Worksharing, access and bypass: the structure of prices in the postal sector[1]

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Abstract

This paper studies a liberalized postal market where entrants may offer end-to-end products or concentrate on one of the segments of the network. Absent effective bypass, entry does not appear to be a serious financial threat to the incumbent, even when the products are perfect substitutes. This is no longer true when the entrant offers cheaper service in delivery. Then, the universal service provider may loose the entire pre-sorted mail market. It is left with probably low volume demand from households and from firms with high preparation cost, and its financial viability may be jeopardized.

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1 Introduction

In most network industries, the ongoing liberalization process has spurred an intense debate on the phenomenon of "downstream access". Accordingly this subject has been extensively studied in the economics literature.[1] In the postal sector the issue of "access" has been relevant long before the debate on liberalization was launched. However, it has appeared under a different form, namely worksharing. Processing workshared mail at a discounted rate is effectively like providing the client with access to one or several segments of the postal network. As in the case of downstream access, we have a situation where the postal operator sells some products which use only part of its network, while other products use the entire network. Put differently, the postal sector has the specific feature that access is a relevant issue even when there are no competing operators in the market. This is reflected in the existing literature on worksharing which typically considers a monopolistic sector; see Billette de Villemeur et al. (2002, 2003a).[2]

The structure of prices derived in this literature has to be reconsidered when the market opens. Competition may take two different forms. First, once entry has occurred, the demand for workshared mail may in part emanate from the competing operators. Specifically, the entrant may have all or part of its mail delivered by the incumbent (for an access charge) rather then build its own delivery network. In that case competition is limited to the upstream segments (mail preparation, etc.). Consequently, "high" access charges (ECPR type corrected by Ramsey elements) are likely to be optimal. They ensure that the entrant's products contribute in an adequate way to the incumbent's fixed cost (and the financing of the universal service obligation). Second, the entrant may find it optimal to "bypass" the incumbent's network in some areas by setting up its own delivery network. Now competition affects all segments and the ability of the incumbent to cover its fixed costs may be undermined. The possibility of bypass limits the potential for the entrant's products to contribute towards universal service costs and pricing rules will have to be amended. The incumbent's pricing policy will be modified accordingly with the expection of a rather significant impact.

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[1] See Laffont and Tirole (1996, 2000) and Armstrong (2002).
[2] See also Crew and Kleindorfer (1995), Mitchel (1999), Sherman (2001) and Panzar (2002).

In this paper, we put together a number of building blocks that we have developed over the last years. Specifically, we build on Billette de Villemeur et al. (2003a, 2004 and 2005) which we generalize by introducing different types of delivery areas and the possibility of bypass. Probably the most useful contribution of this is the specification of the "demand model"[3] which allows business mailers to choose to purchase end-to-end service and/or workshared service from either the incumbent or the entrant. Furthermore, the products of the incumbent and entrant are differentiated. However, the workshared and end-to-end services of both providers are perfect substitutes in terms of their value to final consumers. The closest predecessor to our analysis is Panzar (2005).[4] He also used a setting based on Billette de Villemeur et al. (2003a) to study the interaction between liberalization and unbundling and to introduce the notion of *"piecemeal bypass"*. While our model is more complex than Panzar's, the two papers are fairly complementary in that they envision different types of entry.[5] The crucial ingredient in Panzar's model is end-to-end competition (possibly through piecemeal bypass) on single-piece mail. We do not consider competition in the single-piece market segment. Instead, we concentrate on the industrial mail market that appears to be the main theater for competition at least within the European context.

We provide optimal pricing rules for the specification with general demand (but without uniform pricing constraint). Even though we are able to provide some analytical results, it is clear that a fully fledged study of the general model requires numerical simulations. That part of the paper is thus to be understood as an essentially methodological contribution, setting up a framework to be used in future numerical studies. In the second part of the paper we look at a more restrictive setting and provide crisper results that are not only interesting for their own sake but have important policy implications. The main finding from that perspective is that the possibility of bypass may have a rather drastic impact on the results. It brings about not just a quantitative change in the level of prices but a qualitative shift in the very nature of potential

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[3] We thank the referee for suggesting this terminology.

[4] The current version of Panzar's paper was presented also presented at the 13th CRRI Conference on Postal and Delivery Economics. However, his analysis is anterior to ours. An earlier version of his paper (presented at IDEI in November 2003) already contained the crucial features.

[5] We also provide more elaborated expressions for the pricing rules.

equilibria. Specifically we show that under bypass the universal service operator may not be able to retain the most lucrative market segment which in turn would seriously undermine its financial viability.

2 Model

2.1 Cost and demand

There are two operators: the incumbent universal service operator I and an entrant E. The stylized postal network we consider consists of two segments. Segment 1 corresponds to a composite activity including collecting, sorting and transportation. This activity implies a constant marginal cost of c_1 for operator I and of k^E for operator E. Segment 2 is delivery. Operator I's marginal delivery cost is c_2^u and c_2^r in areas u(rban) and r(ural) respectively. Operator E delivers in areas u only, at a marginal cost of c_2^E. In addition, there is a fixed cost associated with the delivery network which differs across areas and operators. The fixed cost of the incumbent in the two areas is given by F^u and F^r respectively (with $F^u < F^r$). If the entrant decides to build a delivery network in the urban area he incurs a fixed cost of Φ^u. The corresponding level for the rural area Φ^r is assumed to be prohibitive (so that the entrant will never find it optimal to deliver in the rural area).[6] The remaining fixed costs (*i.e.*, those not associated with delivery) are F for operator I and Φ for operator E. There are N addressees of which a fraction α is located in area u, while the remaining fraction $(1 - \alpha)$ is located in area r.

There are two types of senders and two goods. Senders of type h (households) consume good x which is supplied by I and uses both segments. The marginal cost of x is thus given by $c_1 + c_2^i$, $i = u, r$. Customers of type f can patronize the two operators, I and E; furthermore they may or may not use segment 1 of the respective operator. When they use the operator's segment, they buy the end-to-end (*E2E*) product, which is denoted by x for operator I (the product which is also consumed by households) and y for operator E. If they do not use segment 1 (thus engaging in worksharing) they consume good z_I (incumbent) or z_E (entrant). In that case they bear a preparation cost k which is distributed over $\left[\underline{k}, \bar{k}\right]$ according to the cumulative distribution $G(k)$

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[6] To be more precise, the level of fixed cost *per addressee* in the rural area is supposed to be prohibitive.

