Draft of May, 2006

# **PO Box Access:**

# **Competition Issues in a Two-Sided Postal Market**

# **PRELIMINARY DRAFT**

Prepared for 4<sup>th</sup> IDEI/La Poste Conference on Regulation, Competition

and Universal Service in the Postal Sector

March 16<sup>th</sup> and 17<sup>th</sup>, 2006

Professor John C. Panzar

University of Auckland and Northwestern University

# I. Introduction and Summary

This paper sets forth optimal pricing principles for the pricing of Post Office Box services. The analysis deals with both integrated providers of mail delivery and PO Box services as well as PO Box specialty firms. PO Boxes are one of the few generally acknowledge "essential facilities" in the postal sector. Thus the principles developed here form the basis for the analysis of the pricing competitor's access to an incumbent post's PO Box network.

The role of essential facilities has been a controversial feature of the process of liberalizing postal markets. Some have argued that the absence of substantial sunk costs means that there is no need for policies designed to deal with "monopoly bottlenecks," such as those used in other network sectors such as telecommunications or electricity.<sup>1</sup> Others have argued that requiring incumbents to grant downstream assess is essential for the development of significant competition, at least in the short to medium run. I will not try to resolve this question here. However, all parties to the debate seem to agree that entrants must be granted access to the incumbent's PO Box subscribers. But there remains considerable debate over the appropriate pricing methodology.

Incumbent posts tend to argue that the Efficient Component Pricing Rule (ECPR) is the appropriate methodology to use for access pricing. Regulatory commissions tend to argue that the appropriate standard should be cost-based: i.e., "bill and keep" when the costs of receiving mail at a PO Box location are zero. The incumbent post's position is based on the claim that PO Boxes are an integral part of its postal network and that ECPR based pricing of network access is not anticompetitive. The regulatory position is based upon the argument that the likely outcome in workably competitive postal and PO Box markets would be a cost-based access charge. There is also concern lest the incumbent

<sup>&</sup>lt;sup>1</sup> See, for example, de Bilj et. al. (2006), Crew and Kleindorfer (2002), and Panzar (2002).

post succeed in "making use of its dominant position" in the PO Box market to thwart competition in markets for postal services.

It turns out that this debate ignores an important aspect of the market for PO Box services and postal markets generally: they are 2-sided markets. As the emerging literature on this topic has indicated, simple cost-based rules rarely suffice to characterize either desirable or equilibrium characteristics of the marketplace.<sup>2</sup> Therefore, before it is possible to truly understand access pricing for PO Boxes, it is necessary to understand the benchmark pricing outcomes under competition and welfare maximization. That is the objective of my analysis.

The remainder of this paper is organized as follows. Section II presents a rather general model of postal and PO Box services as interrelated 2-sided markets. The analysis is based on the assumption that mail recipients are heterogeneous along two dimensions. They differ in the utility they derive from receiving their mail in a secure PO Box, but they also differ in their desirability to senders of mail. Optimal choice on the part of senders and these heterogeneous recipients gives rise to demand functions for PO Box subscriptions and the volumes of PO Box addressed and street addressed mail.

<sup>&</sup>lt;sup>2</sup> See Rosson (2004) for an early review of this literature.

Optimal pricing rules are similar to those derived in other 2-sided market contexts. The optimal prices for sending mail to PO Box and street addresses is equal to the marginal cost they impose on the postal network *less* the marginal "reception benefit" enjoyed (or suffered) by mail recipients. Unlike many 2-sided market models, the two dimensions of receiver heterogeneity make it possible to derive determinate monthly and per unit charges for PO Box subscribers.

Section III shifts attention to the case of a hypothetical specialized PO Box monopolist serving PO Box customers and selling access to competitive postal service providers. I derive some limited "equivalence results" that demonstrate how such a monopolist can replicate the welfare maximizing prices achieved by an integrated service provider. It turns out that there is no guarantee that such a hypothetical welfare maximizing PO Box monopolist would cover its costs when it sets optimal prices, even under the maintained hypothesis of constant returns to scale. Therefore, I also analyze the prices that would emerge in a competitive PO Box market, assuming that postal services were also competitive. Here, I obtain a result similar to those obtained in models of mobile telecommunications markets: competitive suppliers charge the monopoly access price to postal providers and compete away their profits by offering low (or negative) rates to their subscribers. Section IV proposes some potentially interesting extensions for further analysis. These involve various regulatory scenarios and liberalization. Section V offers some tentative conclusions.

