Access Pricing in the Postal Sector

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Abstract

This paper develops a theoretical model aimed at assessing the optimal access charges and retail prices in the postal sector. It takes explicitly into account the three main characteristics of the postal sector: the ability of entrants to bypass the incumbent's delivery network, the imposition on the incumbent, but not on entrants of universal service obligations, and the provision of access to the incumbent delivery network to both competitors and customers.

The main part of the paper develops analytical formulations of the optimal access charges and incumbent's end-to-end retail price. the paper also presents calibrated results illustrating the impact of the endogenous bypass decision on consumers' welfare.

1 Introduction

The liberalization of network industries, starting with airlines, telecommunications and energy, and now concerning the postal sector as well, has generated an intense debate on the concept of mandatory access to parts of an incumbent network.[1] Although all these sectors are often regrouped under the heading of network industries, any mandatory access policy should take into account the specific characteristics of each of these sectors. The objective of this paper is to develop a theoretical model of access pricing that takes explicitly into account the main characteristics of the postal sector.

In order to understand these characteristics, it is important to first have a look at the postal sector activities (see figure 1)[2]. These activities are collection, local transportation, outward sortation, long haul transportation, inward sortation, transportation to post office and then delivery. Local transportation links the collection points to the sortation offices. These regional sortation offices usually perform both outward and inward sortation, although at different times of the day. The mail is then transported to post offices and delivered to the destinee.

The cost structure of these different activities determines if and where a regulated access policy is needed. There is little if any evidence that collection, transportation and sorting present significant economies of scale or sunk costs (Panzar 2002). On the other hand, most economists agree that delivery[3] presents significant economies of scale (Rogerson et al. 1993, Cazals et al. 2004). Many postal regulators have concluded from this that delivery has the characteristics of a natural monopoly, and that the man-

[1] See for instance Laffont and Tirole(1996,2000) , Armstrong (2002) and Armstrong, M., C. Doyle and J. Vickers (1996).

[2] Figure 1 is taken from Panzar(2002).

[3] Whose costs represent roughly 50% of the total postal costs.

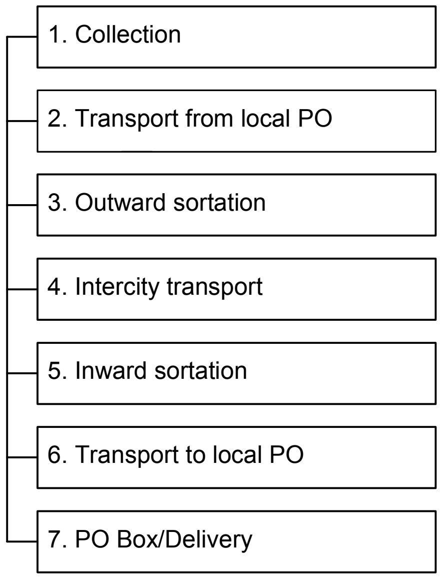

Figure 1: The postal network activities

dating of access to the incumbent postal operator's delivery network is necessary in order for entrants to compete with the incumbent. This is why most postal legislation includes provisions mandating incumbents to provide downstream access to their competitors. This is the case, for instance, of the European Postal Directive of 2002.

Although not all economists agree with the conclusion that mandatory access is necessary to have effective competition in the postal sector[4], I will content myself with observing that such policies exist, and will try to model the consequences of their adoption. Moreover, I explicitly incorporate into the model the possibility for the entrants to bypass the incumbent's delivery activity by setting up their own delivery network. The choice between access or bypass will be endogenous in the model, with the entrant comparing the two possibilities and choosing the less costly one. The case where delivery is a natural monopoly can then be obtained by assuming that the cost for the entrant of delivering mail by itself is prohibitive. I will also contrast the results obtained with and without bypass.

Crew and Kleindorfer (2002) and Panzar(2002), among others, stress that a natural monopoly delivery is not sufficient for mandated access to be socially desirable. This is due to another characteristic of the postal sector, i.e. the existence of universal service obligations. These obligations often take the form of the requirement to serve all customers (ubiquity) at the same, uniform price[5]. Such a requirement is imposed on the incumbent postal operator (which I will call from now on the universal service provider,

[4]Panzar (2002) stresses that the presence of economies of scale in not sufficient to warrant the adoption of mandatory access, since it is the extent of sunk costs that limits a natural monopoly market's contestability. He then argues that, contrary to other network activities (energy, telecommunication,...), there is few if any sunk cost in the postal activity.

[5]Although uniform pricing is not required by the 2002 European Directive, most european countries are still imposing this constraint on the incumbent.

or USP) but usually not to competitors, which may then choose on which market to enter, and which price to post on each market. Such an asymmetry between obligations for various operators, coupled with mandatory access, opens up the possibility of cream-skimming entry. It is easy to imagine a postal operator entering on low cost markets ("urban to urban" mail, for instance), and using mandatory access to the USP rural delivery network to build a "one-stop shopping" operation for his urban customers. Such cream-skimming problems and their link with access are studied in detail in Panzar(2002). Here, I model two different delivery areas and impose that the USP (but not the entrant) posts the same price for mail delivered to either of these areas, although delivery costs may differ substantially. Moreover, the universal service obligation translates into a fixed cost for the incumbent (obligation to maintain post offices in remote areas even if they are unprofitable, inability to lay off redundant workers, especially when they have a civil servant status, etc.). The entrant is not subject to such obligations, and I thus consider that all its (long run) costs are variable. In absence of significant sunk costs (except perhaps for delivery, for which mandated access is available), I assume that competitors act as a competitive fringe.

