Combining Liberalization and Unbundling Policies in Postal Markets*

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Abstract

The introduction of competition into postal markets has taken various forms. In the United States this has been through work-sharing, with little liberalization of entry. Elsewhere, liberalization proceeded with little emphasis on unbundling or work-sharing. In this paper, I develop a simple model that demonstrates that liberalization and unbundling are interrelated in important ways. I introduce the notion of piecemeal bypass, which allows competitors at different levels of the postal value chain to combine to provide an end-to-end alternative. My analysis reveals that unbundling and piecemeal bypass poses greater problems than liberalization for the pursuit of policy objectives such as Universal Service.

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Introduction

The introduction of competition into postal markets has taken many forms. On a value added basis, the United States has had more competition, for a longer time, than any other nation despite the continuing presence of letter and postal box monopolies. This is because competition has been introduced almost entirely through the offering of work-sharing discounts.\(^1\) New Zealand and Sweden have fully liberalized their postal markets with little emphasis on unbundling or work-sharing. The United Kingdom is proceeding with both elimination of the monopoly and the introduction of downstream access.\(^2\)

My purpose in this paper is to develop a simple economic model that demonstrates that liberalization and unbundling are interrelated in interesting and important ways. The model allows for three types of competitors, providing upstream, downstream, and end-to-end services. I study a postal authority whose objective is to minimize the uniform price paid for end-to-end service subject to the constraint that the incumbent postal provider break-even. I find, not surprisingly, that the liberalization of end-to-end services is always inimical to the pursuit of that goal. More interestingly, I find that both upstream and downstream competition make it possible to lower the uniform price as long as \textit{piecemeal bypass} is not allowed. In previous literature, Panzar

\(^1\) See Cohen, et. al. (2002)

(1993) first explained the relationship between work-sharing and access in the postal context. Sherman (2001) presented a formal analysis of work-sharing discounts. Billete de Villemeur et. al. (2003a) presented the model of mailers work-sharing decisions utilized here and developed Ramsey pricing results. However they did not model the bypass issues analyzed here.

A Theoretical Framework: Costs and Supply

The incumbent post is assumed to serve a high cost area and a low cost area at the uniform stamp price \( p \). The incumbent incurs delivery costs of \( F_H + c_H V_H \) in the high cost area, where \( F_H \) and \( c_H \), respectively, denote the fixed and marginal costs of delivery in the high cost area and \( V_H \) is the volume of mail delivered by the incumbent in the high cost area. Similarly, delivery costs in the low cost area are given by \( F_L + c_L V_L \). In addition, the incumbent incurs “upstream” costs of \( F_U + t V_U \). Here, \( F_U \) and \( t \) respectively, denote the fixed and marginal costs incurred upstream and \( V_U \) are the volumes processed by the incumbent at its upstream facilities. Finally, the incumbent may incur network fixed costs of \( F_N \). It is useful to define \( F = F_N + F_U + F_H + F_L \).

There are, potentially, two types of fringe competitors. The first group of fringe firms provide downstream delivery bypass services in the low cost area according to the upward sloping supply schedule \( \lambda A(a) \), where \( a \) is the downstream access rate set by the postal regulatory authority and \( \lambda [0, 1] \) is a delivery access liberalization policy variable. This policy variable denotes the extent of competitive downstream access permitted: i.e., the proportion of potential supply allowed to enter the market. For
example, an “either, or” interpretation of access entry policy would result in $A \{0, 1\}$.

The second group of competitors provides end-to-end service for mail addressed to the low cost area according to the upward sloping supply schedule $S(p)$, where, again, $[0,1]$ is a liberalization policy variable.

**The Demand Model**

Mailers are faced with two service options. The first is traditional end-to-end service purchased from either the incumbent or competitors. The second option is a work-sharing arrangement in which mailers presort their letters before presenting them for delivery. The (constant) unit cost (to the mailers) of self-sorting the letters is $s$ for mailers of type $s \in [0, \bar{s}]$.\(^3\) Let $p$ be the rate that the incumbent post charges for end-to-end services and $p- \bar{s}$ be the work-sharing discount offered by the incumbent post for mailers to presort the letters. For mailers of type $s$, the total mailing cost per piece is $p$ if mailers do not presort the letters (end-to-end service), and $p- \bar{s}$ if mailers self-sort the letters. For any given work-sharing discount, mailers of type $s \in (0, \bar{s}]$ would strictly prefer end-to-end services, and mailers of type $s \in [0, \bar{s})$ would strictly prefer work-sharing arrangement. The demand for letter service of all mailers with a self-sorting cost of $s$ is defined to be

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\(^3\) Individual mailers can be viewed as having very high work-share costs. I do not explicitly model them, except to assume that their preferences are quasi-linear. This ensures that their demand curve is downward sloping and that Hotelling’s Lemma applies to their indirect utility functions.
The first argument of the demand measure, “price”, is the optimal (or minimum) total mailing cost per piece faced by mailers of that type. That is, \( D(p, s) = \min\{p, p-+s\} \). For simplicity, I assume that the proportion, \( s \), of mail addressed to the high cost region is the same for all mailer types. The demand measure is assumed to be twice continuously differentiable, with \( D < 0 \).

