tradeoffs, and show that the maximum scope of the USO under Ramsey pricing is bounded by (a measure of) the transactions costs per unit

demand and the profit per unit demand. The reader interested in greater detail on the nature of the tradeoffs should consult the proof of Proposition 1 in the Appendix.

3. Design of the Multi-National USO

Now consider optimal regional USO design for our region of N = {1, …, n} countries. Per the previous section, we assume that each country has a national PO, which is simultaneously the Universal Service Provider (USP). In this section, we drop the "affordability assumption" that the USP is subject to a zero-profit constraint (although such a constraint is one of several types of constraints that could be imposed in the more general theory that follows). Instead, we assume the USP is a "profit maximizer", but subject to various constraints, whose stringency varies as the scope of USO imposed varies. Denote the scope of the USO by the scalar $u \in U$, where $U \subset \Re$ is assumed to be some non-empty closed interval, and where the usual order in $\Re$ is assumed to reflect the scope of the USO. Each country "i" is assumed to have a USO standard $u_{i0} \in U$, such that USO policies implemented by USP_i must satisfy $u \geq u_{i0}$, $i \in N$.

Denote the set of decisions that the USP must make as $x \in X$, where X is assumed to be a subset of $\Re^n$ (or some other "nice" topological vector space). Such decisions would include pricing, product definitions and operational decisions. Let $\Gamma_i(u)$ be an upper semi-continuous point-to-set mapping $\Gamma_i: U \Rightarrow K(X)$ into the non-empty and compact sets of X, where $\Gamma_i(u)$ is to be interpreted as the set of feasible choices X for USP_i when the prevailing USO in country $i \in N$ is u.

To capture the fact that the USO is a constraint on the USP's choices, $\Gamma_i(u)$ is assumed monotonic non-increasing, in the sense that:

$$[u \leq u'] \Rightarrow [\Gamma_i(u) \supseteq \Gamma_i(u')], \forall u, u' \in U \tag{10}$$

Denoting profits for USP_i by Π_i, assume that $\Pi_i: X \times U \Rightarrow \Re$ is continuous, and consider the derived optimal profits $\pi_i: U \Rightarrow \Re$ for UPS_i, defined for a specified USO $u \in U$ as:

$$\pi_i(u) = \text{Max} \langle \Pi_i(x,u) \mid x \in \Gamma_i(u) \rangle \tag{11}$$

The function π_i is well defined and continuous because of our continuity assumptions on Π_i and $\Gamma_i(u)$. Moreover, because $\Gamma_i(u)$ is monotonic non-increasing, it is easily verified that π_i is also monotonic non-increasing on U. To avoid uninformative technical discussions, assume further that the solution to (11) is unique for any given u (which it would be, for example, if Π_i is strictly quasi-concave in x and $\Gamma_i(u)$ is convex for each u ε U), with the optimal solution $x_i^*(u)$ defined through the equality $\Pi_i(x_i^*(u), u) = \pi_i(u)$.

As in the previous section, define the welfare function for market i ε N as the (possibly weighted) sum of consumer and producer surpluses, and denote this as $W_i(x, u)$ for any given (x, u) ε X × U, and assume it to be continuous. As with profits, define the derived welfare function $w_i(u) = W_i(x_i^*(u), u)$, i.e. $w_i(u)$ is aggregate welfare $W_i(x, u)$ for market i ε N evaluated at the operating decisions $x_i^*(u)$ chosen by USP_i.

The above technical apparatus can now be used to formulate the nature of multi-national USO problem. To state this problem, it is assumed that each USP_i is able to negotiate with country i's regulators such that the actual USO implemented by USP_i is the maximum of the multi-national USO and the country-specific minimum u_{i0}. Since π_i is non-increasing, there would be no reason for USP_i to want to do more than the minimum, but the (national) regulator might be inclined to push for higher than the minimum USO if consumer surplus were strongly increasing beyond the historical USO u_{i0}, so this is clearly an assumption.[13]

A1: (Minimal Response by USPi): For any given regional standard u ε U for the USO, the implemented standard in country u_i ε U will be $u_i = \max [u, u_{i0}]$.