Another characteristic of the postal sector is that access has been relevant for this sector well before the current liberalization process. More precisely, its has taken the form of "work-sharing", by which large senders who presort their mail and bring it directly to one mail processing center receive a rebate on the full retail price. Work-sharing is very similar to downstream access, since in both cases the incumbent sells some products using all of its network (regular mail) and other products using only part of this network (the work-shared mail)[6]. The existence of this possibility for a long time has been reflected in the important literature treating this form of access in a monopolistic sector: see Billette de Villemeur et al. (2002, 2003a), Crew and Kleindorfer(1995), Mitchell (1999), Sherman(2001) among others. In this paper, I introduce the possibility for both the entrant and large senders to access the incumbent's delivery network. This is in line with the European Postal Directive of 2002, which requires that "(access) tariffs shall also be available to private customers who post under similar conditions"(Official Journal, L176/2, 2002, Article 12). The model I develop incorporates both the possibility for the entrant to access the incumbent's delivery network, and customer direct access (CDA) to this network.

To summarize, the main specific characteristics of the postal sector are the ability of the entrant to bypass the incumbent's delivery network, the imposition on the incumbent but not on entrants of universal service obligations, among which the obligation to serve all customers at the same price even when they represent different delivery costs, and the provision of access to the USP delivery network to both competitors and customers (CDA). The model developed here constitutes the first attempt, to the best of our knowledge, at analyzing access in presence of all these characteristics.

The papers closest to ours are de Villemeur et al. (2003b, 2003c, 2004) and Crew and Kleindorfer (2002). de Villemeur et al. (2003b, 2003c) study optimal access pricing in a model with two types of operators (the USP and the entrant), two types of goods (single piece mail and bulk or "commercial" mail) and two destination areas (low and high cost). Single piece mail is

[6]Some authors use the term "upstream access" for worksharing since access is given to the outward sortation facilities, by contrast to "downstream access" for access given to competitors to the incumbent's delivery network (inward sortation centers or even delivery offices). In the model, we regroup collection, sorting and transportation in a compositive activity and use the terms of CDA and entrant's access.

offered solely by the USP, at a uniform price. Entry, if any, occurs in the market for commercial mail. The entrant is not subject to any universal service obligation while the incumbent may also be forced to price uniformly commercial mail. They assume from the outset that the entrant has its own delivery network to the low cost area but must ask for access to the incumbent's delivery network in the high cost area. They also differ with this paper in that they do not model CDA. The model sketched in Appendix 3a of Crew and Kleindorfer(2002) is very close to ours, since it has one mail product, two operators (the USP and an entrant behaving like a competitive fringe) and two delivery areas. Also, the entrant decides whether to ask for access or deliver itself, as in this paper. On the other hand, they do not introduce CDA. Finally, de Villemeur et al.(2004) explicitly consider both CDA and entrant's access at the same time. By contrast to my paper, they model just one delivery area (so there is no consideration of uniform price) to which the entrant must ask for access, i.e. where there is no endogenous bypass possibility.

In this paper, I model the postal sector as a three-good economy, which consists of an "end-to-end" (E2E) mail product offered by the incumbent, an entrant's mail product and customer direct access. There is a representative sender which considers these goods as imperfect substitutes. Beyond offering an end-to-end mail product, the incumbent provides access to its delivery network at the same unit price to its customers (CDA) and to the entrant. There are two delivery areas with different variable costs. The incumbent is obliged to post the same price for its E2E product, irrespective of its area of destination. The entrant chooses whether to deliver itself or ask for access to each delivery area and can post different prices for mail posted to different areas.

The first part of the paper is theoretical and studies the simultaneous determination of the incumbent's access charges and E2E price when the incumbent's objective is to maximize total welfare subject to its own break-even constraint. I first study the case where the access charges can be differentiated according to the delivery area. I obtain that the optimal access charge is the sum of three elements: the delivery cost, a displacement charge and a Ramsey term. As in Armstrong(2002), the displacement charge is the product of the margin made on the E2E product and of a displacement ratio, which measures how much E2E mail is lost by the incumbent when it provides one more unit of access. Although the intuition for this ratio is similar to Armstrong(2002), its statement is made much more complex by the fact that the access charge affects the quantities sold of the three substitutable goods. These interactions also render the Ramsey term more complex. As for the E2E price, a major departure with Armstrong(2002) lies with the uniform pricing constraint. I obtain that the E2E price is a weighted average of the costs in both areas when the break-even constraint is not binding. In the more reasonable case where the constraint binds, different Ramsey terms have to be added not only to each area's cost but also to their weighted average. Finally, I show how the optimal uniform access charge can be obtained as a weighted average of the optimal differentiated access charges.

To sum up, the theoretical part of the paper makes clear the impact that both the uniform pricing requirement and the use of access by two imperfectly substitutable products has on the optimal Ramsey access charges and E2E prices. On the other hand, the determination of optimal prices based on first-order conditions gives no information as to the levels of variables such as quantities or welfare. Also, first order conditions shed few light on the impact of the endogenous choice of delivery method by the entrant, and on the consequences of the access regime studied for the incumbent and for consumers. To answer such questions, the second part of the paper develops a numerical simulation of the postal economy.