#### PRELIMINARY AND INCOMPLETE: PLEASE DO NOT QUOTE OR CITE!

4

# II. A Model of Integrated Markets for Postal and PO Box Services

# A. The PO Box Subscription Decision of Heterogeneous Mail Recipients

Operators of PO Boxes have two sets of customers: mail receivers and mail originators. Mail receivers typically pay a monthly rental fee for the convenience of a private and secure facility for receiving their mail. In principle, but rarely in practice, receivers might also be subject to a (positive or negative) payment based upon the volume of mail that they receive. The demand of mail originators is for delivery to mail receivers. This demand is typically effectuated through the market for postal delivery services: i.e., through the stamp price. I assume that the demand by senders for delivery to mailer recipients is a function of price and a type characteristic  $s \in [0,1]$ . For simplicity, I adopt the standard assumption that sender demand is multiplicatively separable in price and type: i.e., v(p,s) = sv(p) with v' < 0. Mailers pay a price,  $p_B$ , for mail addressed to PO Boxes that may differ from  $p_S$ , the price paid for mail sent to "street" addresses. For notational convenience, I will sometimes let  $v_B$  and  $v_S$  denote  $v(p_B)$  and  $v(p_S)$ , respectively. I assume that senders' demand results from maximization of a quasi-linear mailer utility function, so that the consumers' surplus of mailers, sS(p), is an appropriate measure of mailer net benefits. Under this assumption, S' = -v(p).

Mail receivers are also indexed a type parameter,  $t \in [0,T]$ , that reflects the intensity of their preferences to receive their mail in a secure PO Box. I assume that the characteristics (s,t) are distributed according to the strictly positive joint density function f(s,t). The quasi-linear utility function of a mail recipient of type (s,t) that subscribes to a PO Box is assumed to be given by  $U_B = y + \alpha s v_B + t$ , where, y is the amount of a composite commodity. The utility of that same recipient if he does not subscribe is assumed to be given by  $U_0 = y + \alpha_s s v_s$ . Next, let m denote the monthly subscription fee charged for a PO Box and let r denote any per piece reception fee that Box holders pay<sup>3</sup> for receiving mail. Let  $u(s,t) = U_B - y - m = t + \alpha s v_B - m$  denote the net benefits obtained as a PO Box subscriber of a mail recipient of type (s,t). Similarly, let  $u_0(s,t) = U_0 - y = \alpha_s s v_s$  denote the net benefits obtained if that same recipient receives his mail at his street address.<sup>4</sup> Then, for given value of the volume characteristic s, the

<sup>&</sup>lt;sup>3</sup> Note that r could be negative; i.e., recipients may receive a payment for each piece of mail they receive.

<sup>&</sup>lt;sup>4</sup> I have assumed that a recipient's preference for secure reception (*t*) does not affect his net benefits from receiving street addressed mail. However, it is probably not desirable to go further and normalize the utility of non PO Box holders to zero. There are two reasons for this. First, PO box subscribers and non subscribers of the same type will receive differing volumes of mail if  $p_B \neq p_S$ . Second, possession of a PO Box may affect recipient's utility from receiving an additional piece of mail; i.e.,  $\alpha \neq \alpha_S$ .

recipient whose security type  $t^*(s)$  makes him just indifferent between renting and not renting a PO Box is given by:

(1) 
$$t^*(s) = m - s[(\alpha - r)v(p_B) - \alpha_S v(p_S)].$$

Recipients of type  $t \in [0,t^*)$  prefer not to rent a PO Box, while recipients of type  $t \in (t^*,1]$  prefer to rent one.

Changes in model parameters will influence market quantities through their effects on the subscription margin,  $t^*$ . Performing standard comparative statics analysis on equation (1) yields the following intuitive results:

(2) 
$$\frac{\partial t^*}{\partial m} = 1 > 0$$

(3) 
$$\frac{\partial t^*}{\partial r} = sv(p_B) > 0$$

(4) 
$$\frac{\partial t^*}{\partial p_B} = -(\alpha - r)sv'(p_B)$$

(5) 
$$\frac{\partial t^*}{\partial p_s} = \alpha_s s v'(p_s) < 0$$

Equations (2) and (3) establish that the threshold value  $t^*$  is increasing in the monthly subscription fee and the per unit reception price. In addition, they reveal that the two partial derivatives are proportional to one another, with the factor of proportionality given by the volume of the user's PO Box addressed mail. Equations (4) and (5) derive the effects on  $t^*$  of changes in mailing rates. An increase in the price of street addressed mail has the expected effect of make PO Box subscription more attractive. However, the effect of a change in the price of PO Box addressed mail is ambiguous. This is due to the fact that a large and positive reception charge may offset the increase in utility normally associated with an increase mail volume.

# *B.* Structure of the Demand for Mail and PO Box Services.

The demand for PO Box subscriptions is determined as follows. For any volume type, *s*, a certain fraction of mail recipients will find subscription desirable: those for whom  $t > t^*(p_s, p_B, m, r; s)$ . This fraction is then summed over all volume types.

(6) 
$$B(p_{s}, p_{B}, m, r) = \int_{0}^{1} \int_{t^{*}(s)}^{T} f(s, t) dt ds$$

Similarly, the total volume of PO Box addressed mail is obtained by summing the volume of each subscriber:

(7) 
$$V(p_{s}, p_{B}, m, r) = v(p_{B}) \int_{0}^{1} \int_{t^{*}(s)}^{T} sf(s, t) dt ds \equiv v(p_{B}) Z$$

The total volume of street addressed mail is obtained by summing the volumes mailed to non subscribers.