In the absence of any work-sharing discount (\( \delta = 0 \)), all mailers prefer the end-to-end service over the work-sharing arrangement and the total market demand for the end-to-end service is given by

\[
X(p, 0) = \int_0^s D(p, s) ds.
\]

(Here, the zero argument reflects the fact that no discount is offered for work-sharing.)

Now suppose that a discount of \( \delta > 0 \) is offered to mailers that presort their letters before presenting them for delivery. There are now \textit{two} demand functions to consider. The first is for unsorted mail to be sorted and delivered. This demand function is now given by

\[
X(p, \delta) = \int_0^s D(p, s) ds.
\]

In words, the demand for end-to-end, undiscounted mail service is the total demand of all mailers whose cost of self-sortation \( s \) is greater than or equal to the discount \( \delta \). Such mailers will not find work-sharing advantageous, and will continue to offer their unsorted

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\(^4\) Thus the demand measure includes the measure of mailer types: i.e., \( D(s) = d(s)f(s) \), where \( d(s) \) is the demand of an individual mailer of type \( s \) and \( f(s) \) is the measure of mailers of that type.
mail to the incumbent or its end-to-end competitors. As one would expect, a decrease in the full service price \( p \) will increase the quantity of service demanded:

\[
X_p(p, \delta) = \int_{\delta}^{\delta'} D_p(p, s) ds < 0.
\]

Less obviously, but intuitively, an increase in the presort discount will decrease the demand for the undiscounted service:

\[
X_{\delta}(p, \delta) = -D(p, \delta) < 0.
\]

Those mailers who, because of the nature of their business, can sort their outgoing mail rather economically will choose to take advantage of this discounted service. The demand for discounted service from these customers is given by

\[
W(p, \delta) = \int_0^\delta D(p - \delta + s, s) ds
\]

Here, it is important to note two effects of the size of the discount on the demand for discounted service. First, a larger discount increases the number of mailers who find it profitable to presort their mail. Second, a greater discount also stimulates the demand of

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5 To simplify the exposition, I do not distinguish between customers who actually presort their mail themselves and those who hire outside consolidators to presort it for them. As long as the consolidation market is competitive there is no need to model it explicitly. Presumably, the same characteristics of a customer's mail stream which make it relatively cheap to presort its mail itself, for example, a large volume of computer addressed envelopes, would also make it relatively inexpensive to contract out its presorting tasks. It is these intrinsic features that differ across mailers that the customer specific variable \( s \) is designed to capture.
all those mailers already utilizing the discount. Together, these two effects give rise to the following result:

\[(6) \quad W_\delta (p, \delta) = -\int_0^\delta D_\rho (p - \delta + s, s)ds + D(p, \delta) > 0.\]

Of course, an increase in the stamp price will also decrease the demand for presorted service:

\[(7) \quad W_p (p, \delta) = \int_0^\delta D_\rho (p - \delta + s, s)ds < 0.\]

Putting these facts together yields the following important result relating the demand for the discounted and undiscounted services:

**Proposition 1.** The marginal effect of an increase in the discount on total demand is equal to the marginal effect of a stamp price decrease on work-sharing demand.

**Proof:** Adding equations (4) and (6), and using equation (5) yields

\[W_\delta + X_\delta = -\int_0^\delta D_\rho (p - \delta + s, s)ds = -W_p > 0.\] Q.E.D

Another important characteristic of this demand structure is summarized in the following result:

**Proposition 2.** Discounts stimulate aggregate demand.

**Proof:** Subtract the initial volume of mail at any full service price from the total of the presorted and end-to-end mail offered at that price in conjunction with the discount. That is, the discount stimulation \( T \) is given by
\[ T(p, \delta) = X(p, \delta) + W(p, \delta) - X(p, 0) \]

From (5), \( T(p, 0) = W(p, 0) = 0 \). From Proposition 1,

\[ T_\delta \equiv \frac{\partial T(p, \delta)}{\partial \delta} = W_\delta + X_\delta = -W_p > 0. \]

Therefore, \( T(p, \delta) > 0 \Rightarrow 0 \) and \( T(p, \delta) \) as . That is, discounts stimulate aggregate demand. Q.E.D

Intuitively, this stimulating effect of the discount arises from the fact that mailers taking advantage of the discount face a lower net effective price for mail service (though mailers of type \( s = \), the marginal pre-sorters, are indifferent). As long as mail demand is downward-sloping in price, total mail volumes must increase.

**Profits and Welfare**

With the demand structure specified, it is now possible to define expressions for the incumbent’s economic profits as well as social surplus. By construction, incumbent costs are given by

\[ C = F + tV_U + c_LV_L + c_HV_H + a\lambda A. \]

Here, \( a \lambda A \) is the amount spent on access services purchased from competitive downstream providers. When work-sharing discounts are offered and there is end-to-end bypass, the incumbent’s upstream volumes are just the total demand for traditional mail less the supply of the end-to-end bypass fringe. That is,

\[ V_U = X(p, \delta) - S(p). \]
The volumes delivered by the incumbent to the low cost region consist of the traditional and work-shared volumes addressed there less the volumes delivered by end-to-end and delivery competitors. That is,

\[ V_L = (1 - \lambda)(X(p, \delta) + W(p, \delta)) - S(p) - A\lambda A(a). \]