	I		E	
	E2E	Workshared	E2E	Workshared
Notation	x	z_I	y	z_E
Marginal cost operator	$c_1 + c_2$	c_2	$(k^E + a)$ or $(k^E + c_2^E)$	a or c_2^E
Marginal cost customers	p_x	$p_z + k$	q_y	$q_z + k$

Table 1: Customers of type f : products and costs

with density $g(k)$. Observe that k arises in addition to the price paid to the operators for z_I or z_E. Except for the cost difference x and z_I on the one hand and y and z_E on the other hand are considered as perfect substitutes.

Prices are given by p_x, p_z^u and p_z^r for operator I and by q_y^u, q_y^r, q_z^u and q_z^r for operator E. Observe that I's single piece mail has a uniform price. All other types of mail *may* be priced non uniformly (at least in some scenarios).

The Table 1 summarizes the main features of our model. It lists the different products available to type f customers and for each provides the marginal costs for the operators and the marginal cost for the consumer.[7] It also incorporates some other notations, namely k^E and c_2^E already mentioned (marginal cost of segment 1 and segment 2 for operator E), as well as a (access charge). Note that the cost for the operator E depends on whether there is access or bypass (see Subsection 2.2 for more details).

Let $S_h^i(x_h^i)$ denote the (gross) surplus of household senders per addressee in area $i = u, r$, while $S_f^i(x_f^i + z_I^i, y^i + z_E^i, k)$ represents the (gross) surplus of the sender of type f with characteristic k, per addressee in area $i = u, r$. [8] Observe that k represents not only the preparation cost, but also determines surplus hence demand.[9] Net surplus is obtained by subtracting total cost: payment to the operator plus cost of activity 1, if

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[7]Superscripts u and r are dropped for simplicity.

[8]For simplicity we use surplus as a welfare measure for firms. From a strict welfare economics point of view, this can be understood as representing the surplus of the consumers who buy the goods produced by firms f which use postal services as inputs. One can easily show that our shortcut does not involve any loss of generality in the case where all downstream markets are competitive.

[9]Alternatively one could identify types by, say, θ and write preparation costs as $k(\theta)$. However, this would just introduce redundant notation.

applicable. The demand function for households is given by:

$$x_h^i(p) = \arg\max_x \left\{ S_h^i(x) - px \right\}. \tag{1}$$

Similarly, the demand functions of the representative sender f are obtained by maximizing net surplus

$$S_f^i(x_f^i + z_I^i, y^i + z_E^i, k) - p_x x_f^i - (p_z^i + k)z_I^i - q_y^i y^i - (q_z^i + k)z_E^i$$

$$\text{s.t} \quad x_f^i, z_I^i, y_f^i, z_E^i \geqslant 0.$$

This yields four possible cases, labeled (1), (2a), (2b) and (3) with demand functions (for $i = u, r$):

(1) $x_f^i(p_x, q_y^i, k)$ and $y^i(p_x, q_y^i, k)$ if $p_z^i + k > p_x$ and $q_z^i + k > q_y^i$,

(2a) $z_I^i(p_z^i + k, q_y^i, k)$ and $y^i(p_z^i + k, q_y^i, k)$ if $p_z^i + k \leq p_x$ and $q_z^i + k > q_y^i$,

(2b) $x_f^i(p_x, q_z^i + k, k)$ and $z_E^i(p_x, q_z^i + k, k)$ if $p_z^i + k > p_x$ and $q_z^i + k \leq q_y^i$,

(3) $z_I^i(p_z^i + k, q_z^i + k, k)$ and $z_E^i(p_z^i + k, q_z^i + k, k)$ if $p_z^i + k \leq p_x$ and $q_z^i + k \leq q_y^i$.

$$\tag{2}$$

To understand this expression note first that when $p_z^i + k = p_x$ we have $x_f^i(p_x, q, k) = z_I^i(p_z^i + k, q, k)$ (workshared mail and end to end mail of *a given operator* are perfect substitutes). Furthermore, all users of type f for which $p_z^i + k \leq p_x$ (i.e., when $k \leq p_x - p_z^i$) find it profitable to buy good z_I^i at a level $z_I^i(p_z^i + k, q, k)$. Observe that overall per-unit cost of z^i is equal to $p_z^i + k$; it is this overall cost rather than just p_z^i which determines demand. On the other hand, when $p_z^i + k > p_x$, it is cheaper to consume x (which is otherwise a perfect substitute) and demand is $x_f^i(p_x, p_y^i, k)$. Similarly, we have $y^i(p, q_y^i, k) = z_E^i(p, q_z^i + k, k)$ when $q_z^i + k = q_y^i$.

An alternative way to look at this is to define ($i = u, r$)

$$\widetilde{k}^i = p_x - p_z^i, \quad \text{and} \quad \widehat{k}^i = q_y - q_z^i.$$

Clearly the relevant cases depend on the comparison between $\widetilde{k}^i$ and $\widehat{k}^i$. This is illustrated in Figure 1. In Case 1 the customer's level of k is so high that he buys only end-to-end products, from either operator. Case 3 refers to low levels of k where firms engage in worksharing with both operators. Case 2a and 2b are the intermediate cases. In case 2a the firm buys end-to-end from E while worksharing its mail with I. In case
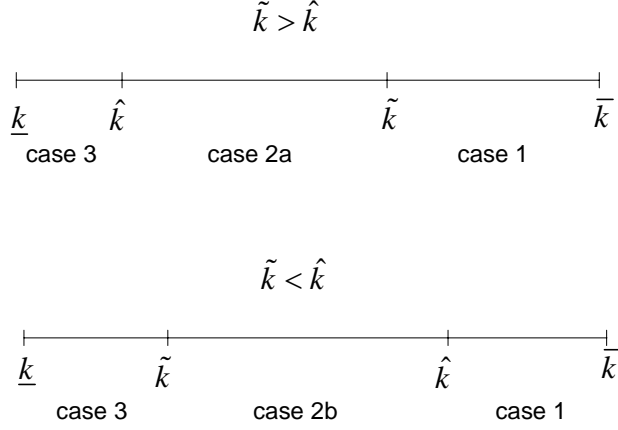
$$\tilde{k} > \hat{k}$$

$$\tilde{k} < \hat{k}$$

Figure 1: Configuration of type f customers' demand functions.