(8) 
$$V^{S}(p_{S}, p_{B}, m, r) = v(p_{S}) \int_{0}^{1} \int_{0}^{t^{*}(s)} sf(s, t) dt ds \equiv v(p_{B}) Z^{S}.$$

Note that this formulation of the demand functions for PO Box addressed mail and street addressed mail allows for the possibility that mailers may be called upon to pay different prices to reach PO Box subscribers and non subscribers.

The following expressions appear repeatedly in the formulae for the partial derivatives of the above demand system. Therefore, it is useful to define:

(9) 
$$G \equiv \int_0^1 f(s, t^*(s)) ds > 0$$
,

(10) 
$$\mu \equiv \int_0^1 sf(s, t^*(s)) ds > 0$$

and

(11) 
$$\sigma \equiv \int_0^1 s^2 f(s, t^*(s)) ds > 0.$$

Using the results in equations (2)-(6) and the definitions for G,  $\mu$ , and  $\sigma$  above, the partial derivatives of the demand for PO Box subscriptions are as follows:

Draft of May, 2006

(14) 
$$B_m \equiv \frac{\partial B}{\partial m} = -\int_0^1 f(s, t^*(s)) ds = -G < 0$$

(15) 
$$B_r \equiv \frac{\partial B}{\partial r} = -\int_0^1 f(s, t^*) \frac{\partial t^*}{\partial r} ds = -v(p_B)\mu < 0$$

(16) 
$$B_B \equiv \frac{\partial B}{\partial p_B} = (\alpha - r)v'(p_B)\mu$$

(17) 
$$B_{S} \equiv \frac{\partial B}{\partial p_{S}} = -\int_{0}^{1} f(s,t^{*}) \frac{\partial t^{*}}{\partial p_{S}} ds = -\alpha_{S} v'(p_{S}) \mu > 0$$

Equations (14) and (15) establish the expected intuitive results that the demand for PO Box subscriptions is a decreasing function of the monthly subscription fee and the per piece reception charge. Equation (17) reveals that the demand for PO Box subscriptions increase with the price of street addressed mail. This effect operates through the participation decision. An increase in  $p_S$  lowers street addressed mail volumes. As long as there is a positive reception benefit for street addressed mail, this increases the relative attractiveness of PO Box subscription at the margin. The analogous effect in the case of an increase in the price of PO Box addressed mail is ambiguous because of the possibility that the reception fee may exceed the reception benefit.

The partial derivatives of the demand function for PO Box addressed mail are given by:

Draft of May, 2006

(18) 
$$V_m \equiv \frac{\partial V}{\partial m} = -v(p_B)\mu = B_r < 0$$

(19) 
$$V_r \equiv \frac{\partial V}{\partial r} = -v(p_B)^2 \sigma < 0$$

(20) 
$$V_B \equiv \frac{\partial V}{\partial p_B} = v'(p_B) [Z + (\alpha - r)v(p_B)\sigma]$$

(21) 
$$V_s \equiv \frac{\partial V}{\partial p_s} = -\alpha_s v(p_B) v'(p_s) \sigma > 0$$

Equation (20) establishes the result that the demand for PO Box addressed mail is a decreasing function of its own price. Equations (18) and (19) reveal the expected result that PO Box addressed mail volumes and PO Box subscriptions are complements. However, equation (21) establishes that PO Box addressed mail and street addressed mail are substitutes. Again, the substitution effect operates through the subscription decision.

The partial derivatives of the demand function for street addressed mail are given by:

(22) 
$$V_m^S \equiv \frac{\partial V^S}{\partial m} = v(p_S)\mu > 0$$

(23) 
$$V_r^s \equiv \frac{\partial V^s}{\partial r} = v(p_s)v(p_B)\sigma > 0$$

Draft of May, 2006

(24) 
$$V_B^S \equiv \frac{\partial V^S}{\partial p_B} = -(\alpha - r)v'(p_B)v(p_S)\sigma > 0$$

(25) 
$$V_S^S \equiv \frac{\partial V^S}{\partial p_S} = v'(p_S)[Z_s + \alpha_S v(p_S)\sigma] < 0$$

Equation (25) establishes that the demand for street addressed mail is a decreasing function of its own price. The other price effects all operate through the effect of price increases on the participation decision. Other things equal, increases in subscription or reception prices make PO Box subscription less attractive at the margin. Again, the possibility of a reception charge greater than the reception benefit renders the impact of an increase in the price of PO Box addressed mail ambiguous.

In summary, all of the above partial derivatives have the expected signs with the exception those involving  $p_B$ , the price of PO Box addressed mail. These effects are of indeterminate sign because of the possibility that the PO Box operator may charge its subscribers a sufficiently high reception fee, r, such that they no longer benefit at the margin from receiving additional mail. However, when r = 0, we see that  $\partial t^* / \partial p_B$  is positive and the remaining comparative statics results take the intuitively expected signs.