The volumes delivered by the incumbent in the high cost region consist of all of the traditional and work-shared volumes addressed there since there are assumed to be no competitors operating in the high cost region. That is,

\[ V_H = [X(p, \delta) + W(p, \delta)]. \]

Recognizing the possibilities for work-sharing discounts and end-to-end bypass, the incumbent’s revenues are given by:

\[ R = p[X(p, \delta) - S(p)] + (p - t)W(p, \delta). \]

Combining all of the above yields the equation for incumbent profits:

\[ \pi = (p - t - c_L)(X - \lambda S + W) + (t - \delta)W - \alpha(c_H - c_L)(X + W) - (a - c_L)\lambda A - F. \]

The following partial derivatives will also play important roles in the analysis:

\[ \pi_a = -\lambda A(a) - (a - c_L)\lambda A'(a) \]

\[ \pi_{\delta} = (p - t - c_L)(X_{\delta} + W_{\delta}) + (t - \delta)W_{\delta} - \alpha(c_H - c_L)(X_{\delta} + W_{\delta}) - W \]

\[ \pi_p = (p - t - c_L)(X_p - \lambda S' + W_p) + (t - \delta)W_p - \alpha(c_H - c_L)(X_p + W_p) + (X + W - \lambda S). \]
Social surplus in this model is just the sum of incumbent profits, bypass fringe profits, and mailers’ net benefits. Let the net benefits (consumers’ surplus) accruing to mailers of cost characteristic $s$ be defined as $B(\ , \ s)$, with $p = p + s$ for presort mailers, and $p = p$ for non-presort mailers. Because the focus of the analysis is on business mailers, the relevant measure of consumer benefits is mailers’ economic profits.

Applying Hotelling’s Lemma yields $B(\ , \ s) = D(\ , \ s)$.

The social surplus can be expressed as:

\[
Z(p, \delta, a) = \pi(p, \delta, a; \lambda, \lambda_A) + \int_0^\delta B(p - \delta + s, s)ds + \int_0^\delta B(p, s)ds + \lambda \Pi(p) + \lambda_A \pi_A(a),
\]

where $\lambda \Pi(p)$ is the total profits of end-to-end bypass fringe, and $\lambda_A \pi_A(a)$ is the total profits of the downstream delivery bypass fringe.

**Ramsey Analysis In the Absence of Piecemeal Bypass**

Note that mailers, in the absence of piecemeal bypass, are faced with two options: present presorted mails to the incumbent for delivery at a discounted price of $(p - \cdot)$, or present the unsorted mails to the incumbent for delivery at full price of $p$. Recall that delivery and end-to-end bypass fringes are present in the low cost area (but not in the high cost area). The incumbent may choose to deliver the mail itself or contract the delivery out to the downstream delivery bypass fringe in the low cost area. The

\[\text{This just says that the decrease in a business’s maximized profits of a small increase in the net price it faces for postal service is just equal to the volume of mail it produces.}\]
presorting mailers in the low cost areas, however, do not have the option to hand their
presorted mails directly to the delivery bypass fringe. That is, in the absence of
piecemeal bypass, the incumbent is acting as a monopoly for presorting mailers and it is
also acting as a monopsony for the downstream delivery bypass fringe.

Next, I conduct a standard Ramsey analysis. That is, the social surplus $Z$ is
maximized with respect to the policy parameters $p$, $\delta$, and $a$ subject to the constraint that
the incumbent at least break-even. The LaGrangian expression is:

\begin{equation}
L = Z(p, \delta, a) + \gamma \pi(p, \delta, a; \lambda, \lambda_a)
\end{equation}

In addition to the break-even constraint, the First Order Necessary Conditions (FONCs)
for an optimum involving positive price and access charge include the following
conditions:

\begin{align}
L_p &= (1 + \gamma)\pi_p - (W + X - \lambda S) = 0, \\
L_a &= (1 + \gamma)\pi_a + \lambda A = 0.
\end{align}

The condition characterizing the optimal nonnegative work-sharing discount is

\begin{equation}
L_\delta = (1 + \gamma)\pi_\delta + W \leq 0; \ \delta \geq 0; \ \delta L_\delta = 0.
\end{equation}

Upon substitution and rearrangement, equation (20) yields the following Ramsey-
style result:
\[
(22) \quad \frac{a - c_L}{a} = \frac{-\gamma}{(1 + \gamma)\eta_A} \equiv -\frac{\kappa}{\eta_A} \leq 0,
\]

where \( aA \ (a)/A(a) > 0 \) is the supply elasticity of the downstream delivery bypass fringe with respect to the delivery access rate, and \( \frac{1}{(1 + \gamma)} \ (0, 1) \) is sometimes referred to as the problem’s Ramsey number.

This establishes:

**Proposition 3:** The optimal access fee set by the postal regulatory authority is less than or equal to the incumbent’s marginal delivery cost in the low cost area. The inequality is strict unless the fringe supply is perfectly elastic.\(^7\)

That is, if the delivery fringe supply is not perfectly elastic, a social optimum with a binding break-even constraint requires the exclusion from the downstream delivery market of ‘efficient’ delivery fringe supply: \( A(c_L) \ aA(a) > 0 \) (as \( a < c_L \)). This result may seem surprising at first, as it involves a “distortion.” However, as demonstrated below, this distortion is due to the postal regulatory authority’s need to allow the incumbent to break-even.