From A1, if a regional USO of u ε U is chosen, then $u_i = \max [u, u_{i0}]$ will be implemented in country i, leading to aggregate welfare of $w_i(\max [u, u_{i0}])$. The regional USO design problem is therefore:

[13] As noted below, however, there may also be upward pressure by POs on the USO under liberalization, so the assumption of a minimal response by the USP is definitely subject to further analysis.

Multi-National USO Design Problem

$$\text{Max} \left\langle \sum_{i \in N} w_i(\max[u, u_{i0}]) \;\middle|\; u \in U \right\rangle \tag{12}$$

A2: (Unimodal Welfare Function): Assume that the welfare function w_i is unimodal (i.e., has exactly one local maximum), i ε N.

Assuming A2, and noting the continuity of w_i, denote the maximum of w_i over U by $u_i^* = \arg\max \{w_i(u) \mid u \in U\} = \arg\max \{w_i(u) \mid u \in U, u \geq u_{i0}\}$, where the second inequality follows from (12). The following proposition is fairly obvious, but nonetheless worth recording.

Proposition 2: Without loss of generality, assume that countries are ordered so that $u_{10} \leq u_{20} \leq \ldots \leq u_{n0}$. Supposing A1 and A2 to hold, a solution u* ε U to the USO design problem (12) exists. Moreover, defining $\underline{N} = \{k \in N \mid u_{i0} < u_i^*\}$:

(i) If $\underline{N} = \phi$, then any regional USO u* ε U satisfying $u^* \leq u_{10} = \text{Min}\{u_{10}, \ldots, u_{n0}\}$ is optimal;

(ii) If $\underline{N} \neq \phi$, let k = Max {i | i ε $\underline{N}$}; there exists an optimal regional USO u* ε U satisfying $u^* \leq u_k^*$.

The proof of Proposition 2 is in the Appendix. The fact that an optimal solution exists to (12) follows from continuity and the fact that, by the structure of (12), such a solution u* can without loss of generality. be assumed to belong to the compact interval:

$$u_{10} = \text{Min}\{u_{10}, \ldots, u_{n0}\} \leq u^* \leq \text{Max}\{u_1^*, \ldots, u_n^*, u_{n0}\} \tag{13}$$

The intuition behind both assertions (i) - (ii) is that unimodality of w_i implies that w_i is non-increasing for $u > u_i^*$. Thus, countries for which the USO lower bound u_{i0} exceeds u_i^* would experience no improvement in welfare from increasing the regional requirement u beyond u_{i0} (since the country regulator would already insist on implementing a $u_i \geq u_{i0}$ and since $u_{i0} > u_i^*$ implies by unimodality that $w_i(u) \leq w_i(u_{i0})$, for

$u \geq u_{i0}$). Only countries in N whose historical/minimal USO standard u_{i0} is below their country-specific welfare-optimal level u_i^* would see any welfare improvement from a more constraining (higher) regional USO. Obviously, if there are no countries for which multi-national regulation would improve welfare, the optimal solution (as shown in (i)) is "hands off", or in the language of the EU "subsidiarty dominates".

4. Implications and Conclusions for Multi-National USO Design

The above results provide some intuition on the interaction of USO design, profits and welfare. If there is anything controversial about these results, in terms of policy implications, it would be two assumptions[14]: 1) the implicit assumption that quantified welfare benefits are available for the assessment of alternative USO designs; and 2) the assumption that POs and their national regulators will attempt to implement a minimal USO design, consistent with their historical practice (see Assumption A1 in the previous section). Let us briefly comment on each of these.