2b the firm buys end-to-end form I while worksharing its mail with E. When $\tilde{k}^i = \hat{k}^i$, only case 1 and 3 are relevant but since prices are endogenous, we cannot impose this restriction on an a priori basis.

Substituting demand functions (1) and (2) into net surplus yields the indirect utility functions $V_h^i(p_x)$ and $V_f^i\left(p_z^i, p_x, q_z^i, q_y^i, k\right)$ (for f, these are per addressee in area $i = u, r$).[10] Total utility of type f consumer k is then given by:

$$\alpha N V_f^u\left(p_z^u, p_x, q_z^u, q_y^u, k\right) + (1 - \alpha) N V_f^r\left(p_z^r, p_x, q_z^r, q_y^r, k\right).$$

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[10] For h we have $V_h^i(p_x) = S_h^i\left[x_h^i(p_x)\right] - p_x x_h^i(p_x)$. For f, net surplus is given by

$$S_f^i(x_f^i + z_I^i, y^i + z_E^i, k) - p_x x_f^i - (p_z^i + k)z_I^i - q_y^i y^i - (q_z^i + k)z_E^i.$$

The full expression for $V_f^i\left(p_z^i, p_x, q_z^i, q_y^i, k\right)$ is complicated because it has to account for the four demand cases. It is omitted for simplicity.

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2.2 Access, bypass and profit levels

Operator E pays an access charge of a^r per unit of (rural) mail which is to be delivered by I. Operator I is assumed not to be allowed to discriminate in the pricing of the downstream services it provides entrants and its own customers, giving rise to the requirement that $a^r = p^r_z$. Consequently p^r_z is not just the price for workshared mail, it is also the access price charged to E to deliver its mail in the rural area.

To write the cost and profit functions of the operators we have to distinguish between two regimes: access (subscript ac) and bypass (subscript bp) in the urban area (recall that there is no bypass in the rural area). Furthermore, we use uppercase letters for (total) market demand levels.

Access

The cost of operator I is given by

$$C^I_{ac} = (c_1 + c^u_2)\, X^u + (c_1 + c^r_2)\, X^r + c^u_2 (Z^u_I + Y^u + Z^u_E) + c^r_2 (Z^r_I + Y^r + Z^r_E) + F + F^u + F^r, \tag{3}$$

while for operator E we have

$$C^E_{ac} = k_E Y^u + a^u (Y^u + Z^u_E) + k_E Y^r + a^r (Y^r + Z^r_E) + \Phi. \tag{4}$$

For the profits, we have respectively:

$$\pi^I_{ac} = p_x (X^u + X^r) + p^u_z Z^u_I + a^u (Y^u + Z^u_E) + p^r_z Z^r_I + a^r (Y^r + Z^r_E) - C^I_{ac}, \tag{5}$$

$$\pi^E_{ac} = q^u_y Y^u + q^r_y Y^r + q^u_z Z^u_E + q^r_z Z^r_E - C^E_{ac}. \tag{6}$$

Bypass

Under (urban) bypass the following expressions apply :

$$C^I_{bp} = (c_1 + c^u_2)\, X^u + (c_1 + c^r_2)\, X^r + c^u_2 Z^u_I + c^r_2 (Z^r_I + Y^r + Z^r_E) + F + F^u + F^r, \tag{7}$$

$$C^E_{bp} = k_E Y^u + c^E_2 (Y^u + Z^u_E) + k_E Y^r + a^r (Y^r + Z^r_E) + \Phi + \Phi^u, \tag{8}$$

$$\pi^I_{bp} = p_x (X^u + X^r) + p^u_z Z^u_I + p^r_z Z^r_I + a^r (Y^r + Z^r_E) - C^I_{bp}, \tag{9}$$

$$\pi^E_{bp} = q^u_y Y^u + q^r_y Y^r + q^u_z Z^u_E + q^r_z Z^r_E - C^E_{bp}. \tag{10}$$

Equations (3)–(6) on the one hand and (7)–(10) on the other hand have of course a very similar structure. The only differences are due to the way Z_E^u and Y^u are processed. Under access Z_E^u and Y^u appear in the incumbent's profits both on the cost and on the revenue side. Their marginal cost to the entrant is given by a^u (see also Table 1). Under bypass, neither Z_E^u nor Y^u do at all appear in the incumbents profits. Their marginal cost to the entrant is c_2^u and the entrant incurs an extra fixed cost Φ^u.

2.3 Pricing of the entrant

We assume that the entrant realizes exogenously given markups: $\beta_z^u, \beta_z^r, \beta_y^u$ and β_y^r that may differ according to the area and/or the product. Observe that the case where all or some of the markups are equal is not ruled out.

In regime ac, prices of E are thus given by:

$$q_y^u = (a^u + k^E)(1 + \beta_y^u), \tag{11}$$

$$q_y^r = (a^r + k^E)(1 + \beta_y^r), \tag{12}$$

$$q_z^u = a^u(1 + \beta_z^u), \tag{13}$$

$$q_z^r = a^r(1 + \beta_z^r). \tag{14}$$

We assume that in this regime we have $Z_E^u = Z_E^r = 0$. This assumption appears to be particularly compelling when $p_z^i = a^i$.

In regime bp, prices of E in area u are given by:

$$q_y^u = (c_2^E + k^E)(1 + \beta_y^u), \tag{15}$$

$$q_z^u = c_2^E(1 + \beta_z^u). \tag{16}$$

Prices in area r are the same as in regime ac and continue to be given by (12) and (14). Following the approach adopted in regime ac, we also assume $Z_E^r = 0$ under regime bp. In essence this amounts to assuming that the entrant's workshared product is offered only in u and only under bypass.