\(^7\) Note also that if the break-even constraint is not binding the at the Ramsey optimum, the LaGrangian multiplier and the Ramsey Number \( \frac{1}{(1 + \gamma)} \) would be equal to zero. In this case, the Ramsey optimal access rate, \( a \), is equal to \( c_L \). However, as shown later, the incumbent’s profits are non-positive at the social optimum without break-even constraint. Thus, the break-even constraint must be binding and the Ramsey Number, \( \kappa \), must be positive at the Ramsey optimum.
The FONCs can also be used to demonstrate that it is always optimal to introduce a work-sharing discount.

**Proposition 4:** The optimum requires a positive work-sharing discount \( \lambda^* > 0 \).

**Proof.** From equations (15) and (21):

\[
L_\delta = (1+\gamma)[(p-t-c_L)(X_\delta + W_\delta) + (t-\delta)W_\delta - \alpha(c_H - c_L)(X_\delta + W_\delta) - \kappa W(p, \delta)],
\]

From (4), (5) and (6), \( (X + W)^0 = (W)^0 = 0 \), and \((W)^0 = D(p, 0) > 0 \).

Thus, \( (L_\delta)^{\delta=0} = t(1+\gamma)D(p, 0) > 0 \). Therefore, there must be a positive work-share discount at the optimum. Q.E.D

Next, I examine the relationship between the optimal work-sharing discount \( \lambda^* \) and the incumbent’s upstream unit cost saving \( (t) \). Using (15)-(16), rearrangement of terms in equation (19) and the equality version of equation (21) yield the following more intuitive pair of conditions:

\[
(p-t-c_L)(X_p - \lambda S' + W_p) + (t-\delta)W_p = \alpha(c_H - c_L)(X_p + W_p) - \kappa(X + W - \lambda S), \tag{23}
\]

\[
(p-t-c_L)(X_\delta + W_\delta) + (t-\delta)W_\delta = \alpha(c_H - c_L)(X_\delta + W_\delta) + \kappa W, \tag{24}
\]

These equations involve total postal volumes \((X + W - S)\), work-share volumes \((W)\) and their respective partial derivatives with respect to the stamp price \((p)\) and work-sharing discount \( \lambda^* \). This system can be readily solved for the qualitative policy variables of interest.
Rearranging (24) and using (25) yields

$$\begin{align*}
(27) \quad (p - t - c_L) = \frac{\kappa W - (p - t - c_L) X_\delta + \alpha (c_H - c_L) (X_\delta + W_\delta)}{W_\delta} > 0;
\end{align*}$$

From (22), \( a < c_L \). Thus (25) and (27) also imply

$$\begin{align*}
(28) \quad (p - t - a) > 0, \text{ and } (p - t - a) > 0.
\end{align*}$$

In words, the results in (25), (27) and (28) state that the optimal stamp price, work-sharing discount and delivery access rate are such that the incumbent is able to make profits at the margin on work-shared mails and non-work-shared mails in the low cost area, whether it delivers the mails itself at a marginal cost of \( c_L \), or contracts out the delivery at a cost of \( a \) per piece.

The sign of equation (26) is indeterminate, even without the complication of the high cost delivery area (i.e., even when \( c_H = 0 \)). It is not hard to understand the reason for this indeterminacy. The introduction of a presort discount is analogous to the introduction of a new product. Setting the discount equal to the incumbent’s cost savings is equivalent to setting equal mark-ups for both services’ use of the delivery function. In
a Ramsey analysis, relative mark-ups depend on demand elasticities, and are not generally equal. This aspect can be seen more clearly if the above expression is rearranged slightly:

\[ t - \delta = \frac{\kappa W (X - \lambda S) \left( \epsilon_p^{X - \lambda S} - \epsilon_p^W \right) - \alpha (c_H - c_L) p \lambda S W_p}{p [X_\delta W_p - (X_p - \lambda S') W_\delta]}. \]

Here, \( \epsilon_p^{X - \lambda S} \) is the absolute value of the elasticity of the incumbent’s residual demand, \((X - S)\), with respect to the stamp price, holding the discount constant. Similarly, \( \epsilon_p^W \) is the absolute value of the elasticity of work-shared volumes with respect to the stamp price, again holding the discount constant. This establishes

**Proposition 5.** The optimal work-sharing discount \((\ )\) will be less than the incumbent’s unit cost savings \((t)\) whenever the incumbent’s residual demand for end-to-end mail services is more elastic with respect to the stamp price than the demand for work-shared mail services.

This result is quite consistent with Ramsey, inverse elasticity notions. To better understand the optimal policy at the social optimum under a break-even constraint, I shall look at the optimal policy without the break-even constraint. The policy that maximizes the social surplus without the break-even constraint can obtained from equations (19) – (21) with \( p \) set equal to zero. Therefore, the social optimally policy *without a break-even constraint* satisfies the following conditions:

1. \( a = c_L \);
2. \( < t, p > (t + c_L) \) if \( > 0 \); and \( = t, p = (t + c_L) \) if \( = 0 \).
One can also examine the incumbent’s profits at the unconstrained social optimum.