Interestingly, at the time of writing, we know of no published attempt to evaluate the costs and benefits of the postal USO empirically. Agreed, some aspects of this problem have been considered, such as the work of Reay (2002) and Cremer et al. (1997) on service quality (one of the important attributes of the USO). However, the USO itself has been mostly the subject of political debates without any significant empirical assessments. Consider the following issues. What is the value arising from the transactions-costs savings from pricing uniformity and access to counter services to various classes of customers? How many postal counters should there be in a country? What criteria should be used to assess their location? Should every counter in the country be equipped to offer the full range of services? If not, what range of services? Should the USO cover both First and Second Class mail? What other products should be a part of this? Should access products be included? Does the USO have elements of the public good (such as existence value), i.e. arising from its non-excludability and non-rivalrous aspects, that transcend the value that could be identified in principle from individual

[14] On the first assumption, we are indebted to Regina Stöldt of the European Commission for raising this issue. On the second point, a number of commentators, who probably wish to remain nameless, have contributed to our understanding on this point,.

willingness-to-pay estimates[15]? Each of these questions has had some airing in public debates about the USO, but we are far from having idea about what the welfare function, or its component parts, in this paper have taken as given. It may be that competition will sort all of this out, making policy assessments unnecessary, but since USO decisions will almost certainly be made contemporaneously with liberalization choices, some benchmarks on the value of various USO design options would obviously be useful.

The second question raised above is whether national POs or their regulators would really press for the minimum USO scope consistent with historical trends (which perhaps represent some proxy for an efficient tradeoff between the relevant costs and benefits of USO scope). In the opposite direction there are several reasons to believe that, in some countries, there will be upward pressure on the USO, not downward pressure. Moreover, some of these pressures may be in the direction of self-serving rent seeking and not efficiency enhancing.[16] For example, several commentators seem to see a USO of broad scope as a means of maintaining the reserved area for some products, or other advantages (such as negotiated rather than mandated access prices) for the PO incumbent. Similarly, organized labor might use proposed reductions in the scope of the USO to rally the public to maintain an expanded scope to assure continuing levels of employment or to ward off increased requirements for flexible labor arrangements. As a further example of upward pressure in the EU, many countries continue to see their national PO exempt from Value Added Taxes (VAT) for USO services, even while potential competitors would face the requirement for collecting VAT. In this instance, the broader the scope of the USO, the larger the revenues are that are protected (at least to the level of the VAT) from entry, since entrants would start with a disadvantage in pricing equal to the VAT in the respective country (on the range of 15-20% in many EU countries). In such countries, it would not be a surprise to see continuing pressures for a broad USO. To the extent that the USO is, in fact, desirable from an efficiency perspective (i.e., as measured by appropriately measured net benefits), it would naturally be required to provide the means to the Incumbent (and others in the market) to provide the USO and to achieve financial

[15] The issue of system-wide attributes of a USO has some relationship to the problem of reliability in other network industries. Attempts to value these network attributes have met a number of empirical and theoretical challenges, e.g. Hartman, Doane and Wu (1991).

[16] See Finger et al. (2005) for a recent discussion of the pressures, pro and con, for reducing the scope of the USO in the European Union.

viability under liberalization. Clearly, some of these examples indicate forces other than a desire for greater efficiency.

These limitations, and others, suggest that caution must be exercised in drawing strong conclusions from this theoretical treatise on how to design regional USO policies. As with other important policy decisions, a little empirical research and understanding of the motivations of the stakeholders involved in any particular regional USO application will add considerably to the relevance and efficiency of the economic design and policy evaluation process.

Appendix

Lemma 1: Assume the regularity conditions RC. Let $U \subset \Re^+$ be the set for which a solution P(u) to (2)-(3) exists and such that the profit function $\Pi(P(u), u)$ is locally increasing in P at P(u). Assume also that $\Pi^* = MAX\langle \Pi(P,0) \,|\, P \geq 0 \rangle \geq 0$. Then U is a non-empty closed interval $U = [0, \bar{u}]$, with

$$\bar{u} = \frac{\Pi^*}{\int_0^T D(t)dt} = \frac{\Pi^*}{V} \tag{A1}$$

Moreover, for any $u \in U$, P(u) is unique and (strictly) monotonic increasing on U.

