Chapter 1

Access and the USO for Letters and Parcels*

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The recent history of postal administrations (POs) and postal regulation has clearly underlined the continuing tension between the financial burden associated with the Universal Service Obligation (USO) and the desire to promote efficiency and innovation through increased competition. Nowhere is this tension more evident than in the area of access, not only for letters but also for parcels. Opportunities for rent seeking abound in both areas, and there is a pressing need for cogent analysis to inform regulatory policy under conditions that are likely to be present in letter and parcel markets going forward. Experience in other sectors has been hardly reassuring and has been indicative of severe rent seeking. In particular, while opening up access has the potential to promote efficiency, misguided attempts to subsidize access should be avoided. Indeed, this is especially true in postal service as access in postal facilities can hardly be regarded as an "essential facility".

While entry is the normal means of promoting competition, the presence of the USO means that in the letter market, entry will occur in low-cost areas and cream skimming will be the likely result POs present an attractive prospect for rent seekers in the name of competition and efficiency. Under these conditions, responsible regulatory policy is absolutely crucial; ill informed access prices and policies, albeit aimed at encouraging entry, may

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result in subsidies to entrants that damage both efficiency and the PO's ability to sustain the USO. In attempting to encourage competition, regulators have to exercise considerable skill in designing the arrangements for access to postal networks.

In this paper we build on our earlier paper on efficient access policies (Crew and Kleindorfer, 2002) extending the analysis beyond letters to include the parcel and small packet market. Access arrangements in postal service differ significantly from access in fixed network industries, for example, telecommunications, in that typically a PO's monopoly power derives much less from the network technologies that are present in the case of fixed networks. Indeed, if a local telecommunications company were freed from regulatory control, its access and other prices would likely increase dramatically. Thus, regulation seems to provide a significant cap on the prices it can charge. By contrast, a PO is likely to have a lot less market power under freedom of entry and may require some form of regulated monopoly or reserved area if it has to satisfy a USO. In this paper we continue our study of postal access. Section 1 provides the background, statement of the problem and summarizes our approach. In section 2 we discuss the structure of a model of access developed in the Appendix, and we summarize the results of simulations derived from the model. Section 3 discusses the implications of our approach for pricing and entry regulation, including the advantages of our approach in discouraging discriminatory practices by the incumbent PO intended to raise entrants' costs. Section 4 is by way of summary, conclusions and implications for policy and future research.

1. ACCESS IN THE POSTAL SECTOR

Access in the form of worksharing is common in the postal sector especially in the United States. Other forms of access are also possible. One possibility is what is termed "upstream access" where an entrant might actually use a PO's processing facilities directly. In Crew and Kleindorfer (2002), we argued that such upstream access should not be mandated, but available on a negotiated basis between POs and entrants. The other type of access, namely access to the PO's delivery network, is termed downstream access and this is the subject of this paper. In particular, this paper examines access arrangements to PO delivery networks not just for letter mail but also for the more competitive parcel sector. As in out previous work, we are seeking an approach that attempts to reconcile the two conflicting objectives of increased competition and providing the USO.

The USO has traditionally been maintained by a monopoly in letter mail. Over the years this has been eroded in many countries. We argue that while it may be possible by means of carefully crafted access pricing to reduce the reliance on monopoly further and still satisfy the USO, it may not be possible to eliminate the reserved area entirely. This approach contrasts to that of others, for example, Cohen (2000, 2003). They argue that experience in notably Sweden and New Zealand indicates that a reserved area is not needed. POs have enough scale and scope economies to provide universal service, especially if service to outlying areas is reduced by means of less frequent deliveries. Their approach is strictly cost based and does not address the demand side and the details of customer loss.[1] Sappington and Sidak's (2003) arguments go a step further and argue that the USO provides advantages not available to the other carriers. While there is an element of truth to this, we argue that it is deceptively attractive, as we will now discuss by reviewing the nature of the USO.

The USO has three elements: ubiquity of coverage, uniformity of price, and some uniformity in service standards. Ubiquity is the part of the USO that gets most attention. There are distinct advantages from a marketing point of view of delivering everywhere. However, if this is coupled with the requirement that a uniform price be charged, then the benefits of ubiquity look distinctly less attractive. If the PO could choose any price it wanted, there would not be any cost to the USO, as the PO could set prices everywhere at a compensatory level thereby eliminating any cross subsidy from low-cost to high-cost areas.[2] Similarly, the PO could avoid much of the expense of delivery to high-cost areas by dramatically varying service standards. These three features of the USO provide powerful arguments that the USO is a genuine obligation and not just a ruse on the part of POs to provide them with legalized monopoly power. The question then is how and to what extent is it possible to open up postal markets to competition and yet at the same time maintain the USO? In this paper we examine these possibilities by examining the role of access.