Substituting (22) and (25)–(26) into (13) with set equal to zero yields

\[
(30) \quad + F = \left[ \alpha (c_H - c_L) \right] \frac{\lambda S[X_p W_\delta - X_\delta W_p] + \lambda S'[W X_\delta - W_\delta X]}{X_\delta W_p - (X_p - \lambda S') W_\delta} = 0.
\]

Note that the traditional unconstrained social optimization result, \( = - F \), holds if the volume of mails addressed to the high cost area is zero. If the volume of mail addressed to the high cost area is positive, the incumbent’s loss at the unconstrained social optimum is greater than the fixed cost (\( F \)); i.e., \( < - F \).

It is also interesting to note that the impact of end-to-end bypass on the work-sharing discount and the incumbent’s profits (or loss) at the unconstrained social optimum. From (26) and (30), the incumbent’s loss is equal to its fixed cost and the work-sharing discount is equal to the incumbent’s cost saving at the unconstrained social optimum if no end-to-end bypass is allowed (\( \gamma = 0 \)). The introduction of end-to-end bypass has the effect to increase the incumbent’s loss and reduce the work-sharing discount at the unconstrained social optimum.

Returning to the Ramsey policy results obtained earlier, it is easier to understand why the constrained social optimum may require setting the work-sharing discount greater, equal to or less than the incumbent’s cost saving. For simplicity, I shall abstract
the complexity of the high cost and consider the case in which \( c = 0 \). \(^8\) As noted, at the unconstrained social optimum, \( a = c_L, p = t + c_L, \quad = t \) and \( = -F \). At the constrained social (Ramsey) optimum, \( a < c_L, p > t + c_L, \) but \( t \) and \( = 0 \). Starting at the unconstrained social optimum, the postal regulatory authority raises the stamp price and lowers the delivery access rate in order to satisfy the break-even constraint. The postal regulatory authority, however, may or may not lower the incumbent’s work-sharing discount from its unconstrained social optimal level. If residual demand for end-to-end services and work-shared volumes are equally responsive to the stamp price, the constrained surplus-maximizing result requires that the work-sharing discount be set exactly equal to the incumbent’s cost savings (the same as the unconstrained social optimal discount). Adjustments in work-sharing discount from this reference point (constrained social optimum level) are made in favor of work-sharers (\( \geq t \)) or against work-sharers (\( < t \)), as work-sharing demand is more or less responsive than the residual demand for the incumbent’s end-to-end services to stamp price changes. This is precisely in accord with the logic of the inverse elasticity rule. Setting \( = t \) is equivalent to equal mark-ups for the two services, which is the optimal result when the elasticities are equal. Setting \( > t \) is equivalent to choosing a lower mark-up for presort service than for full-service, and the result shows that this is optimal when the presort demand is more elastic. Finally, setting \( < t \) is equivalent to choosing a higher mark-up for the presort

\(^8\) The presence of the high cost area tends to reduce the discount. For example, when the above elasticities are equal but \( > 0 \), the optimal discount is less than the incumbent’s cost savings.
service, and, under the above pricing rule, that is optimal when full-service is more price elastic.

**Break-Even Outcomes in the Absence of Piecemeal Bypass**

While there are some novel aspects of the current formulation, the basic results of such an analysis are well known.\(^9\) Therefore, I shall proceed to analyze a situation in which the object of postal policy is not (necessarily) to maximize social surplus. Instead, policy makers are assumed to satisfy their statutory mandates by choosing policies to provide Universal Service at the lowest possible uniform price subject to the constraint that the incumbent break-even. While not generally “optimal” in the economist’s sense, studying the implications of such a policy objective seems to me to be of considerable practical relevance.

Since the incumbent is assumed to operate under conditions of increasing returns to scale, this break-even price \(p^0\) will be greater than the marginal cost of providing full service in the low cost area: i.e., \(p^0 > t + c_L\). The break-even uniform price will be a function of the policy parameters in the model. Its properties are determined (implicitly) by the condition:

\[
\pi(p^0(\delta, a; \lambda, \lambda_A), \delta, a; \lambda, \lambda_A) = 0
\]

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\(^9\) See, for example, Armstrong, et. al. (1996) and Billete de Villemeur et. al. (2003a).
I begin the policy analysis by considering the effects of introducing work-sharing discount. Totally differentiating the zero profit conditions yields the standard system of comparative static results:

\[ \frac{\partial p_i^0}{\partial t} \equiv p_i^0 = -\frac{\pi_i}{\pi_p}; \text{ for } i = \delta,a, \lambda \text{ and } \lambda_A. \]

If the break-even constraint is strictly binding, it must be the case that \( p > 0 \). That is, an increase in the uniform stamp price would increase, not decrease, the incumbent’s profits. This establishes:

**Proposition 6.** \( \text{sgn}(p_i^0) = -\text{sgn}(\pi_i); \text{ for } i = \delta,a, \lambda \text{ and } \lambda_A. \)

This result is quite intuitive. An increase in any variable whose direct effect increases (decreases) the incumbent’s profits must decrease (increase) the break-even price, *ceteris paribus*.