2 The model

We consider two categories of postal operators: the universal service provider (USP) and a set of entrants which act as a competitive fringe. The assumption of a competitive fringe is motivated by the fact, discussed in the introduction, that the postal activity requires few sunk costs except perhaps in delivery. Moreover, roughly 80% of delivery costs are labor costs, and one can argue that labor costs will be more flexible for entrants than for the incumbent (because for instance the entrants will not face the same constraints as the incumbent, such as offering civil servant status to their employees). In absence of significant sunk costs for entrants, the competitive fringe assumption seems a reasonable benchmark.

Both the USP and entrants offer a single product (average mail) which can be sent to the rural or to the urban area. The USP has to serve both markets at a uniform price. The entrants are not subject to a uniform service obligation and choose which market (urban and/or rural) to serve and at which price. In addition to those two mail services, customers can directly access to the USP's delivery network. We call this possibility customer direct access (CDA) and model it as a third service that can be used by a representative consumer wishing to send mail. The three services offered (the USP's, the entrants's and CDA) may differ on several accounts: in quality (reliability, speed of delivery) or in terms of ease of access to each collection network, for instance. We then assume that they are (imperfect) substitutes on any given market, so that a price increase in one market raises the quantity sold of the other two services in the same market. On the other hand, the two markets are modeled as independent, as the price on one area does not affect the number of letters sent to the other area.

We separate the postal activity into two segments: one for collection-sorting-transportation and a second for delivery. All operators are active on the first segment. The USP delivers its letters on both markets while the entrants can choose whether to deliver themselves or to ask access to the USP's delivery network. Access is measured in terms of the number of letters delivered by the USP for the entrants and directly for customers, and we restrict our setting to linear access pricing. Hence, the entrant delivers itself if its delivery cost is (strictly) lower than the access charge. Moreover, if the access charge is higher than the full retail price of the USP, the entrant prefers remailing its letters through the USP rather than asking for access.

The representative customer may also access directly the USP delivery network. In that case, it bears a preparation cost in order to presort its mail and to bring it to the interconnection point on the USP network and then pays an access charge. We assume, in line with the European directive, that the USP is required to post the same access price for the entrant and for CDA customers.

We now introduce the notation used in the paper. We denote by an upperscript I variables pertaining to the end-to-end (E2E) mail services of the USP, by E to the entrant mail services and by D to CDA. We use the subscript U for the urban market and R for the rural market. The net surplus that the representative agent gets from sending mail to area j is given by

$$V_j\left(q_j^I, q_j^E, q_j^D\right) - pq_j^I - p_j^E q_j^E - p_j^D q_j^D$$

where q_j^i denotes the quantity of mail of type $i \in \{I, E, D\}$ for delivery in area $j \in \{U, R\}$, the USP uniform retail price is denoted by p, p_j^E stands for the entrant's retail price for delivery to area j and the total unit price of CDA is $p_j^D = a_j + k$.[7] We assume that the sender's surplus does not depend on the method the entrant chooses to deliver mail. The "make or buy" decision by the entrant is considered as a choice of production method that does not affect the characteristics of the good in the consumers' eyes. In other words, the differentiation between the entrants' and the incumbent's mail product is to be found in the upstream activity (collection, transport and sorting) rather than in delivery. This is a strong assumption that we would like to weaken in future research.

Maximization of this net surplus by the representative sender on both markets gives the demand functions for the three kinds of mail sent to area j: $q_j^D(p, p_j^E, p_j^D)$ for CDA, $q_j^I(p, p_j^E, p_j^D)$ for the USP's good and $q_j^E(p, p_j^E, p_j^D)$ for the entrant, with negative own price derivatives and positive cross-price derivatives.

The function $z_j^E(p, p_j^E, p_j^D, a_j, d_j^E)$ gives the number of letters effectively delivered by the entrant in area $j \in \{U, R\}$. It is a function of the three competing mail services' prices (which jointly determine the demand faced by the entrant) and of the unit access price a_j and entrant's delivery cost d_j^E to area j (which jointly determine whether the entrant delivers by itself or ask for access to the USP network). We then obtain as $q_j^E(p, p_j^E, p_j^D) - z_j^E(p, p_j^E, p_j^D, a_j, d_j^E)$ the amount of access to area j sold by the USP to the entrant.

The universal service obligation translates into a global fixed cost for the USP, which is denoted by F. As discussed in the introduction, one

[7] The preparation cost k does not depend on the delivery area

can mention the obligation to maintain post offices in remote areas even if they are unprofitable, the inability to lay off redundant workers, especially when they have a civil servant status, etc.. The entrant is not subject to such obligations, and I thus consider that all its (long run) costs are variable. Both operators face a (constant) marginal collection cost of $c^i, i \in \{I, E\}$. As is intuitive, the collection cost is independent of the area the letter should be delivered to, but may differ from one operator to the other with the entrant using a different technology than the USP (the absence of fixed costs being compensated by a higher marginal cost for the entrant, for instance)[8]. As for the delivery costs, both operators $i \in \{I, E\}$ have a constant marginal cost of delivery to area $j \in \{U, R\}$, which is denoted by d_j^i.