# C. Sender and Receiver Benefits

Total consumer benefits consist of the sum of the (net) maximized utilities of mail recipients and the consumers' surplus of mail senders. The total net utility of mail recipients includes that of both PO Box subscribers and non subscribers: i.e.,

(26) 
$$R = \int_0^1 \int_0^{t^*} u_0(s,t) f(s,t) dt ds + \int_0^1 \int_{t^*}^T u(s,t) f(s,t) dt ds$$

Mailers' consumers' surplus is given by

(27) 
$$M = S(p_S) \int_0^1 \int_0^{t^*} sf(s,t) dt ds + S(p_B) \int_0^1 \int_{t^*}^T sf(s,t) dt ds$$

For future reference, it is useful to derive the formulae for the partial derivatives of these surplus measures with respect to prices.

Differentiating the expression for the net economic benefits accruing to mail recipients with respect to x, m and r yields:

(28) 
$$\frac{\partial R}{\partial m} \equiv R_m = -\int_0^1 \int_t^T f(s,t)dtds = -B$$

(29) 
$$\frac{\partial R}{\partial r} \equiv R_r = -\int_0^1 \int_{t^*}^T v(p_B, s) f(s, t) dt ds = -V$$

Differentiating receiver net benefits with respect to mailing rates yields:

Draft of May, 2006

(30) 
$$\frac{\partial R}{\partial p_B} \equiv R_B = (\alpha - r)v'(p_B) \int_0^1 \int_t^T sf(s, t) dt ds = (\alpha - r)v'(p_B) Z$$

(31) 
$$\frac{\partial R}{\partial p_s} = R_s = \alpha_s v'(p_s) \int_0^1 \int_0^{t^*} sf(s,t) dt ds = \alpha_s v'(p_s) Z^s$$

A bit of explanation is in order. All of the expressions have been simplified using the characterization of  $t^*$  derived in equation (1). The use of this substitution makes possible the cancellation of the terms multiplying the derivatives of  $t^*$ . Not surprisingly, equations (28) and (29) reveal that a simple version of Roy's Law holds in this quasi-linear model: i.e., the derivatives of net benefits with respect to the monthly charge and per piece reception charge are equal, respectively, to the negative of subscription demand and PO Box addressed volumes.

Differentiating the expression for mailer consumers' surplus with respect to m and r yields:

(32) 
$$\frac{\partial M}{\partial m} = M_m = [S(p_S) - S(p_B)] \int_0^1 sf(s, t^*) ds = [S(p_S) - S(p_B)] \mu$$

(33) 
$$\frac{\partial M}{\partial r} = M_r = v(p_B)[S(p_S) - S(p_B)] \int_0^1 s^2 f(s, t^*) ds = v(p_B)[S(p_S) - S(p_B)] \sigma$$

Equations (32) and (33) reveal a potential externality. An increase in the subscription charge or reception fee will decrease the number of PO Box subscribers. The resulting

shift in mail volumes will *increase* the surplus of mailers if the price of street addressed mail is below that of PO Box addressed mail. Let  $x(p_S,p_B) = S(p_S) - S(p_B)$  denote the magnitude of this potential externality for mail recipients of reception type s = 1. Note that x(p,p) = 0; i.e., there is no externality when the prices of PO Box addressed and street addressed mail are equal.

Differentiating mailer surplus with respect to mail rates yields:

(34) 
$$\frac{\partial M}{\partial p_B} \equiv M_B = -(\alpha - r)v'(p_B)x(p_S, p_B)\sigma - V$$

(35) 
$$\frac{\partial M}{\partial p_s} = M_s = x(p_s, p_B)\alpha_s v'(p_s)\sigma - V^s$$

The last terms in equations (34) and (35) are, as expected, the (negative) volumes of, respectively, PO Box addressed and street addressed mail. The first term in each equation again reflects a potential externality resulting from the switch of mail volumes between differently priced PO Box addresses and street addresses.

### D. Profits of an Integrated Postal Operator

Next, I characterize the profits of a fully integrated, traditional monopoly provider of delivery and PO Box services. For simplicity, assume that the sector operates under constant costs. That is, the total cost of collecting, sorting, transporting, and delivering a

piece of street addressed mail is assumed to be  $c_S$ , whereas the total cost of collecting, sorting, transporting, and delivering a piece of PO Box addressed mail is assumed to be  $c_B$ . Assume also that the firm incurs a constant cost *b* for each PO Box provided and a cost *c* for each piece of mail accepted by the PO Box. Thus, any difference between  $c_B$ and  $c_S$  reflect differences in the *network costs* of collecting, sorting, transporting, and delivering the mail to a PO Box rather than a street address. Depending on the network configuration, it is possible (and plausible) that  $c_B$  may be greater than, less than, or equal to  $c_S$ .