However, in order to analyze the impact of various parameters on the equilibrium uniform price, it is necessary to take account of the fact that policy makers are (assumed to be) actively adjusting their policy variables in order to make the uniform price as low as possible. In this context, the minimized uniform priced, is defined as

\[ p^*(\lambda, \lambda_A) = \min_{a, \lambda} p^0(\delta, a; \lambda, \lambda_A) \]

The First Order Necessary Conditions associated with this optimization problem are given by:
(34) \[ \frac{\partial \rho_0}{\partial a} = -\frac{\pi_a}{\pi_p} \geq 0; \quad a \geq 0 \implies \pi_a = -\lambda A(a) - (a - c_L) \lambda A'(a) \leq 0 \]

and

(35) \[ \frac{\partial \rho_0}{\partial \delta} = -\frac{\pi_\delta}{\pi_p} \geq 0; \quad \delta \geq 0 \implies \pi_\delta = [p - t - \alpha c_H - (1 - \alpha)c_L] (X_\delta + W_\delta) - W + (t - \delta)W_\delta \leq 0. \]

(Recall that $\rho$ must be positive when the break-even constraint is binding.)

These First Order Necessary Conditions are themselves informative. In fact, they enable me to directly establish:

**Proposition 7.** The optimal work-sharing discount is always positive. Therefore, the introduction of a small work-sharing discount makes it possible to charge a lower uniform price.

**Proof:** From (4)-(6), \( (X + W)_{=0} = (W)_{=0} = 0 \) and \((W)_{=0} = D(p, 0) > 0\). Using equation (19) to evaluate \( \delta = 0 \) yields

\[ \left( \pi_\delta \right)_{\delta = 0} = [p - t - \alpha c_H - (1 - \alpha)c_L] (X_\delta + W_\delta)_{\delta = 0} - W(p, 0) + t(W_\delta)_{\delta = 0} = tD(p, 0) > 0, \]

and

\[ \left( \frac{\partial \rho_0}{\partial \delta} \right)_{\delta = 0} = -\frac{\pi_\delta}{\pi_p} < 0. \]

Thus \( \delta = 0 \) violates the First Order Necessary Condition, so the optimal work-sharing discount must be strictly positive. This implies that the introduction of work-sharing discount makes it possible to charge a lower uniform stamp price. Q.E.D.
A similar analysis can be used to analyze the properties of the optimal delivery price. In particular, we have

**Proposition 8.** *In the absence of piecemeal bypass,* the optimal delivery access rate is strictly less than the incumbent’s marginal delivery cost in the low cost area.\(^\text{10}\)

**Proof:** From equation (34), \(a = -\lambda A(a) - (a - c_L)\lambda A'(a) < 0\) and thus \(\frac{\partial p^0}{\partial a} > 0\) for \(a < c_L\). Therefore, it follows that the optimal access rate must be less than the incumbent’s marginal delivery cost in the low cost area. Q.E.D

At first, this result seems surprising. How can it be desirable to price access below the incumbent’s marginal delivery cost? The answer lies in the incumbent’s *monopsony* power that results from the absence of (implicit or explicit) piecemeal bypass. Note that the first order necessary condition for minimizing the uniform stamp price (subject to break-even) in (34) is identical to the condition maximizing the incumbent’s profits with respect to the delivery access rate in (14). That is, the delivery access bypass rate achieving the minimum uniform stamp price (subject to break-even) is identical to the delivery access bypass rate that maximizes the incumbent’s profits. The access providers

\(^{10}\) Here, I continue to assume that the market outcome is such that the incumbent’s delivery operation in the low cost area is not completely replaced by competitors: i.e., the fixed costs \(F_L\) cannot be avoided.
in the current formulation of the model have no option but to sell to the monopolist. In particular, they are not allowed to provide delivery services for work-shared mail except through the incumbent. Thus, they are really in the business of supplying downstream work-sharing services to the incumbent. The incumbent sets $a$ to extract the maximal monopsony profit, which enables it to lower the uniform price.

Given this, it is not surprising that the existence of competing providers of delivery services makes it possible to charge a lower uniform price.

**Proposition 9.** In the absence of piecemeal bypass, an increase in the supply of competitive delivery services results in a lower uniform price.

**Proof:** Differentiating equation (33), using the Envelope Theorem, equation (32), and equation (13) yields:

$$\frac{\partial p^*}{\partial \lambda_A} = \frac{\partial p^0}{\partial \lambda_A} = -\frac{\pi_{\lambda_A}}{\pi_p} = \frac{(a-c_L)A}{\pi_p} < 0. \text{ Q.E.D.}$$

Interestingly, end-to-end bypass fringe has an effect opposite to that of the work-sharing discount and downstream delivery access bypass. Because end-to-end competition reduces the incumbent’s volume, it forces the incumbent to raise the uniform price in order to break even. It is possible to state the following result.

**Proposition 10.** An increase in the supply of end-to-end competitors always increases the uniform price.

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11 Below, I will introduce (what amounts to) piecemeal bypass. This leads to dramatically different results.
Proof: As above, differentiating equation (33) and applying the Envelope
Theorem, we have

$$\frac{\partial p^*}{\partial k} = \frac{\partial p_0}{\partial k} = \frac{\pi_k}{\pi_p} = \frac{(p - t - c_L)S}{\pi_p} > 0.$$  Q.E.D

To summarize, in the absence of piecemeal bypass both the introduction of work-
shared discount and the expansion of delivery bypass competition facilitate the postal
authority’s efforts to maintain a low uniform price for end-to-end service. In contrast, the
expansion of end-to-end competition frustrates the pursuit of this objective by reducing
the incumbent’s volumes and its ability to exploit its economies of scale.