The USP's profit is now given by[9][10]

$$\begin{aligned} \Pi^I &= \left(p - c^I\right)\left(q_U^I + q_R^I\right) - d_U^I q_U^I - d_R^I q_R^I - F \\ &\quad + \left(a_U - d_U^I\right)\left(q_U^E - z_U^E + q_U^D\right) + \left(a_R - d_R^I\right)\left(q_R^E - z_R^E + q_R^D\right), \end{aligned}$$

where the first line gives the profit made by the USP on its own end-to-end letters and the second line is the profit made on selling access. The entrant's profit is given by

$$\begin{aligned} \Pi^E &= \left(p_U^E - c^E\right) q_U^E + \left(p_R^E - c^E\right) q_R^E - d_U^E z_U^E - d_R^E z_R^E \\ &\quad - a_U\left(q_U^E - z_U^E\right) - a_R\left(q_R^E - z_R^E\right) \end{aligned}$$

with $0 \leq z_j^E \leq q_j^E$ and $a_j \leq p, j \in \{U, R\}$. Maximization of entrant's profit

[8] Note that the marginal costs used here are long run marginal costs, which include many things which one may consider as "fixed costs" from an accounting perspective.

[9] To simplify the exposition, we drop the arguments of the functions q_j^i and z_j^E in most of what follows.

[10] It would be straightforward to include also an explicit acceptance or metering charge incurred by the USP in providing access, as in Crew and Kleindorfer(2002). Such a charge enters the results below in the expected way and has been excluded from the discussion here to simplify the model.

gives that

$$z_j^E(p, p_j^E, p_j^D, a_j, d_j^E) = \begin{cases} 0 \text{ if } d_j^E \geq a_j \\ q_j^E(p, p_j^E, p_j^D) \text{ if } d_j^E < a_j, \end{cases}$$

that is, that the entrant delivers itself only if it is strictly cheaper to do so rather than to ask access. Recall that the entrant acts as a competitive fringe i.e. that any positive profit made by the entrant would attract new competitors until prices are driven down to average (and marginal) costs. Hence, the entrant uses marginal cost pricing and we have $p_j^E = c^E + \min(d_j^E, a_j)$.

Total welfare W is the sum of postal operators' profits and consumer net surpluses. We look for the optimal access charges and USP retail price, i.e. access charges a_U, a_R, and price p that simultaneously maximize total welfare W under the constraint that the USP profit is non-negative ($\Pi^I \geq 0$) and that $a_j \leq p, j \in \{U, R\}$:

$$\underset{a_U, a_R, p}{Max} \quad W = \sum_{j=\{U,R\}} \left(V_j \left(q_j^I, q_j^E, q_j^D \right) - p q_j^I - p_j^E q_j^E - p_j^D q_j^D \right) + \Pi^I + \Pi^E$$

such that

$$\begin{aligned} \Pi^I &\geq 0 \\ a_j &\leq p, j \in \{U, R\}. \end{aligned}$$

3 Optimal differentiated access charges and USP retail price

We concentrate on the most interesting case[11], where the access charge influences both CDA and the entrant's price ($a_j \leq d_j^E$)[12]in area j, in which

[11] We also make the assumption that the optimal access charge is less than the USP retail price in both markets: $a_j \leq p, \quad j \in \{U, R\}$.

[12] When the access charge is greater than the entrant's delivery cost, the entrant bypasses the USP's network and delivers the mail itself. The access charge then only affects CDA, and the optimal pricing formulae can easily be obtained from the first order conditions derived below, taking into account that $z_j^E = q_j^E$, $p_j^E = c^E + d_j^E$, and thus that $\partial q_j^E / \partial a_j = 0$.

case, $z_j^E = 0$, $p_j^E = c^E + a_j$. It will also prove handy below to introduce the total amount of access provided by the USP (to the entrant and directly to customers) as $q_j^A(p, p_j^E, p_j^D) = q_j^E(p, p_j^E, p_j^D) + q_j^D(p, p_j^E, p_j^D)$.

To find the optimal access charges and USP retail price, we differentiate total welfare with respect to a_U, a_R and p. The first-order condition for the optimal value of a_j is then given by

$$(1+\lambda)\left\{\left(p - c^I - d_j^I\right)\frac{dq_j^I}{da_j} + \left(a_j - d_j^I\right)\frac{dq_j^A}{da_j} + q_j^A\right\} - q_j^A = 0$$

where λ is the Lagrange multiplier associated with the USP's budget constraint.

Similarly, the optimal value of the USP retail price is obtained from the following first order condition

$$q_U^I + q_R^I + (1+\lambda)\left\{\left(p - c^I - d_U^I\right)\frac{\partial q_U^I}{\partial p} + \left(a_U - d_U^I\right)\frac{\partial q_U^A}{\partial p}\right.$$
$$\left. + \left(p - c^I - d_R^I\right)\frac{\partial q_R^I}{\partial p} + \left(a_R - d_R^I\right)\frac{\partial q_R^A}{\partial p}\right\} = 0.$$

3.1 Case 1: The USP profit constraint is not binding

In order to get a better understanding of the meaning of these equations, we first assume that $\lambda = 0$, i.e. that the USP's profit constraint is not binding at the optimum. We obtain the following first order conditions

$$\left(p - c^I - d_j^I\right)\frac{dq_j^I}{da_j} + \left(a_j - d_j^I\right)\frac{dq_j^A}{da_j} = 0 \quad (1)$$

for the optimum access charge in area $j \in \{U, R\}$ and

$$\left(p - c^I - d_U^I\right)\frac{\partial q_U^I}{\partial p} + \left(a_U - d_U^I\right)\frac{\partial q_U^A}{\partial p} \quad (2)$$
$$+ \left(p - c^I - d_R^I\right)\frac{\partial q_R^I}{\partial p} + \left(a_R - d_R^I\right)\frac{\partial q_R^A}{\partial p} = 0$$

for the optimum retail price.