Proof: Note that $t_I(P)$ is unique and well defined in (2), strictly increasing and continuous by strict montonicity and continuity of C_E. We first establish that the profit function is (strictly) unimodal under conditions RC(i)-RC(iii). Since $t_I(P)$ is strictly increasing in P, it suffices to show modality of the following transformed profit function in t_I (obtained from (3) by substituting $P = C_E(t_I)$):

$$\pi(t_I, u) = \int_{t_I}^{T} (C_E(t_I) - C_I(\tau))\, D(\tau)\, d\tau - u \int_0^T D(\tau)\, d\tau \tag{A2}$$

To show the unimodality of $\pi(t, u)$ for any fixed $u \in U$, compute first

$$\frac{\partial \pi(t,u)}{\partial t} = \left[C_I(t) - C_E(t)\right] D(t) + \frac{dC_E(t)}{dt} \int_t^T D(\tau)\, d\tau \tag{A3}$$

Now note that the first term defining $\partial\pi/\partial t$ is positive for t = 0. Moreover, since the second term defining $\partial\pi/\partial t$ is always positive, $\partial\pi/\partial t = 0$ requires that $C_I(t) < C_E(t)$, so that any t_0 solving $\partial\pi / \partial t = 0$ must satisfy $t > t^*$ in condition RC(i). Thus, for $t < t_0$, $\partial\pi/\partial t > 0$ and for $t > t_0$, $\partial\pi/\partial t < 0$, i.e. $\partial\pi(t, u)$ is strictly unimodal in t for any u such that there exists a solution solving $\pi(t_I, u) = 0$ in (A2).

For the main assertion, consider any $u \in U$, so that there is a solution P(u) to (2)-(3) with $\Pi(P, u)$ locally increasing in P at P = P(u). Take any $u' \in \Re^+$ satisfying $u' \leq u$. From the definition of $\Pi(P, u)$, we see that

$$\Pi(C_E(T), u') < 0 = \Pi(P(u), u) < \Pi(P(u), u') \leq \Pi(P(u), 0) \leq \Pi^* \qquad \text{(A4)}$$

so that continuity of $\Pi(P, u)$ implies there exists a $P(u') \in [P(u), C_E(T)]$ satisfying $\Pi(P(u'), u') = 0$. From the unimodality of $\Pi(P, u)$, it follows that, for $u' \leq u \leq \bar{u}$, there exists solutions $P(u') \leq P(u) \leq P(\bar{u})$ with $\Pi(P, u)$ is locally increasing in P at each such solution. (Note, by the definition of $\bar{u}$ and the profit function $\Pi(P, u)$, that $\bar{u}$ is the largest value of u for which a solution to (3) exists.)

Finally, since $\Pi_P(P, u) > 0$ at P = P(u) for any $u < \bar{u}$, the strict monotonicity of P(u) follows from the Implicit Function Theorem (IFT) since from (3) and the IFT, $\partial\Pi/\partial P > 0$ implies:

$$\frac{\partial \Pi}{\partial P}\frac{dP}{du} - \frac{\partial \Pi}{\partial u} = 0 \quad \Rightarrow \quad \frac{dP}{du} = \frac{\int_0^T D(t)dt}{\dfrac{\partial \Pi(P, u)}{\partial P}} > 0 \qquad \text{(A5)}$$

from which the assertion follows.

Proof of Proposition 1: The fact that W(P, u) is well defined and continuous on $\Re \times U$ follows from Lemma 1, from which the existence of an optimal solution (P*, u*) follows directly. To show (9), note that $u^* \leq \Pi^*/V$ follows since $u^* \in U = [0, \bar{u}] = [0, \Pi^*/V]$. To show $u^* \leq \sqrt{K} / V$, note first that since the profit constraint is binding at the Ramsey optimal, it suffices in evaluating the optimal solution to consider the function w(u) =

W(P(u), u), with P(u) the solution to (3) (which exists and is continuous by Lemma 1). Now note:

$$\frac{dw}{du} = \left[C_I(t_I(P(u)) - C_E(t_I(P(u))\right]D(P(u))\frac{dt_I}{dP}\frac{dP}{du} \quad - \quad \left[V - \frac{K}{Vu^2}\right] \qquad \text{(A6)}$$