The constant markup assumption is made for simplicity. It is the simplest framework compatible with the existence of fixed costs for the entrant. Alternatively one could

assume that the entrant's prices are given by Bertrand type reaction functions; see Billette de Villemeur et al. (2003b).[11] For instance, we would have

$$q_y^r = q_y^r(a^r, p_x) \tag{17}$$

i.e., the entrant's price (best reply) is a function of the access charge (which determines its cost) but also of the incumbents price. This shows that our specification involves two different restrictions. First, that $\partial q_y^r / \partial a^r$ is constant and, second, that we neglect the strategic interaction through which the incumbents price affects the entrant's pricing policy. One can easily check that the first restriction has no impact on the results we provide; in particular, the optimal pricing rules remain valid.[12] Accounting for the effect of p_x on the other hand would complicate the expressions (there would be extra terms which we implicitly assume to be of second order).

An alternative way to rationalize the constant markup assumption is to assume that the entrant's demand functions have constant price elasticity. In that case (and given that marginal cost is constant) the Bertrand reaction function of the entrant (17) reduces to a simple constant markup rule.[13]

To simplify the subsequent expressions it is convenient to define market demand functions $X^i\left(p_x, p_z^i, q_y^i, q_z^i\right)$ and $Z_I^i\left(p_x, p_z^i, q_y^i, q_z^i\right)$ for the incumbent and $Y^i\left(p_x, p_z^i, q_y^i, q_z^i\right)$ and $Z_E^i\left(p_x, p_z^i, q_y^i, q_z^i\right)$ for the entrant $(i = u, r)$.[14]

2.4 Bypass and entry decisions

The entrant will bypass if

$$\beta_y^u(a^u + k^E)Y^u[p_x, p_z^u, (a^u + k^E)(1 + \beta_y^u), a^u(1 + \beta_z^u)] <$$
$$\beta_y^u(c_2^E + k^E)Y^u[p_x, p_z^u, (c_2^E + k^E)(1 + \beta_y^u), c_2^E(1 + \beta_z^u)]$$
$$+ \beta_z^u c_2^E Z_E^u[p_x, p_z^u, (c_2^E + k^E)(1 + \beta_y^u), c_2^E(1 + \beta_z^u)] - \Phi^u.$$

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[11] In other words, we have a leader follower setting.

[12] Some redefinitions of elasticities are required, though.

[13] This is a commonly used shortcut in monopolistic competition model; see Tirole (1988), ch. 7. Observe that Crew and Kleindorfer (2006) also work with a specification that involves a constant markup. However, they adjust the markup so that fixed costs are just covered. We simply assume that markups are exogenous but argue that this may be consistent with profit maximization.

[14] The formal definitions are straightforward but somewhat tedious. They are contained in a technical appendix available on the authors' website at www.idei.fr.

The LHS of this expression is the profit of operator E in area u if he uses the incumbent's network to deliver the mail.[15] Recall that the operator applies a constant markup. To determine the profit we can thus multiply unit costs by the markup and multiply by the quantity. The RHS is the profit when he uses his own network (and thus incurs the extra fixed cost Φ^u).

Assuming that the LHS of this expression is decreasing in a^u, there exists a critical value of the access charge, $\widetilde{a}^u$ such that the operator bypasses whenever $a^u > \widetilde{a}^u$ and uses I's delivery network otherwise. This critical level is of course increasing in Φ^u. Note that when the constraint $a^u = p_z^u$ is imposed this becomes more complicated.

3   Results with general demand

The model we have introduced is rather complicated. In particular, uniform pricing of x and (possibly) z, will lead to complicated expressions. To keep the model as simple as possible we shall concentrate on two special (and extreme) cases. We shall successively assume $\alpha = 0$ (all addressees are in area r) and then $\alpha = 1$ (all addressees are in area u). The first setting $\alpha = 0$ yields the no bypass case; the entrant's products are delivered by the incumbent. This is similar to Billette de Villemeur et al. (2005), except that the entrant's pricing strategy is different (constant markup rather than competitive fringe). We assume $p_z = a$ so that worksharing customers and competitors pay the same price for delivery. The second setting, $\alpha = 1$ is the "full bypass" case where all the entrant's products are delivered through its own network. The access price only applies to the worksharing customers.

In either case we make other, more specific assumptions which will be discussed below. The main advantage of looking at these extreme cases is that we do not have to worry about uniform pricing. Furthermore, since we have a pure access and a pure bypass regime, we can try to compare the pricing rules to assess the impact of bypass on access prices.

Before proceeding let us point out that while the two cases we consider are admittedly restrictive their analysis has more far-reaching implications. This is because the

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[15] Making use of the assumption that $Z_E^u = 0$ under access.

results remain valid when $0 < \alpha < 1$, *as long as there is no uniform pricing.* To be more precise, the expressions for area r are then simply those we obtain for $\alpha = 0$, while those for u correspond to the solution with $\alpha = 1$. With uniform pricing, on the other hand, expressions would be significantly more complex. As the FOCs would then be convex combinations of the conditions we obtain, an analytical study of the pricing rules would no longer appear to be possible.[16]

3.1 The case $\alpha = 0$

By setting $\alpha = 0$, we assume that all mail is to be delivered in the rural area where, by assumption, there is no bypass. Furthermore, we impose $a^r = p_z^r$ and assume $Z_E^r = 0$: under access the entrant does not offer z. This is necessarily true when for the workshared mail, I and E's products are sufficiently close substitutes to obtain $Z_E^r(q_z^r, p_z^r) = 0$ if $q_z^r > a^r = p_z^r$. In this case we return to the setting of Billette de Villemeur et al. (2005) and the pricing rules can be obtained from the expression provided there by redefining $q_y^r(p_z^r)$ according to (12).[17] This yields

$$\frac{p_x - (c_1 + c_2^r)}{p_x} = \frac{\lambda}{1 + \lambda} \frac{1}{\widehat{\sigma}_X^r} \tag{18}$$

$$\frac{p_z^r - c_2^r}{p_z} = \frac{\lambda}{1 + \lambda} \frac{1}{\widehat{\sigma}_{Y+Z_I}^r} \tag{19}$$

where $\widehat{\sigma}_X^r$ and $\widehat{\sigma}_{Y+Z_I}^r$ are the superelasticities of $\widetilde{X}^r(p_x^r, p_z^r) = X^r\left[p_x^r, p_z^r, q_y^r(p_z^r)\right]$ and $\widetilde{Y}^r(p_x^r, p_z^r) + \widetilde{Z}_I^r(p_x^r, p_z^r) = Y^r\left[p_x^r, p_z^r, q_y^r(p_z^r)\right] + Z_I^r\left[p_x^r, p_z^r, q_y^r(p_z^r)\right]$ respectively.[18]