We first discuss the optimal access charge as given by equation (1). Increasing the access charge impacts both the USP E2E quantity and the total amount of access provided. With the competitive fringe assumption, increasing the access charge to area j results in an increase by the same amount of both the entrant's price and CDA's price in that area. This is why the total derivatives of quantities with respect to the access charge appear in equation (1). More precisely, we have

$$\begin{aligned}
\frac{dq_j^I}{da_j} &= \frac{\partial q_j^I}{\partial p_j^E} + \frac{\partial q_j^I}{\partial p_j^D}, \\
\frac{dq_j^A}{da_j} &= \frac{dq_j^D}{da_j} + \frac{dq_j^E}{da_j} \\
&= \frac{\partial q_j^D}{\partial p_j^E} + \frac{\partial q_j^D}{\partial p_j^D} + \frac{\partial q_j^E}{\partial p_j^E} + \frac{\partial q_j^E}{\partial p_j^D}.
\end{aligned}$$

To obtain the impact on welfare, one has to multiply the effects on quantities by the difference between price and marginal cost of the good supplied. The USP supplies two goods: a final good (its E2E letter to area j) and an intermediate good (access to area j for the entrant). The final good sold by the entrant does not enter into the formula (except for the amount of access it requires) because it is, by definition of a competitive fringe, sold at marginal cost.

A first consequence of formula (1) is that first best access pricing ($a_j = d_j^I$) is only called for when the retail price is set at its first best level $p = c^I + d_j^I$. Unfortunately, the uniform pricing constraint prevents this from happening simultaneously on the urban and rural markets when $d_R^I \neq d_U^I$. If the letter price is not set at its first-best level, the access price formula can be rewritten as

$$a_j = d_j^I + (p - c^I - d_j^I)\sigma_j, \tag{3}$$

where

$$\sigma_j = -\frac{dq_j^I/da_j}{dq_j^A/da_j}$$

is the displacement ratio which measures the substitutability between the USP E2E mail service and the access it provides to market j, i.e. by how much the USP E2E demand decreases when it supplies one more unit of access to this market. Multiplying this displacement ratio by the difference between the letter price and its marginal cost, one obtains the USP's lost profit on the retail market caused by providing access. This is thus an ECPR (efficient component pricing rule) formula, which compensates the USP for the opportunity cost in terms of foregone profit (and hence contribution towards the network cost of providing universal service) of any traffic lost to the entrant (see Armstrong, 2002).[13]

The optimal access charge increases with the displacement ratio when the E2E price is above marginal cost. Formula (3) is equivalent to the margin (or net avoided cost) rule ($a_j = p - c^I$, where the USP makes the same margin on access as on the E2E product) if and only if $\sigma_j = 1$, i.e. if each letter sent through the entrant simply displaces one E2E USP letter. When the differentiation between the USP E2E mail service and the other services using access increases, the displacement ratio decreases and so does the optimal access charge. At the limit, if the USP E2E product did not eat into the sales of the two other goods, formula (3) would call for marginal cost pricing of access.

[13] One can also show that the part of the access charge that is above the marginal cost of giving access is equal to the second-best output tax on the entrant. The intuition for this tax is the following: if the USP's letter price is above marginal cost, the quantity produced is too low from a social welfare viewpoint. If the letter price is exogenously fixed, the welfare maximiser's only available instrument to raise this quantity is the access charge. Increasing this charge results in an increase in both the entrant's and CDA prices, which in turn increase the number of letters sold by the USP in the same market, since entrant's, CDA and USP's letters are substitutes in any given market.

We now turn to equation (2) which determines the optimal value of the retail price p. There are four markets where p affects quantities: two final goods, E2E markets (the selling of USP letters to the urban and the rural areas) and two intermediate good markets (providing access to urban and rural areas). On each market, the impact of p on welfare is the product of the effect of p on quantities by the difference between price and marginal costs.[14]

We now look at the simultaneous determination of access charges and retail price. Using (3) in (2), we reformulate the expression for the optimal p as

$$\begin{aligned} &\left(p - c^I - d_U^I\right)\left(\frac{\partial q_U^I}{\partial p} + \frac{\partial q_U^A}{\partial p}\sigma_U\right) \\ &+ \left(p - c^I - d_R^I\right)\left(\frac{\partial q_R^I}{\partial p} + \frac{\partial q_R^A}{\partial p}\sigma_R\right) = 0. \end{aligned} \tag{4}$$

In words, to obtain (4) we have used the relationship between access prices and retail price to express the optimal retail price as a function of its impact on the two final good markets. The effect of p on the quantity sold in each area is the sum of two effects: the usual direct effect of price on quantity, $\partial q_j^I/\partial p$, and an indirect effect through the total quantity of access provided (to the entrant and to customers). This second effect is the product of the effect of p on the access quantity, $\partial q_j^A/\partial p$, by the displacement ratio σ_j.