The integrated postal provider may receive revenue from both mailers and mail recipients. As noted above, he may charge PO Box subscribers a monthly subscription fee m and a per piece handling fee r. Street addressed mail and mail addressed to PO Boxes are priced at  $p_S$  and  $p_B$ , respectively. The profits of the integrated postal provider are then given by:

(36) 
$$\pi^{I} = (m-b)B + (p_{B} + r - c_{B} - c)V + (p_{S} - c_{S})V^{S}$$

It is useful to also explicitly set out the partial derivatives of the postal monopolist's profits with respect to m, r,  $p_B$ , and  $p_S$ . These formulae are given by:

(37) 
$$\pi_{m}^{I} \equiv \frac{\partial \pi^{I}}{\partial m} = (m-b) B_{m} + B + (p_{B} + r - c_{B} - c) V_{m} + (p_{S} - c_{S}) V_{m}^{S}$$

Draft of May, 2006

(38) 
$$\pi_r^I = \frac{\partial \pi^I}{\partial r} = (m-b)B_r + (p_B + r - c_B - c)V_r + V + (p_S - c_S)V_r^S$$

(39) 
$$\pi_B^I = \frac{\partial \pi^I}{\partial p_B} = (m-b) B_B + (p_B + r - c_B - c) V_B + V + (p_S - c_S) V_B^S$$

(40) 
$$\pi_{S}^{I} = \frac{\partial \pi^{I}}{\partial p_{S}} = (m-b) B_{S} + (p_{B} + r - c_{B} - c) V_{S} + (p_{S} - c_{S}) V_{S}^{S} + V^{S}$$

Next, I set forth the pricing conditions for total surplus maximization in this model. Total surplus is given by the sum of the surplus of the integrated postal provider plus the surplus of mailers and mail recipients: i.e.,

$$W = \pi^{I} + R + M .$$

Differentiating with respect to r, m,  $p_B$ , and  $p_S$  yields the following First Order Necessary Conditions:

$$W_m \equiv \frac{\partial W}{\partial m} = \pi_m^I + R_m + M_m = 0$$
$$W_r \equiv \frac{\partial W}{\partial r} = \pi_r^I + R_r + M_r = 0$$
$$W_B \equiv \frac{\partial W}{\partial p_B} = \pi_B^I + R_B + M_B = 0$$
$$W_S \equiv \frac{\partial W}{\partial p_S} = \pi_S^I + R_S + M_S = 0$$

Draft of May, 2006

Upon substitution and simplification, these become:

(42) 
$$W_m = (m-b)B_m + (p_B + r - c_B - c)V_m + (p_S - c_S)V_m^S + M_m = 0$$

(43) 
$$W_r = (m-b)B_r + (p_B + r - c_B - c)V_r + (p_S - c_S)V_r^S + M_r = 0$$

(44) 
$$W_B = (m-b)B_B + (p_B + r - c_B - c)V_B + (p_S - c_S)V_B^S + R_B + X_B = 0$$

and

(45) 
$$W_{S} = (m-b)B_{S} + (p_{B} + r - c_{B} - c)V_{S} + (p_{S} - c_{S})V_{S}^{S} + R_{S} + X_{S} = 0$$

Next, I exploit the special structure of the heterogeneity of sender demand to simplify this system. Using the definitions in equations (9)-(11), equations (42)-(45) become:

(46) 
$$G(m-b) - \mu[(p_S - c_S)v(p_S) - (p_B + r - c_B - c)v(p_B) + x] = 0$$

(47) 
$$\mu(m-b) - \sigma[(p_s - c_s)v(p_s) - (p_B + r - c_B - c)v(p_B) + x] = 0$$

$$(48) \mu(\alpha - r)(m - b) - (\alpha - r)\sigma[(p_s - c_s)v_s - (p_B + r - c_B - c)v_B + x] - (p_B + \alpha - c_B - c) = 0$$

$$(49)\,\mu(\alpha_{s}-r)(m-b) - \alpha_{s}\sigma[(p_{s}-c_{s})v_{s} - (p_{B}+r-c_{B}-c)v_{B}+x] - (p_{s}+\alpha_{s}-c_{s}) = 0$$

Now, substituting equation (47) into equations (48) and (49) yields the following optimal pricing results for mail services:

$$(50) \qquad P_B^* = c_B + c - \alpha$$

 $(51) \qquad P_s^* = c_s - \alpha_s$ 

Equations (50) and (51) establish:

<u>Proposition 1</u>: The optimal mailing rates for both PO Box addressed and street addressed mail are equal to their respective end-to-end marginal costs *less* the associated reception benefit.

Substituting these results into equations (46) and (47) yields a simplified equation that can be used to determine optimal PO Box charges:

(52) 
$$\mu[(\alpha - r)v(p_B) - \alpha_S v(p_S) + x] - G(m - b) = 0$$

(53) 
$$\sigma[(\alpha - r)v(p_B) - \alpha_S v(p_S) + x] - \mu(m - b) = 0$$

Solving this reduced system, I obtain a "cost based" structure of PO Box charges:

$$(54) \qquad m^* = b$$

(55) 
$$r^* = \alpha - \alpha_s \frac{\nu(c_s - \alpha_s)}{\nu(c_B + c - \alpha)} + \frac{x}{\nu(c_B + c - \alpha)}$$

I find a determinate solution for both prices on the receiver side of the market because of the heterogeneity of mail recipients.<sup>5</sup> These results are summarized by the following propositions.

<u>Proposition 2</u>: The optimal PO Box fixed subscription charge is set equal to the per subscriber fixed cost of operating and maintaining it.