Since both dt_I/dP and dP/du are positive by Lemma 1, the first term in (A6) has the sign of $\Delta(u) = [C_I(t_I(P(u)) - C_E(t_I(P(u))] = [C_I(t_I(P(u)) - P(u)]$ by (2). But $\Delta(u) < 0$ follows from (3) and RCi-iii since $\Delta(u) \geq 0$ would imply $P(u) \leq C_I(t_I(P(u)) < C_I(t)$, $t > t_I(P(u)$, implying that $\Pi(P(u), u) < 0$, a contradiction.

Knowing that the first term in (A6) is always negative, it follows that the Ramsey optimal $u \in U$ must occur where the second term $(V - K/(Vu^2))$ is positive, from which $u^* \leq \sqrt{K}/V$ follows.

Concerning the FOCs for the Ramsey problem, these are derived from the Lagrangian for the problem. Since there is one-to-one relationship between t_I and P, with some abuse of notation, we state the optimization problem (5) in terms of the pair (t_I, u) as:

$$L(t_I, u) = W(t_I, u) + \lambda\Pi(t_I, u) \qquad \text{(A7)}$$

where $\lambda > 0$ is the dual variable associated with the profit constraint. From (A7), we have the following FOCs for (5):

$$\left[C_I(t_I) - C_E(t_I)\right]D(t_I) + kC_E'(t_I)\int_{t_I}^{T} D(t)dt = 0 \qquad \text{(A8)}$$

$$u = \frac{\sqrt{K(1-k)}}{D} \qquad \text{(A9)}$$

where $k = \lambda/(1+\lambda) \in (0, 1)$. The fact that $k > 0$ follows from the fact (noted in the text) that the profit constraint is binding at the Ramsey optimum. The fact that $k < 1$ follows since λ is finite. It is straightforward to show that the conditions (A8)-(A9) have a unique solution for any given constellation of costs and demands satisfying RCi-iii. This follows by showing that RCi-iii imply that the solution $t_I(k)$ to (A8) is increasing in k, while the solution u(k) to (A9) is clearly decreasing in k. The Ramsey solution results when $t_I(k)$ as computed in (A8) equals the solution $t_I(u(k))$ generated from (A9) and (2)-(3).

Proof of Proposition 2: The existence of a solution to (3) is justified in the text. We consider claim (ii) first. Suppose there exists some k ε N such that $u_{k0} < u_k^*$ and $u_{i0} \geq u_i^*$ for all i > k. Take any $u > u_k^*$; then reducing u to u_k^* will not reduce aggregate welfare in (3). To see this, note that reducing u as indicated will not decrease any of the functions $w_i(\max(u, u_{i0}))$, $i \geq k$. For i = k, this follows from the unimodality of w_i and the assumption that $u > u_k^* > u_{k0}$. For i > k, we have two cases: either $u > u_{i0} > u_k^*$ or $u > u_k^* \geq u_{i0}$. In the first case, decreasing u to u_k^* will result in the implementation of $u_i = u_{i0} = \max(u_k^*, u_{i0})$ in country i, leading to an improvement in country i's welfare because of the unimodality of w_i. In the second case, $u > u_k^* \geq u_{i0}$, so that with our standing assumption that $u_{i0} \geq u_i^*$ for all i > k, a decrease of u in the direction of u_i^* will also imply a USO in country i closer to the welfare optimal solution u_i^*. Thus, (ii) follows. If $\underline{N}$ is empty, case (i) of the Proposition, then it must be true that $u_{i0} \geq u_i^*$ for all i ε N. In this case, any u ε U which implies an increase in country i's USO beyond the required level u_{i0} can only lead to a (further) decrease in country i's welfare. Clearly, any solution that does not cause such an increase will be optimal, and the outcome for each country will be its unconstrained USO u_{i0}. Thus, (i) follows.

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Figure 1: Illustrating Scope of USO and Entry