Slightly abusing notation, we define

$$\frac{dq_j^I}{dp} = \frac{\partial q_j^I}{\partial p} + \frac{\partial q_j^A}{\partial p}\sigma_j'$$

as the total derivative of q_j^I with respect to p, and we reformulate (4) to

[14] Final goods sold by the entrant do not appear in the formula since they are priced at marginal cost.

obtain:

$$p = \left(c^I + d_U^I\right) \frac{dq_U^I/dp}{dq_U^I/dp + dq_R^I/dp} + \left(c + d_R^I\right) \frac{dq_R^I/dp}{dq_U^I/dp + dq_R^I/dp}. \qquad (5)$$

Equation (5) shows that the USP retail price is a weighted average of marginal costs in the urban and rural markets. The weights used are equal to the share of variation of quantity in one delivery area (when the letter price is changed) in the total variation in both areas. It is worth noting that weights are proportional to variation of quantities when the price changes, and not to the absolute value of quantities in the areas: it is not the size of the market that matters, but its sensitivity to variations in the letter price (the size of the market still plays a role in that weights are proportional to the derivatives of quantities, and not to elasticities).

Moreover, with imperfect substitutes we have that $0 \leq \sigma_j \leq 1$ and $\partial q_j^A/\partial p > 0$. If we make the reasonable assumption that the direct price effect on q^I is greater than the indirect price effect (so that $dq_j^I/dp < 0$), we obtain that

$$\left|\frac{dq_j^I}{dp}\right| < \left|\frac{\partial q_j^I}{\partial p}\right|$$

and the optimal letter price formula puts less weight on area j when access is supplied to this area than if it were not! The reason for this surprising result is the following. Increasing the USP letter price has two effects on area j's welfare, and they play in opposite directions. The first, direct, effect is to decrease the number of USP letters. The second effect is to increase the quantity of access demanded. To link these variations in quantities to variations in welfare, note that the access charge formula implies that the access charge is larger than social cost ($a_j > d_j^I$) if and only if the USP letter price is greater than total marginal cost for delivery to this area ($p > c^I + d_j^I$). Direct and indirect effects on quantities are thus of opposite signs, while markup over marginal cost has the same sign for access and USP retail letter. This implies that the two effects of varying p on welfare go in opposite directions, with the indirect effect mitigating the direct impact. Differences between price and marginal cost are then less damaging for social welfare in presence of this indirect effect, i.e. when access is offered, and the optimal pricing formula puts a lower weight on markets where access exists.

Finally, since the (uniform) retail price is a weighted sum of marginal costs, and since the (differentiated) access charges simply compensate the USP for retail profit loss due to access, it is highly unlikely that these prices will allow the USP to cover its fixed costs F. This means that the USP profit will be binding at the optimum, a case we cover in the next subsection.

3.2 Case 2: Binding USP profit constraint

We now turn to the case where $\lambda > 0$, i.e. where the USP profit constraint is binding at the optimum. The access pricing formula can be restated as

$$a_j = d_j^I + (p - c^I - d_j^I)\sigma_j + \frac{\lambda}{1+\lambda}\frac{a_j}{\hat{\varepsilon}_j^A} \tag{6}$$

where $\hat{\varepsilon}_j^A = -(dq_j^A/da_j)/(a_j/q_j^A)$ is the (absolute value) of the direct price elasticity of the total demand for access to area j. This formula builds on (3) and adds the usual Ramsey term as a mark-up, which is inversely proportional to the demand direct price elasticity. The intuition for this last term is that it is less costly in terms of welfare to raise prices on markets where the demand is less sensitive to price, i.e. where demand direct price elasticity is lower.

Using together the first order condition for p and formula (6) gives after a lot of tedious algebra the following optimality condition for p:

$$p = \left(c^I + d_U^I + \frac{\lambda}{1+\lambda}\frac{p}{\hat{\varepsilon}_U^I}\right)\frac{dq_U^I/dp}{(dq_U^I/dp) + (dq_R^I/dp)}$$

$$+\left(c^I + d_R^I + \frac{\lambda}{1+\lambda}\frac{p}{\hat{\varepsilon}_R^I}\right)\frac{dq_R^I/dp}{(dq_U^I/dp)+(dq_R^I/dp)}$$

$$+\frac{\lambda}{1+\lambda}\left(\frac{a_R}{\hat{\varepsilon}_R^A}\frac{\partial q_R^A}{\partial p}+\frac{a_U}{\hat{\varepsilon}_U^A}\frac{\partial q_U^A}{\partial p}\right)\frac{1}{(dq_U^I/dp)+(dq_R^I/dp)}. \qquad (7)$$

Equation (7) expresses p as the sum of three terms. The first two terms together represent a weighted average of USP's marginal costs (as in formula (5)) each augmented by a Ramsey term. One peculiarity of these two terms is the use of the total derivative of q_j^I with respect to p in both the weight dq_j^I/dp and in the computation of the elasticity $\hat{\varepsilon}_j^I = -(dq_j^I/dp)(p/q_j^I)$. As explained above, this is due to the fact that p affects directly q_j^I but also indirectly through its effect on q_j^A. The third term in the expression has the form of a Ramsey markup based on the access market, with on each area a weight proportional to the derivative of the access quantity by the USP's letter price. Observe also the absence of any marginal cost in this third term.

The intuition for this formula goes as follows. When setting the optimal value of p, the USP takes into account its impact on its own retail markets (including the indirect effect through modifications in the access demand - the first two lines), but also on the access market (the last term). The optimal price is of course based on the USP's own marginal cost in the two markets, but also needs to raise money to cover the USP's fixed cost. As usual, the distortion (and thus the need to keep p as close to marginal cost as possible) is inversely proportional to the elasticity of demand. Since the USP retail price influences four markets, all four elasticities appear in the optimality formula.