Consequently, the access/workshared price $p_z = a$ is determined by the usual inverse superelasticity rule. Since the price pertains to two products Y and Z_I (which have the same cost for I, but different demands) the superelasticity is that of the sum of these demands and we can think about $Y + Z_I = \widetilde{Y}^r(p_x^r, p_z^r) + \widetilde{Z}_I^r(p_x^r, p_z^r)$ as aggregate demand for "access" (or rather access *cum* worksharing).

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[16] Even with linear demand functions, one would have to resort to numerical simulations.

[17] Billette de Villemeur et al. (2005) consider a competitive fringe which amount to setting all the β's to zero. The current setting is thus a generalization of Billette de Villemeur et al. (2005) but the expression are derived exactly along the same lines (and interestingly change very little essentially because the markup is a multiplicative factor which cancels out in the various elasticities.)

[18] Recall that the definition of $\widetilde{X}^r(p_x^r, p_z^r)$ accounts for the induced price variations of the entrant; see Billette de Villemeur et al. (2005), p. 149.

3.2 The case $\alpha = 1$

Assume now that all mail is to be delivered in the urban area where the entrant has his own delivery network. Access is now only provided to worksharing customers. For the time being, we do not analyze the bypass decision of the entrant; we simply assume that bypass occurs at the equilibrium. Put differently, all the expressions here are derived conditional on there being bypass. Doing this, we neglect two aspects. First, the optimal p_z in the access regime (determined according to (19) for a marginal cost of c_2^u) may be such that bypass is not interesting anyway (for instance, because Φ^u is large). Second, even when this is not true, the incumbent might find it desirable to lower its price to discourage bypass. We shall revisit this issue below.

The entrant's prices are determined by (15) and (16). Consequently, they are given and do not depend on the incumbent's prices. This implies that the *structure* of operator I's pricing problem is exactly the same as in the monopoly case studied by Billette de Villemeur et al. (2003a). There are terms in the objective function which were not present in the monopoly case (e.g. the profit of E) but these are constant when it comes to determining I's price structure. The level and elasticity of demand for X and Z will of course differ from the monopoly case, but like in that situation these are effectively only functions of p_x and p_z (the other arguments being constant).

It thus follows that the optimal pricing rules are given by expression (15) and (16) of Billette de Villemeur et al. (2003a) so that we have (with the notation of the current paper)

$$\frac{p_x - (c_1 + c_2^u)}{p_x} = \frac{\lambda}{1 + \lambda} \frac{1}{\sigma_X^u} = \frac{\lambda}{1 + \lambda} \frac{1}{\widehat{\sigma}_X^u}, \tag{20}$$

$$\frac{p_z^u - c_2^u}{p_z^u} = \frac{\lambda}{1 + \lambda} \frac{1}{\sigma_{Z_I}^u} = \frac{\lambda}{1 + \lambda} \frac{1}{\widehat{\sigma}_{Z_I}^u} \tag{21}$$

where σ_X^u and $\sigma_{Z_I}^u$ are the superelasticities of X and Z_I respectively. Observe that we do not have to distinguish between X and Z_I on the one hand and $\widetilde{X}$ and $\widetilde{Z}_I$ on the other hand because the indirect effect through the price of the other operator does not occur here. Consequently, we have $\sigma_X^u = \widehat{\sigma}_X^u$ and $\sigma_{Z_I}^u = \widehat{\sigma}_{Z_I}^u$ so that $\widehat{\sigma}$'s are not needed here; they are only used for reasons of symmetry with expression (18) and (19).

Let us now consider the implications of (18)–(21) for p_z under access and bypass. We set $c_2^u = c_2^r = c_2$ (which makes sense here) and then have to compare $\widehat{\sigma}_{Z_I}^u$ and $\widehat{\sigma}_{Y+Z_I}^r$ or dropping the index (because in each case we are considering the entire set of addressees) $\widehat{\sigma}_{Z_I}$ and $\widehat{\sigma}_{Y+Z_I}$. On purely theoretical grounds this comparison does not appear to be unambiguous; to be more precise it is an empirical issue. The following elements appear to be relevant. First, in $\widehat{\sigma}_{Z_I}$, we have a single product whereas $\widehat{\sigma}_{Y+Z_I}$ includes two products. It is not clear how this affects the comparison. Second, and more significantly, the content of Z_I is not the same in the two expressions. Under bypass, Z_I has a direct competitor and thus substitute (namely Z_E). Under access, on the other hand, there is no alternative to Z_I; even when the customer patronizes E, the mail will eventually be delivered by I. For this reason, we can expect the elasticity of Z to be significantly higher under bypass. Third, the value of λ is likely to differ between the two cases and possibly in ways that offset the impact of the higher elasticities of Z under bypass.

Summing up, it appears possible to make a case for p_z to be lower under bypass (even when "strategic", bypass preventing behavior is not accounted for). Introducing such strategic behavior can of course only reinforce this conclusion.

4   Access vs. bypass with perfect substitutes

Let us now assume that the entrant's and the incumbent's products are perfect substitutes. More precisely we assume that x and y are perfect substitutes, so that the same property applies to z_E and z_I. Once again, we successively study the cases $\alpha = 0$ (access) and $\alpha = 1$ (full bypass). The first case has essentially already been studied in Billette de Villemeur et al. (2004), except that we have a markup for the entrant rather than the competitive fringe.