#### Proposition 3:

Since both types of mail are optimally priced below cost, it is interesting see whether or not the integrated postal operator covers its costs at the 1<sup>st</sup> best prices. (Recall that I have assumed that the sector operates under constant returns to scale, so there are not any overhead or institutional costs that must be recovered.) Rewriting equation (36) using equations (54) and (55), one obtains:

$$\pi^{I^*} = (m^* - b)B + (p_B^* + r^* - c_B - c)\nu(p_B^*)Z + (p_S^* - c_S)Z^S$$

Substituting in the optimal mail pricing conditions from equations (50) and (51) yields:

(56) 
$$\pi^{I^*} = x(c_s - \alpha_s, c_B - \alpha + c)Z - \alpha_s(Z + Z^s)$$

<sup>&</sup>lt;sup>5</sup> See Armstrong and Vickers (2001) and Rochet and Stole (2002) for similar results.

Depending on parameter values, the profit level in equation (56) may be positive, negative, or zero. However, it is easy to see that 1<sup>st</sup> best profits must be zero when (i) there are no net costs associated PO Box delivery ( $c_S = c_B + c$ ) and (ii) the reception benefits are equal ( $\alpha = \alpha_S$ ). In that case, x = 0 and  $\pi^{I^*} = -\alpha_S(Z+Z^S) \le 0$ .

While not uncommon in 2-sided market models, it is somewhat disturbing that 1<sup>st</sup> best prices may involve losses, even under constant returns to scale. Because I am ultimately interested in deriving pricing rules that can be applied to competitive PO Box and/or postal services markets, it is desirable to limit such "2<sup>nd</sup> Best" problems as much as possible. Therefore, from now on, I will also assume that only the PO Box market is 2-sided in the usual sense. That is, I assume that there are no reception externalities for recipients that do not purchase PO Box services: i.e.,  $\alpha_S = 0$ .

# III.Pricing by "PO Box specialists"

In this section, I analyze the pricing policies of a PO Box monopolist. First, it is necessary to specify a mechanism for the delivery firms to "pass through" such access charges to mailers. That is, it is necessary to define functions  $p_S(a)$  and  $p_B(a)$  that relate how the prices paid by mailers for street addressed and PO Box addressed mail are affected by the per unit access charge, *a*, set by the PO Box monopolist.

Two approaches suggest themselves for modeling this pass through effect. The relative realism of the two depends upon market circumstances. First, suppose that delivery firms are able to charge mailers a different rate for PO Box addressed mail, passing through the higher costs directly to mailers. In that case, the stamp price for street addressed mail remains unaffected by the access charge, while the price of PO Box addressed mail increases penny for penny: i.e.,  $p_B = p_S + a$ . This assumption seems reasonable in the context of a highly competitive postal delivery market in which mailer transactions costs are low. The second approach assumes that it is too costly for delivery firms to charge different rates for street addressed and PO Box addressed mail. Rather, the access charges levied by the PO Box monopolist are spread over all mail on an averaged basis: i.e.,  $p_B = p_S = p(a)$ , with  $p'(a) \in (0,1)$ . This assumption seems appropriate when delivery is provided by a franchised monopolist whose prices are determined on a "cost plus" basis. The focus of my analysis is on the impact of PO Box access pricing policies on competition in postal services. Therefore, I shall usually assume that delivery operators "pass through" any access charges they may face to mailers, so that the price of street addressed mail is unaffected. That is,  $p_B = p_S + a$ ,  $p_S'(a) = 0$ , and  $p_B'(a) = 1$ .

Making use of the dependency of mailing rates on the PO Box access fee charged to mailers allows me to write the profits of a PO Box monopolist as:

(57)  $\pi^{B}(m,r,a) = (m-b)B(m,r,p_{B}(a)) + (a+r-c)V$ .

Equation (57) reflects the fact that the number of PO Box subscribers does not depend upon  $p_S$  when there are no reception externalities for street addressed mail.<sup>6</sup> The partial derivatives of PO Box monopoly profits are given by:

(58) 
$$\pi_m^B \equiv \frac{\partial \pi^B}{\partial m} = (m-b)B_m + B + (a+r-c)V_m$$

(59) 
$$\pi_r^B \equiv \frac{\partial \pi^B}{\partial r} = (m-b)B_r + (a+r-c)V_r + V$$

(60) 
$$\pi_a^B = \frac{\partial \pi^B}{\partial a} = (m-b)B_B + (a+r-c)V_B + V$$

I begin by considering the case in which the PO Box monopolist faces competitive providers of postal delivery services for PO Box and street addressed mail, so that  $p_S = c_S$  and  $p_B = c_B + a$ . In addition, I assume that the PO Box monopolist sets rates to maximize total surplus. Since the postal delivery markets are assumed to be competitive, total surplus is given by:

$$(61) W = \pi^B + R + M$$

<sup>6</sup> Because, in that case,  $\alpha_s$ ,  $\partial t^* / \partial p_s$ , and  $B_s$  are all equal to zero.