4 Optimal uniform access charge

Finally, our framework allows us to look at the optimal uniform access charge, in the case where the access charge cannot (for regulatory or practical reasons) be differentiated according to the final destination of the entrant's mail. In this case, the optimal uniform access charge is a weighted average of the optimum differentiated access charges obtained above. The weight used for each market corresponds to the share of the variation of access quantities in this market in the total variation of access in both markets when the uniform access charge is increased.

More precisely, introducing the new notation

$$\alpha = \frac{dq_U^A/da}{(dq_U^A/da) + (dq_R^A/da)},$$

we obtain after simplification that the optimum uniform access charge is given by

$$a = \alpha \left(d_U^I + (p - c^I - d_U^I)\sigma_U \right) + (1 - \alpha) \left(d_R^I + (p - c^I - d_R^I)\sigma_R \right)$$

in the case where $\lambda = 0$, and by

$$\begin{aligned} a \;\; = \;\; & \alpha \left(d_U^I + (p - c^I - d_U^I)\sigma_U + \frac{\lambda}{1+\lambda} \frac{a}{\hat{\varepsilon}_U^A} \right) \\ & + (1 - \alpha) \left(d_R^I + (p - c^I - d_R^I)\sigma_R + \frac{\lambda}{1+\lambda} \frac{a}{\hat{\varepsilon}_R^A} \right) \end{aligned}$$

if $\lambda > 0$.

The expression for p is very complicated but basically boils down to a weighted sum of the marginal cost, augmented by a Ramsey term if $\lambda > 0$, in both areas of delivery.

The analytical results obtained in this section assume that the optimal access charge is lower than the entrant's delivery cost on both market.

One the other hand, it may well be that the optimal access charge is lower than the entrant's delivery cost in the high-delivery cost are (the rural one) and higher than the delivery cost in the low cost area (the urban one). In that case, the entrant bypasses the USP delivery network in the urban area, and the only form access takes in that area is that of CDA. The optimal pricing formulae can easily obtained from the equations above, by making the following substitutions: $z_U^E(p, p_U^E, p_U^D) = q_U^E(p, p_U^E, p_U^D)$ so that $q_U^A(p, p_U^E, p_U^D) = q_U^D(p, p_U^E, p_U^D)$.

5 Calibrated results

The theoretical analysis performed above has allowed me to obtain optimal access charges and USP E2E price. Unfortunately, the exploitation of first-order conditions does not shed light on the access regime that will emerge in each delivery area (i.e., will entrants bypass or ask for access?) or on the welfare consequences of this access pattern. To obtain some insight on those two dimensions, I now resort to numerical simulations. Calibration assumptions are summarized in an appendix.

The benchmark situation is that before liberalization, where the monopoly USP breaks even with a 0.35 euro E2E price and where no access is provided. In order to disentangle the impact of the possibility of bypass, the uniform access charge constraint and the availability of CDA, we study four different scenarios. The first scenario (labeled Case 1 in Table 1) corresponds to the case where there is no CDA available and no possibility for entrants's bypass (i.e. the entrants have to ask for access if they wish to deliver in a given area). The difference between Cases 2 and 1 is that the former allows for differentiated access charges while the latter imposes both charges to be identical. Case 3 introduces the possibility for the entrant to bypass delivery while Case 4 also introduces CDA. Both Cases 3 and 4 allow for differentiated access charges.

Comparing Case 1 to the pre-liberalization scenario allows us to see the beneficial impact of entry when delivery bypass is not an option for entrants. More precisely, the margin made by the USP on selling access contributes to funding its fixed cost and enables it to slightly decrease its E2E price. The consumers thus benefit in two ways from the opening to competition: through the availability of a new service offered by entrants, and through the fact that the more intensive use of the USP network allows it to lower its price.

Table 1 : Simulation results

		Monopoly	Case 1	Case 2	Case 3	Case 4
Access charges	Urban	-	0.178	0.183	>0.12	>0.12
	Rural	-	0.217	0.183	0.244	0.333
USP E2E price		0.35	0.346	0.346	0.383	0.468
Consumer surplus	Urban	4.142	4.257	4.251	4.087	3.905
	Rural	0.512	0.521	0.525	0.480	0.390
Welfare		4.654	4.778	4.776	4.567	4.285

Case 1: No CDA, no bypass, differentiated access charges.
Case 2: No CDA, no bypass, uniform access charges.
Case 3: No CDA, bypass, differentiated access charges.
Case 4: CDA, bypass, differentiated access charges.

Comparing Cases 1 and 2 allows to assess the impact of imposing uniform access pricing, i.e. that the access charge be the same for both delivery areas. This optimal uniform access charge is a convex combination of the optimal differentiated access charges, and is much closer to the urban charge than to the rural one. The impact of this constraint is very small under our calibration assumptions, with the USP 2E2 price barely affected. Urban consumers welfare decreases slightly while rural consumers benefit slightly from the lower access price (which is reflected in the entrants' price through the assumption of competitive fringe). Overall welfare in the economy decreases very slightly. To sum up, for the calibrations assumptions chosen, the impact of imposing uniform access pricing is negligible, and we thus assume in Cases 3 and 4 that access charges may be differentiated.