**Problems Posed by Piecemeal Bypass**

Additional issues emerge when mailers are permitted to bypass the facilities of the
incumbent on, what I shall term, a “piecemeal” (unbundled) basis. With piecemeal
bypass, mailers can completely bypass the incumbent’s facilities on an unbundled basis.
Unlike in the previous analysis, the mailers now have the additional option of presorting
their mails and handing them to the delivery bypass fringe. The analysis of the previous
sections, in contrast, does not allow mailers to hand their presorted mails directly to the
delivery bypass fringe those, though allowing the mailers to either purchase end-to-end
mail services or presort mails and present to the incumbent. The distinction may seem
minimal, but the market impact is pronounced.
When piecemeal bypass is permitted, the postal rate-maker loses its ability to independently set the rate for downstream access and the upstream work-sharing discount. Note that the implicit delivery access rate for the incumbent’s discount service is \((p - \ )\). With piece-meal bypass, the access rate charged by the delivery fringe (price-takers) is equal to the incumbent’s implicit delivery access rate, i.e., \(a = (p - \ )\). This because work-shared mailers are assumed to be indifferent between the incumbent’s discounted services and the delivery bypass’ delivery services.

An intuitive explanation of the situation is as follows. The introduction of work-sharing discount brought into being an industry of presorting mailers (competitive suppliers of presorting services). Similarly, the practice of “contracting out” of delivery services created a competitive supply for that component as well. Without the ability of mailers to engage in piecemeal bypass, these industries had no customer but the incumbent, thereby making it possible for the incumbent to engage in monopsonistic exploitation of both industries.

The incumbent can still exercise substantial control over the market, even when piecemeal bypass is possible. This is due to the fact that, unlike in the traditional dominant firm model, the incumbent has the opportunity to act on either side of the market: i.e., he can provide delivery services for work-shared mail; or he can contract out the delivery of a portion of his end-to-end volumes. Also, the incumbent may choose not to contract out any of its own volumes to competitive delivery providers, leaving them to compete for the volumes of work-shared mails destined for the low cost area.

At profit maximization, Ramsey optimum and uniform stamp price minimization,
the incumbent is expected to make profits at the margin in the low cost area on all its services: discounted as well as undiscounted services. That is, \( p - t c_L \) (and \( p - t c_L \)), which implies, \( a > c_L \) (Recall that \( a = p - \) with piecemeal bypass). In other words, the incumbent’s marginal delivery cost in the low cost area is lower than the access rate charged by delivery bypass fringe suppliers. Therefore, the incumbent would not contract out its own delivery services under profit maximization, at the Ramsey optimum or under the Minimization of Uniform Stamp Pricing \([W A(a)]\).

**Ramsey Analysis with Piecemeal Bypass**

In what follows, I will continue to assume that the incumbent continues to serve at least a portion of the downstream delivery market in the low cost area. In that case, the Lagrangian expression for the constrained surplus maximization problem can be written as:

\[
G = (1 + \gamma)\pi(p, \delta, p - \delta; \lambda, \lambda_A) + \int_0^\delta B(p - \delta + s, s)ds + \int_\delta^\delta B(p, s)ds + \lambda\Pi(p) + \lambda_A\pi_A(p - \delta).
\]

This is the same as equation (18), with the constraint \( a = (p - \) imposed. (Recall that, in the absence of piecemeal bypass, the optimal access rate is less than the optimal stamp price minus the optimal work-sharing discount.) Subject to the break-even constraint maximization with respect to \( p \) and \( y \) yields the following First Order Necessary Conditions:

\[
G_p = L_p + L_a = (1 + \gamma)(\pi_p + \pi_a) - (W + X) + \lambda S + \lambda_A A = 0
\]
and

\begin{equation}
G_\delta = L_\delta - L_a = (1 + \gamma)(\pi_\delta - \pi_a) + W - \lambda_\delta A = 0.
\end{equation}

Rewriting these equations using equations (14)-(16) results in

\begin{equation}
p - t - c_L = \frac{\kappa[(X - \lambda S)(W_\delta + \lambda_\delta A') - (W - \lambda_\delta A)X_\delta] - \alpha(c_H - c_L)[X_p(W_\delta + \lambda_\delta A') - W_pX_\delta]}{X_\delta(W_p - \lambda_\delta A') - (X_p - \lambda S'')(W_\delta + \lambda_\delta A')} > 0
\end{equation}

and

\begin{equation}
t - \delta = \frac{\kappa(W - \lambda_\delta A)(X_p - \lambda S') - (X - \lambda S)(W_p - \lambda_\delta A') - \alpha(c_H - c_L)W_p\lambda S'}{X_\delta(W_p - \lambda_\delta A') - (X_p - \lambda S'')(W_\delta + \lambda_\delta A')} > 0
\end{equation}

Once again, it is clearer to express this result in elasticity terms:

\begin{equation}
t - \delta = \frac{\kappa(W - \lambda_\delta A)(X - \lambda S)[e_p^{x_\gamma - \lambda S} - e_w^{x_\gamma - \lambda A}] - \alpha(c_H - c_L)pW_p\lambda S'}{p[X_\delta(W_p - \lambda_\delta A') - (X_p - \lambda S'')(W_\delta + \lambda_\delta A')]}
\end{equation}