The FONCs for an optimum with respect to *r* and *m* are:

(62) 
$$W_m = \pi_m^B + R_m + M_m = -(m-b)G - (a+r-c)v_B\mu + x\mu = 0$$

(63) 
$$W_r = \pi_r^B + R_r + M_r = -(m-b)v_B\mu - (a+r-c)v_B^2\sigma + xv_B\sigma = 0$$

The FONC for an optimum with respect to the access charge is given by

(64) 
$$W_B = \pi_B^B + R_B + M_B = v'_B \{ (\alpha - r) [(m - b)\mu + (a + r - c)v_B\sigma - x\sigma] + (a + \alpha - c)Z \} = 0$$

After solving equation (63) for x and substituting, this reduces to a simple formula for the optimal access for mail addressed to PO Boxes:

$$(65) a = c - \alpha \,.$$

Substituting this into (62) and (63) yields m = b and  $r = \alpha + x/v_B$ . Under the assumption that the postal delivery markets are competitive, the equilibrium price paid by the sender for delivery to a PO Box is given by

$$(66) p_B = c_B + a = c_B + c - \alpha$$

Equation (66) reveals that a surplus maximizing PO Box monopolist can, through suitable choice of access charge, achieve the same outcome as a surplus maximizing integrated postal and PO Box provider. However, binding non negativity constraints may

break this equivalence. Let me explain. I have not imposed non negativity constraints thus far in the analysis. As mentioned earlier, it is not unreasonable, in general, for *r* to be negative. While it does not make sense for mail rates to be negative, I merely assumed that the FONCs resulted in strictly positive prices. In the current disintegrated model: (i) access price must be constrained to be non negative in order to prevent arbitrage; and (ii) plausible parameter values might lead to a negative solution to equation (65). Therefore, the results in equation (48) must be restated as follows:

(67) 
$$a^{**} = \max\{0, c - \alpha\}.$$

Equation (67) establishes the benchmark welfare maximizing access pricing result:

<u>Proposition 3</u>: The welfare-maximizing PO Box access price is equal to the marginal cost of receiving mail at the PO Box less the per piece reception externality if that difference is non negative. If the reception externality is greater than the per piece handling charge, the optimal PO Box access fee is zero.

Equation (49) must be similarly rewritten to take into account the possibility of an optimal zero access price: i.e.,

(68) 
$$p_B^{**} = c_B + a^{**} = \max\{c_B, c_B + c - \alpha\}$$

Equation (68) establishes the following (partial) equivalence result:

<u>Proposition 4</u>: When the optimal access price is strictly positive, the resulting equilibrium competitive price for PO Box addressed mail is equal to the welfare optimal price. However, when the optimal access price is zero, the equilibrium competitive price for PO Box addressed mail is equal to marginal postal costs, which may be greater than the welfare maximizing price.

Thus, in cases in which the reception benefit,  $\alpha$ , exceeds the marginal cost of PO Box reception, *c*, the optimal access charge would be zero and the resulting postal price would be  $c_B$ . For the same parameter values, the planner in the integrated situation would do better by setting a PO Box mail rate such that  $0 < p_B = c_B + c - \alpha < c_B$ .

What about the profits of a surplus maximizing PO Box monopolist? Examining equations (54) and (55) reveals that, at the values of m and r consistent with surplus maximization, firm profits are always exactly equal to xZ, the difference in mailer surplus from sending items to PO Box subscribers and non subscribers. Substituting in the optimal value of a and the resulting mail rates into equation (57), we have

(69) 
$$\pi^{B^{**}} = \max \{ x(c_s, c_B + c - \alpha) v(c_B + c - \alpha), x(c_s, c_B) v(c_B) \}$$

Equation (69) reflects the possibility that the non negativity constraint on the access charge may be binding. For example, when  $c_B = c_S$ , profits at the optimum are positive if *c* is greater than  $\alpha$ , but zero if *c* is less than  $\alpha$ . In general, profits at the optimum can be either positive or negative.

Since the profits of a welfare maximizing PO Box specialist need not be zero, it is interesting to examine the behaviour of a "perfectly competitive" PO Box sector. Following Armstrong and Vickers (2001), I assume that, at equilibrium, firms act "as if" they were maximizing the surplus of each type of customer subject to a break even constraint. That is, assume that the representative firm chooses m, r, and a to maximize  $(\alpha - r)sv(p_B(a)) - m$  subject to  $(m - b) + (a + r - \alpha)sv(p_B(a)) = 0$ . Upon solving the constraint for m and substituting, it turns out that s, r and m drop out, so that one is left with a single variable, unconstrained maximization problem that characterizes the utility maximizing competitive access price offered to all receiver types: i.e.,

(70) 
$$a^{c} = \arg\max\left\{(a+\alpha-c)v(a+c_{B})\right\} \Longrightarrow a^{c} = c-\alpha - \frac{v(c_{B}+a^{c})}{v'(c_{B}+a^{c})} > c-\alpha.$$

This expression can be rearranged into a more intuitive form by defining letting  $\varepsilon$  denote the price elasticity of sender demand evaluated at the competitive price for PO Box addressed mail,  $p_B^{\ c} = c_B + a^c$ . Then equation (70) can be rewritten as

(71) 
$$a^{c} = \frac{\varepsilon(c-\alpha)}{(\varepsilon-1)} > c - \alpha$$

To obtain the associated values of the competitive charges to PO Box subscribers, note that least costly way to achieve any level of subscriber net utility involves a "cost

based" nonlinear tariff, <sup>7</sup> so that  $m^c = b$ . Then, the zero profit condition can be solved to obtain  $r^c = (\alpha \varepsilon - c)/(1 - \varepsilon)$ .