The only difference between Cases 1 and 3 is that the latter allows the entrants to bypass the USP delivery network. The 0.178 euro urban access charge for case 1 is greater than the entrant's delivery cost to this area (0.12euro) and so that the entrant will bypass the USP urban delivery network. We assume, as is the case in practice, that the USP is prevented by the regulator from basing its access charge on the entrant's delivery cost (alternatively, we could assume that the USP does not know its competitors' delivery cost), and so that it cannot prevent urban bypass from happening. The entrant asks for access to the rural delivery area. Compared to Case 1, the USP then loses the business of selling access to the urban area and is obliged to increase its rural access charge and also its E2E price in order to break-even. On the other hand, urban consumers benefit from the cheaper entrant's good. With our calibration assumptions, the impact of a higher USP 2E2 price on their surplus is greater than the impact of the lower entrant's price, and urban (as well as rural) consumers are worse off when bypass is available! We obtain that total welfare is lower than under monopoly, because (inefficient[15]) bypass by entrants forces the USP to

[15] A continuity argument shows that bypass would still be detrimental to welfare even if the entrants' marginal delivery costs were slightly lower than the USP's. In other words, for bypass to increase welfare, it is necessary but not sufficient that the entrants' variable

increase its prices.

Finally, Case 4 introduces the possibility for (large) customers to use direct access to the USP delivery network, at the same price as the one paid by entrants. The optimal access charge in the urban area is still higher than the entrant's delivery cost, so bypass will occur there as in Case 3. Introducing CDA reinforces the effects already mentioned in Case 3: faced with a even higher loss of volumes, the USP raises both its rural access charge and its E2E price. These price increases more than compensate the availability of new products for the consumers so that their surplus decreases, and end up being lower than before liberalization!

These results of course depend on the precise calibration assumptions, and I do not claim that they hold in general[16]. They nevertheless complement the theoretical analysis presented above by illustrating the importance of taking into account the endogenous bypass decisions of entry when setting the optimal access policy.

6 Conclusion

This paper has developed a theoretical model of access pricing that incorporates three main characteristics of the postal sector: the ability for the incumbent to bypass the incumbent's delivery network, the imposition of universal service obligations (among which uniform pricing) on the incumbent but not on entrants, and the presence of customer direct access beyond access by competitors. I obtain that the optimal access charges can be presented à la Armstrong(2002), but that both the displacement ratio and the

delivery costs be lower than the USP's.

[16]Although the sensitivity analysis contained in De Donder et al.(2004) points toward a large robustness of the qualitative results reported above, at least for modifications in the displacement ratio and the entrant's market share.

Ramsey term are more complex due to the two different goods using access. The uniform pricing constraint on the USP E2E mail product appears explicitly in its optimal price formulation. As for the bypass decision, it does not appear explicitly in the formulas I obtain because they are based on first-order conditions while the "make or buy" decision involved in bypass rather result in different regimes or sub-cases (see Crew and Kleindorfer 2002). To shed some light on the influence of bypass, and to illustrate the impact of access on welfare, I develop a calibrated simulation. Numerical results show the importance of allowing for bypass, since the no-bypass case results in an increase in consumers' surplus while allowing for (inefficient) bypass results in a lower consumer surplus.

This paper constitutes the first attempt -to the best of my knowledge- at introducing these three characteristics in the same model. There is much need for further research. I suggest two ways to improve on this model. First, I have introduced CDA as a third good, without developing the micro-decisions of the many customers who decide whether to buy an E2E or an access-based product. My approach can be considered as a reduced form of a more micro-founded model, but a full treatment of this decision, as in Billette et al (2003a) would be more satisfactory. Second, and more important, I have assumed that the entrant's good is essentially the same whether the entrant delivers itself or ask for access. In other words, all the differentiation between the entrant's and USP's mail products comes from collection, sorting and transportation activities. It would certainly be more interesting if this restricting assumption were lifted.

Appendix

Calibration assumptions follow De Donder et al (2004), and we refer the reader to this paper for a more detailed presentation and motivation of these assumptions. We use linear demands that we calibrate to obtain that the total quantity sold by the USP under monopoly at an assumed current price p of 0.35 euro is 8 900 millions items for urban delivery and 1 100 millions items for rural delivery. Both demand functions exhibit a direct price elasticity of -0.376 (obtained by averaging the elasticities on the households' and firms' markets in De Donder et al (2004)) on both markets at the 0.35 euro price.

Regarding the USP costs, the universal service obligation translates into a global fixed cost F of 1 701 millions euros. The collection plus transportation and sorting unit cost is $c^I = 0.1$ euro for the USP and the unit delivery cost is $d_U^I = 0.07$ euro on the urban market and $d_R^I = 0.16$ euro on the rural market. The reader can easily check that the USP just covers its costs (including the fixed cost) at the 0.35 euro price before opening of the market to competition. The entrant's collection cost is $c^E = 0.13$ euro. The entrant does not face a fixed cost but has a higher marginal delivery cost than the USP on both markets : $d_U^E = 0.12$ euro on the urban area and $d_R^E = 0.35$ euro on the rural one.

As for demand, we first assume that the entrant would serve 10% of the total postal market if all goods available are priced at 0.35 euro. We assume that the displacement ratio is equal to 0.5 when only the entrant's good is available (Case 2 and 3), and equal to 0.65 when CDA is also available (Case 4). In this latter case, we assume that the CDA share of total USP volumes (i.e. E2E + CDA) is 40% when CDA represents a 20% cost saving for senders compared with the 0.35 price of the E2E product.

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