4.1   The case $\alpha = 0$ (no bypass)

In this case we have either $q_y^r > p_x$ (Regime I) or $q_y^r \leq p_x$ (Regime II). Recall that product z_E is not provided.

4.1.1 Regime $I : q_y^r > p_x$

In this case, the entrant's market share is zero and we return to the monopoly setting of Billette de Villemeur et al. (2003a). The case is excluded by assumption (the entrant has no revenue and cannot cover its fixed cost; anticipating this, he would not enter in the first place).

4.1.2 Regime $II : q_y^r \leq p_x$

To assess if this regime occurs, we have to compare $q_y^r (p_z^r) \geq k^E + p_z^r$ to $p_x = \widetilde{k}^r + p_z^r$. A *necessary* condition for $q_y^r \leq p_x$ is that $k^E < \widetilde{k}^r = p_x - p_z^r$. In this regime, we have $X^r (p_x, p_z^r) = X_h^r (p_x)$: the good X is consumed only by households. The mail of the different firms is split between the entrant E (for the high k) and the incumbent I (for the low k) as shown on Figure 2 and we have

$$
Z^r (p_z^r) = \int_{\underline{k}}^{q_y^r - p_z^r} z_k^r(p_z^r + k)g (k) \, dk,
$$

$$
Y^r (q_y^r) = \int_{q_y^r - p_z^r}^{\overline{k}} y_k^r(q_y^r)g (k) \, dk.
$$

Note that, since y and x (hence z) are perfect substitutes, $y_k (p) = z_k (p)$. As a result, this is "as if" the entry of firm E were allowing firms with $k \geq q_y^r - p_z^r \geq k^E$ to sort their mail at a cost of only k^E. Firm I is now facing a set of firms with a distribution of k which is cut from above at the level $q_y^r - p_z^r$ and all these firms consume the workshared mail. Note however that this allocation is not necessarily efficient since if the entrant makes a positive markup, it follows that $q_y^r > k^E + a^r$ hence even if $a^r = p_z^r$ some firms with $k > k^E$ will nevertheless find it profitable to workshare their mail (instead of letting the entrant prepare it).

4.2 The case $\alpha = 1$

We now turn to the case with full bypass. If the incumbent's products are perfect substitutes, then the demand for a product is positive only if the corresponding operator offers the lowest price. It follows that a firm with a sorting cost k consumes x_f^u when
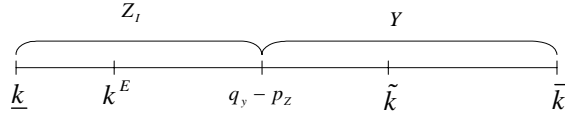
Figure 2: Partition of type f customers in Regime II under access. Customers with $k < q_y - p_z$ consume workshared mail (provided by the incumbent). Customers with larger levels of k buy the entrant's end-to-end product Y.

the following conditions hold

$$
\begin{aligned}
p_x &\leq q_y^u = (c_2^E + k^E)(1 + \beta_y^u), \\
p_x &\leq p_z^u + k, \\
p_x &\leq q_z^u + k = c_2^E(1 + \beta_z^u) + k.
\end{aligned}
$$

Similarly, it consumes z_f^u when the following conditions are satisfied

$$
\begin{aligned}
p_z^u + k &\leq q_z^u + k = c_2^E(1 + \beta_z^u) + k, \\
p_z^u + k &\leq p_x, \\
p_z^u + k &\leq q_y^u = (c_2^E + k^E)(1 + \beta_y^u),
\end{aligned}
$$

For given levels of q_y^u, q_z^u we then obtain 4 regimes, as illustrated in Figure 3.

Regime I: the entrant is more expensive for all products $p_x < q_y^u$ and $p_z^u < q_z^u$.

In this case, the entrant does not enter. This solution is equivalent to Regime I in the
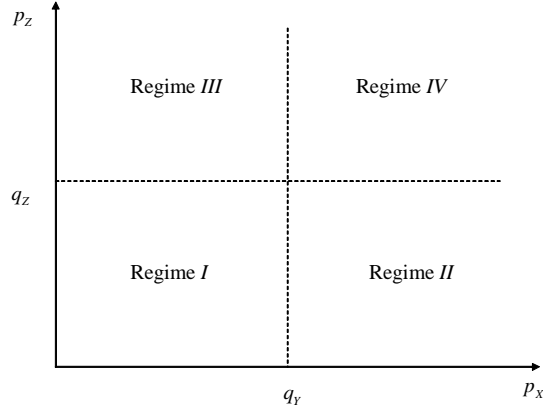
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Figure 3: Regimes in the bypass case.

no bypass case. Once again, it is excluded by assumption (the entrant has no revenue and cannot cover its fixed cost; anticipating this, he would not enter in the first place).

Regime II : the entrant is cheaper for end-to-end mail only: $p_x > q_y^u$ but $p_z^u < q_z^u$. In this case, the demand for commodity X reduces to the one of households $X_h^u(p_x)$. Firms workshare their mail to the incumbent (consume z_I) when $p_z + k \le q_y^u$; otherwise, they consume Y; see Figure 4. Observe that this regime is similar to Regime II in the no bypass case discussed in subsection 4.1.2. The difference is that the entrant's end-to-end product is no longer delivered by the incumbent. This is to a large extent an artifact of our assumption that there is effectively bypass. With $p_z^u < q_z^u$ this is, however, not likely to occur when the bypass decision is endogenous. In that case we would thus effectively return to Regime II in the access case.

The price p_x is the same as in the no bypass case, Regime II:

$$\frac{p_x - (c_1 + c_2^u)}{p_x} = \frac{\lambda}{1 + \lambda} \frac{1}{\varepsilon_{X_h^u}}$$
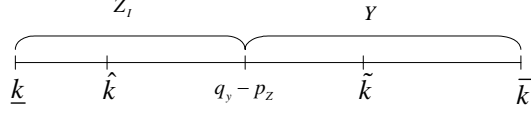
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Figure 4: Partition of type f customers in Regime II under bypass. Customers with $k < q_y - p_z$ consume workshared mail (provided by the incumbent). Customers with larger levels of k buy the entrant's end-to-end product Y.