It is easily shown that a profit maximizing PO Box monopolist would set the same access price. Substituting the definitions from equations (9)-(11) into equations (58)-(60), yields

(72) 
$$(m-b)G + (a+r-c)v_B\mu = B$$

(73) 
$$(m-b)\mu + (a+r-c)v_B\sigma = Z$$

(74) 
$$(\alpha - r)v'_{B}[(m-b)\mu + (a+r-c)v_{B}\sigma] = Z[(a+r-c)v'_{B}+v_{B}].$$

Inserting equation (73) into equation (74) yields the result in equation (70), so that  $a^m = a^c$ . This establishes:

<u>Proposition 5</u>: Profit maximizing PO Box firms charge the same access price under monopoly and perfect competition. The effect of competition is to lower the fees paid by PO Box subscribers.

Again, this result is familiar from the 2-sided market literature. As in the case of fixed-to-mobile termination charges, a "competitive bottleneck" results: firms charge

<sup>&</sup>lt;sup>7</sup> See Armstrong and Vickers (2001) and Rochet and Stole (2002) for similar results.

mailers a monopoly rate and compete away the profits by offering low prices to PO Box customers.<sup>8</sup>

# IV. Suggestions for Further Research: Regulatory Scenarios

Consider the situation of an incumbent post offering integrated postal and PO services at regulated postal rates. Assume that, because of Universal Service requirements, there is no rate differential between street addressed mail and mail destined for PO Boxes. Assume that the PO Box operation yields exactly zero profits. For concreteness and simplicity, I impose this latter condition by assuming that m = b and  $r = c_B + c - c_S$ .

Now suppose that a competitive fringe supplying postal delivery services enters, the market, but that the PO Box market remains monopolized. Assume that the Postal Regulatory Commission decrees that competitors must be granted access to the incumbent's PO Box addresses. How the PRC determine the appropriate access rate? Obviously, the answer to this question depends on the extent of the market adjustments envisioned by the PRC.

<sup>8</sup> See Armstrong and Wright (2004).

<u>Scenario 1</u>: The PRC is content with the established mail and PO Box rates. Therefore, it attempts to establish the surplus maximizing *a*, taking the other rates as fixed.

<u>Scenario 2</u>: The PRC keeps the mail rates fixed, but declares PO Boxes a "non core service" and allows the post to set profit maximizing *m* and *r*, *given p* and *a*.

Scenario 3: The PRC keeps mail rates fixed, but seeks to set *m* and *r* in addition to *a*.

<u>Scenario 4</u>: The PRC declares a general rate investigation in order to set the optimal mail and PO Box rates as well as *a*.

# V. Conclusion

My analysis has revealed that the market for PO Boxes is exhibits many of the now classic characteristics of 2-sided markets. This means that care must be taken before applying the standards of traditional competition policy when evaluating the pricing of access to this essential facility.<sup>9</sup> In particular, an access price well in excess of the marginal cost of access does not constitute *prime facie* evidence of either "abuse of dominance," or an attempt at "leveraging monopoly power." Nor does it necessarily signal a lack of competition in the PO Box market itself.

<sup>&</sup>lt;sup>9</sup> For a discussion of the necessary caveats, see Wright (2004)

#### References

Armstrong, M. (2004) "Competition in Two-Sided Markets," mimeo, University College, London.

Armstrong, M. and Vickers, J. (2001): "Competitive Price Discrimination," *Rand Journal of Economics*, 32(4), 579–605.

Armstrong, M. and J. Wright (2004) "Two-Sided Markets, Competitive Bottlenecks and Exclusive Contracts," mimeo, University College, London, and National University of Singapore.

de Bijl, P, van Damme, E. and Larouche, P. (2006) "Regulating Access to Stimulate Competition in Postal Markets?" In: *Progress Toward Liberalization of the Postal and Delivery Sector*, edited by M. A. Crew and Paul. R. Kleindorfer, New York, Springer.

Crew, M. and Kleindorfer, P. (2002) "Balancing Access and the Universal Service Obligation." In In: *Postal and Delivery Services: Delivering on Competition*, edited by M. A. Crew and Paul. R. Kleindorfer, Boston, Kluwer.

Panzar, J. C. (2002) "Reconciling Competition, Downstream Access, and Universal Service in Postal Markets." In: *Postal and Delivery Services: Delivering on Competition*, edited by M. A. Crew and Paul. R. Kleindorfer, Boston, Kluwer.

Rochet, J., and J. Tirole (2004) "Two-Sided Markets: An Overview," mimeo, IDEI University of Toulouse.

Roson, R. (2005) "Two-Sided Markets: A Tentative Survey," *Review of Network Economics* Vol.4, Issue 2 – June 2005.

Wright, J. (2004) "One-sided Logic in Two-sided Markets," *Review of Network Economics* Vol.3, Issue 1 – March 2004.