Similar to the case of Ramsey optimality without piecemeal bypass, we have

\textbf{Proposition 11}: With piecemeal bypass, the Ramsey work-sharing discount \( t \) will be less than the incumbent’s unit cost savings \( (\bar{r}) \) whenever the residual demand for the incumbent’s end-to-end mail services with respect to the stamp price is more elastic than the residual demand for its work-shared mail services.
Break-even Outcomes with Piecemeal Bypass

The analysis proceeds exactly as before, except that now the policy maker has only one instrument, the work-sharing discount, to set in his efforts to minimize the undiscounted rate. Therefore, define

\[ \psi(p, \delta; \lambda, \lambda_A) \equiv \pi(p, \delta, p - \delta; \lambda, \lambda_A). \]

Then, by analogy to the analysis above,

\[ \psi(P^0(\delta; \lambda, \lambda_A), \delta; \lambda, \lambda_A) = 0. \]

I begin the policy analysis by considering the effects of introducing a work-sharing discount. Totally differentiating the zero profit conditions yields the standard system of comparative static results:

\[ \frac{\partial P^0}{\partial \lambda} \equiv P^0_{\lambda} = -\frac{\psi_{\delta}}{\psi_p} = -\frac{\pi_{\lambda}}{\pi_p + \pi_a}. \]

\[ \frac{\partial P^0}{\partial \lambda_A} \equiv P^0_{\lambda_A} = -\frac{\psi_{\lambda}}{\psi_p} = -\frac{\pi_{\lambda_A}}{\pi_p + \pi_a}. \]

and

\[ \frac{\partial P^0}{\partial \delta} \equiv P^0_{\delta} = -\frac{\psi_{\delta}}{\psi_p} = -\frac{\pi_{\delta} - \pi_a}{\pi_p + \pi_a}. \]

If the break-even constraint is strictly binding, it must be the case that \( p = p + a > 0. \)

This result is quite intuitive. An increase in any variable whose direct effect increases
(decreases) the incumbent’s profits must decrease (increase) the break-even price, *ceteris paribus*. Similar to the case without piecemeal bypass, we have

**Proposition 12:** With piecemeal bypass, the optimal work-sharing discount is always positive. That is, the introduction of discounted services makes it possible to keep a lower uniform stamp price.

**Proof:** From Proposition 7, \((\pi_{\delta})_{\delta=0} = tD(p,0) > 0\). Note also that

\[
(\pi_{\delta})_{\delta=0} = -[\lambda_A A(p) + (p-c_L)\lambda_A A'(p)] < 0.
\]

This implies that the introduction of discounted services (or work-sharing discount) makes it possible to keep the uniform stamp price lower. Q.E.D

In order to analyze the impact of various competition policy parameters \((A, \lambda_A)\) on the equilibrium uniform price, it is necessary to take account of the fact that policy makers are (assumed to be) actively adjusting their policy variables in order to make the uniform price as low as possible. In this context, the minimized uniform priced, is defined as

\[
P^* (\lambda, \lambda_A) = \min_\delta P^*(\delta; \lambda, \lambda_A).
\]

**Proposition 13.** *In the presence of piecemeal bypass*, an increase in either the supply of competitive delivery or end-to-end services results in a higher uniform price.

**Proof:** Differentiating equation (46), using the Envelope Theorem, equation (44), and equation (45) yields:
\[
\frac{\partial P^*}{\partial \lambda_A} = \frac{\partial P^0}{\partial \lambda_A} = -\frac{\pi_{\lambda_A}}{\pi_p + \pi_a} = \frac{(p - \delta - c_L)A}{\pi_p + \pi_a} > 0,
\]

and

\[
\frac{\partial P^*}{\partial \lambda} = \frac{\partial P^0}{\partial \lambda} = -\frac{\pi_{\lambda}}{\pi_p + \pi_a} = \frac{(p - t - c_L)S}{\pi_p + \pi_a} > 0. \quad \text{Q.E.D}
\]

Combining the analysis of minimizing the uniform stamp price with and without piecemeal bypass, we have the following policy conclusions. The introduction of work-shared services *always* facilitates the postal authority’s efforts to maintain a lower uniform stamp price. The introduction (or expansion) of end-to-end bypass competition, in contrast, *always* frustrates the pursuit of this objective by reducing the incumbent’s volumes and its ability to exploit its economies of scale. The introduction (or expansion) of delivery bypass competition, however, would facilitate the postal authority’s effort to keep lower the uniform stamp price if and only if piecemeal bypass is absent.

**Conclusion**

This paper has analyzed a model with three types of postal competition: traditional work-sharing, end-to-end bypass, and delivery bypass. Most importantly, the paper has introduced the notion of piecemeal bypass, which allows competitors at different levels of the postal value chain to combine to provide an end-to-end alternative. The analysis reveals that piecemeal bypass poses more serious problems than end-to-end bypass for the pursuit of public policy objectives such as Universal Service, Ramsey Pricing, or low basic rates. On the other hand, without piecemeal bypass, competition in
individual segments of the postal value chain improves the regulator’s ability to pursue such policy objectives.
References