The demand for Z^u writes

$$Z_I^u \left(p_z^u, q_y^u\right) = \int_{\underline{k}}^{q_y^u - p_z^u} z_k^u(p_z^u + k, k)g\left(k\right)dk.$$

Interestingly enough, it does not depend on p_x. Consequently, the optimal price p_z^u, as defined by the standard Ramsey expression

$$\frac{p_z^u - c_2^u}{p_z^u} = \frac{\lambda}{1+\lambda}\frac{1}{\varepsilon_{Z_I^u}},$$

is also independent from p_x, *for a given level of* λ. The aggregate elasticity $\varepsilon_{Z_I^u}$ can be decomposed as follows:

$$
\begin{aligned}
\varepsilon_{Z_I^u} &= \frac{p_z^u}{Z_I^u}\left(\int_{\underline{k}}^{q_y^u - p_z^u}\frac{-\partial z_k^u(p_z^u + k, k)}{\partial p_z^u}g\left(k\right)dk + z_k^u\left(q_y^u\right)g\left(q_y^u - p_z^u\right)\right) \\
&= \int_{\underline{k}}^{q_y^u - p_z^u}\alpha_{Z_I^u}^k\varepsilon_k^u dk + \alpha_{Z_I^u}^{k=q_y^u}
\end{aligned}
$$

where $\alpha_{Z_I^u}^k = g\left(k\right)z_k^u/Z_I^u$ is the share of demand by type k firms and ε_k^u the price elasticity. Clearly when q_y^u increases, the interval $\left[\underline{k}, q_y^u - p_z^u\right]$ increases incorporating firms with lower elasticities which suggest that the aggregate elasticity will also decrease. As a result, the socially optimal price p_z^u increases with q_y^u.

Regime III: the entrant is cheaper for workshared mail only: $p_x < q_y^u$ **but** $p_z^u > q_z^u$. For this regime to occur, we have to assume that:

$$
\begin{aligned}
p_x &< q_y^u = (1 + \beta_y^u)(c_2^E + k^E), \\
q_z^u &= c_2^E (1 + \beta_z^u) < p_z^u,
\end{aligned}
$$

which is unlikely to arise if the markup of entrants is sufficiently low and their upstream costs are well below those of the incumbent.

Assume nevertheless that both of these inequalities hold. In this case, the demand for the commodity Z_I^u is equal to zero. As a result, there is no loss on the incumbent's revenue if price p_z is reduced to c_2^u. It follows that $q_z^u = c_2^E (1 + \beta_z^u) \leq c_2^u$ is a necessary condition for Regime III to arise.

In this regime, as illustrated by Figure 5, consumers of type f with low levels of k consume z_E, while those with high k's consume x. The only demand for the incumbent's products is the demand for commodity X:

$$
X^u (p_x, q_z^u) = X_h^u (p_x) + \int_{p_x - q_z^u}^{\overline{k}} x_f^u(p_x, k) g(k) \, dk.
$$

Interestingly enough, it does not depend on p_z. The price p_x is set according to the Ramsey rule

$$
\frac{p_x - (c_1 + c_2^u)}{p_x} = \frac{\lambda}{1 + \lambda} \frac{1}{\varepsilon_{X^u}}
$$

and is independent from p_z^u, *for a given level of* λ. The aggregate price-elasticity is

$$
\varepsilon_{X^u} = \frac{p_x}{X^u} \left(\frac{-\partial X_h^u (p_x)}{\partial p_x} + \int_{p_x - q_z^u}^{\overline{k}} \frac{-\partial x_f^u(p_x, k)}{\partial p_x} g(k) \, dk + x_f^u (p_x, p_x - q_z^u) g(p_x - q_z^u) \right)
$$

which is likely to increase when q_z^u decreases. (The "high elasticity consumer" shift to the entrants product). As a result the socially optimal price p_x increases with q_z^u.

Observe that, in Regime III, the incumbent's demand emanates only from households and from firms with high preparation cost (that are likely to be also the customers with a lower volume). Compared to the previous two regimes, the incumbent has thus totally lost a crucial market segment (namely the firms with low preparation cost). Budget balancing would thus "at best" require a rather large price for X. Moreover,
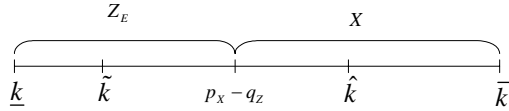
Figure 5: Partition of type f customers in Regime III under bypass. Customers with $k < q_z - p_x$ consume the entrant's workshared mail product. Customers with larger levels of k buy the incumbent's end-to-end product X.

since the remaining market segments can be expected to yield a rather low volume, it may well be the case that the highest possible (gross) profit that can be achieved is not sufficient to cover the fixed cost. We shall return to this point below.

Regime IV: the entrant is cheaper for both type of products $p_x > q_y^u$ and $p_z^u > q_z^u$. In this case the demand for the incumbent reduces to the demand of households $X^u \left(p_x, p_z^u, q_y^u, q_z^u \right) = X_h^u \left(p_x \right)$. Compared to Regime III an additional segment (namely the firms with high preparation costs) has been lost by the incumbent. With a single category of customers left, it is now even more unlikely that the incumbent would be able to break-even.

When break even is possible the optimal pricing rule is given by

$$\frac{p_x - (c_1 + c_2^u)}{p_x} = \frac{\lambda}{1 + \lambda} \frac{1}{\varepsilon_{X_h^u}},$$

where λ adjusts for the firm to be able to break-even. When the fixed cost to be covered equals the (gross) monopoly profit the multiplier λ goes to infinity and the incumbent does not differ from a profit-maximizing firm. For higher levels of F no solution exists and the incumbent would not be able to survive.

When do these regimes occur? In Figure 3 and in the subsequent discussion, we have characterized the regimes by conditions that involve *endogenous* variables (in par-
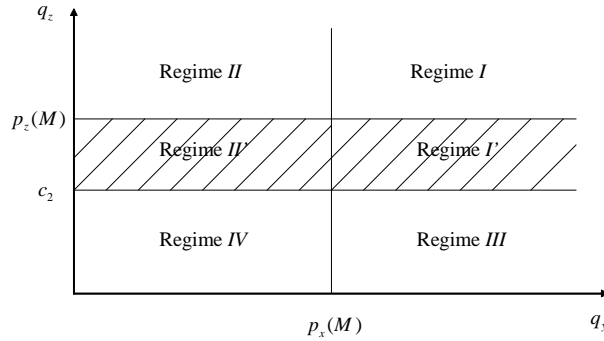
Figure 6: Regimes in the bypass case in the (q_y, q_z) space.

ticular p_x and p_z). This presentation is most convenient in that it allows us to easily get an intuitive understanding of the implication of the different regimes. However, it does not give us a full characterization of the solution and it does not tell us precisely which exogenous parameter combination result in which regime. To address this question, we use a representation in the (q_y, q_z) space (see Figure 6). Recall that under bypass, both of these prices are exogenous and given by equations (15) and (16). In this space, we depict the incumbent's (welfare maximizing) prices under monopoly $p_x(M)$ and $p_z(M)$. These levels are also well defined and can be considered as exogenous for the question under investigation here. The incumbent's delivery cost c_2 is also depicted on the vertical axis. It is plain that when $q_y > p_x(M)$ and $q_z > p_z(M)$ we will have Regime I, while $q_y < p_x(M)$ and $q_z < c_2$ yields Regime IV. Similarly, one easily shows that $q_y < p_x(M)$ along with $q_z > p_z(M)$ yields Regime II while $q_y > p_x(M)$ and $q_z < c_2$ results in Regime III. To see this, one has to recall the properties of the different regimes discussed above, while keeping in mind the regimes depend on the incumbent's effective price (and not directly on the hypothetical monopoly price).[19] The intermediate (transitional) regimes I' and II' require a more careful explanation. For

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[19] For instance, when $q_y > p_x(M)$ and $q_z > p_z(M)$ the incumbent can just set the same prices as under monopoly.

instance, when $q_y > p_x(M)$ along with $p_z(M) > q_z > c_2$, the incumbent would end up in Regime III if he were to maintain its high monopoly price (for z). Clearly it is a better strategy to "undercut" the entrant to retain the industrial mail segment, as long as this yields a price which exceeds the incumbent's delivery cost c_2 (and thus a positive markup which contributes towards the financing of fixed costs). This corresponds to the strategic bypass deterring we have not addressed above.

5 Concluding remarks

This paper has studied the potential market equilibria in a liberalized postal market where a regulated incumbent (the universal service provider) competes with non regulated entrants. The model accounts for a number of features that are already or may become relevant in the postal sector in most European member states. These include the possibility of access, bypass, consolidation and worksharing. Doing this, we have considered that entrants may offer end-to-end products or concentrate on one of the segments of the network. We have shown that a wide variety of scenarios can emerge depending on the regulatory environment and on the relative cost and demand structures for the incumbent and the entrants' products.

To wrap up and to draw some lessons, let us concentrate on the case where the products offered by incumbent and entrant are perfect substitutes (Section 4). To stress the main contributions of this paper, we shall particularly emphasize the impact of bypass. We have seen that when bypass is possible a number of possible scenarios can arise.

It may be the case that liberalization induces no changes compared to the (regulated) monopoly scenario. This is the case when the (regulated) monopoly prices make entry by any potential operator non profitable (Regime I). When entry effectively does occur, the new operator may offer cheaper service than the incumbent in some or in all market segments. The most favorable case for the incumbent is when the entrant is cheaper only for end-to-end mail (Regime II). This can occur for instance when the entrant is able to sort mail at a lower cost than the incumbent ($k^E \leq c_1$). In this case, the incumbent's end-to-end product is consumed exclusively by households. Firms (and the

entrant operator in the no bypass case) use the incumbent's delivery services only for the workshared mail. Compared to Regime I, the incumbent has lost market share, but it retains probably the most lucrative segment, namely the firms with low preparation costs. Observe that both of these regimes can occur in the access as well as in the bypass case. Even if it is theoretically possible, bypass will not have a significant impact under these two regimes. Consequently, bypass is unlikely to occur in the first place. In other words when the model is extended to account for the bypass decision (as discussed in Subsection 2.4), it is not likely that the entrant will find it profitable to build its own delivery network.

A very different result obtains when the entrant offers cheaper service in delivery. This can occur for instance in relatively dense areas where the delivery costs of the entrant may be well below the (possibly uniform) delivery price charged by the incumbent $(c_2^E < c_2^E(1 + \beta_z^u) \leq p_z^u)$. In this case, the incumbent loses the entire pre-sorted mail market (Regime III). It is left with demand emanating only from households and from firms with high preparation cost (that are likely to be also the customers with lower volumes). Since the remaining market segments can be expected to yield a rather low volume, the universal service operator's revenues may no longer be sufficient to cover its fixed cost. Consequently, under Regime III the financial viability of the universal service operator is jeopardized.

This would be even more likely in Regime IV, where the incumbent is left solely with the demand from households. Volumes are then even smaller than in Regime III and one cannot expect them to provide a sufficient contribution to cover the universal provider's fixed costs. It is not clear how universal service (and specifically service to households) can be guaranteed in this setting. Observe that the two critical regimes require bypass. Absent bypass, the existence of the incumbent does not appear to be seriously threatened, as long of course as access charges are set appropriately.

Throughout the paper, we have implicitly restricted the incumbent's pricing strategies in several ways. The restrictions are meant to account for regulatory constraints that are often imposed in practice. In particular, we have not considered price differentiation (for instance between households and firms) and we have not considered the

possibility of strategic "bypass deterrence" (setting an access price just below the competitor's delivery cost). When the incumbent's pricing policy is restricted, the entrant may be able to offer services at a lower price only because it is able to differentiate its prices between customers (while the incumbent is subject to uniform or non discriminatory pricing requirements). In that case, allowing the incumbent to differentiate prices as well may improve welfare. More generally, providing the universal service provider with more flexible pricing tools could mitigate the threat that bypass poses to its survival.

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