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[1] For a discussion and analysis of the microstructure of postal markets, see Crew and Kleindorfer (2001), who argue that a critical determinant of PO viability is the structure of large customer demands and their interaction with PO policies for pricing downstream access. They make the point that a PO faces a double threat from poor access policies. On the one side, this could obviously cause inefficient diversion of mail to competitive entrants. But poor access policies could simultaneously also lead entrants to collect mail and remail only that portion of the mail collected from large customers destined for high-cost areas, leading to further erosion of the PO's profitability and potentially even to its financial collapse.

[2] Furthermore, at the limit the PO could escape the requirement to deliver ubiquitously by setting an infinite price for delivery to any areas it wished to shed.

Making the letter market more competitive presents especially difficult problems for POs faced with a USO. The problem is that a letter is a low value product and the transactions costs of varying the price according to whether it is delivered in a high-cost or a low-cost area at least for single piece mail. While it may be possible for large mailings to vary the price according to postal code, the single piece price places a ceiling on the price that can be charged in such cases. As we showed in Crew and Kleindorfer (2002), this ceiling resulting from the single-piece price may be a significant constraint on the access prices a PO can charge.

The parcel market is a different story. Some competition has existed for many years, POs being just one of the players. POs may participate in the parcels market in two ways, often simultaneously. They may have a separate parcel company that competes directly with parcel operators for the B2B and B2C markets. They may simultaneously have a USO in parcels. This is primarily for single-piece parcels and is fed through the extensive postal counters network. However, unlike letters, parcels are high value items. So in the case of the USO in parcels ubiquity is required but not price uniformity. Transactions costs of charging different prices according to origin and destination are much less significant. USPS, for example, operates a zonal system for packages, which is distance related. Given the advances in information technology, a more sophisticated system based on origin and destination would also be feasible even for single-piece parcels. In this paper we develop a model of entry and access to the postal network in the case of a PO that has a USO in both letters and parcels.[3]

The addition of the parcel market requires the extension of Crew and Kleindorfer (2002) in a number of ways, the most important being the relaxation of the uniform pricing constraint. This is a significant difference in that it makes the USO in parcels much less onerous than the traditional USO in letters, so much so that competition and entry in the parcels sector is not an issue. Similarly, the access tariff in the parcels sector suffers from few of the adverse selection problems that occur in the letter market. Given this, a parcel USO is not expected to place a burden on a PO but it is likely to confer scope economies on the PO. The question is whether this benefit is likely to mitigate significantly the losses that occur from the USO in letters.

While the parcel market is currently relatively small for most USO providers, parcel post is expected to grow significantly as a result of the

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[3] We examine only the USO network and do not analyze and discuss the role of a separate PO owned parcel company. It, like independent competitors, would be allowed access to the USO parcels network.

growth in B2B and B2C commerce.[4] In the US, the projected growth over the period 2002-2007 is around 300%, going from a total market of $72.1 billion in 2002 to $217.8 billion in 2007, accounting for 8% of projected total retail sales in 2007 and reaching nearly 63 million or two-thirds of all US households. Similar trends are expected in Europe and Asia. Added to this growth in B2C markets is an even more significant growth in B2B markets (direct shipping from business to business using third-party logistics service providers[5]).

This growth could provide significant new revenues to POs at a time when they are most needed. However, bad pricing and access policies in the parcel area could have the same negative consequences as noted above for letters: inefficiency, rent seeking and damage to the sustainability of the enterprise. An analysis of parcel post and its role in the USO requires attention to the special characteristics of parcel post and its delivery networks and its distinctions from letter mail. While in letters uniform pricing and ubiquity inseparably characterize the USO, in parcels ubiquity is paramount and uniform pricing should not be a constraint (and is not a constraint in most countries). The increased pricing flexibility in parcels can be both enticing and confusing to regulators as they attempt to structure access pricing policies in the new era of e-Commerce.

We contend that the key to efficient access pricing in both letters and parcels lies in elaboration of the framework we recently proposed under the heading of delivery access pricing (DAP), initially proposed in Crew and Kleindorfer (2002). This framework recognizes the balance that must be struck between efficient pricing signals to entrants and the sustainability of the USO. It recognizes the benefits of significant entry and access to a PO's network but under conditions that do not undermine the USO. The approach envisions tariffed downstream access and negotiated upstream access. This approach is new for the postal sector and may offer opportunities to both POs and those regulators who are attempting to institute significant

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[4] In 2002, for example, the parcel and package business in USPS yielded approximately 10% of their total revenue. The increasing importance of parcels in the USO as an area of research is exemplified in De Donder et al. (2002). To become more competitive in this arena will require that POs address the "final mile" problem, by using new technologies such as lockboxes on the premises or groups of these lockboxes at convenient locations, with internet-based or mail-based delivery notification procedures. Prototypes of such systems are currently being deployed in Deutsche Post World Net. This issue is also examined in Porter (2002).

[5] To date, B2B markets have been dominated by major private sector companies, but it is conceivable that POs could make in-roads into these markets in the future. To do so will require rather different marketing and customer support strategies than POs have traditionally provided.

competition. Concerning downstream access, the DAP approach emphasizes the importance of charging for downstream access according to work yet to be done by the PO and not only for avoided cost upstream work accomplished by entrants. Access prices are, of course, bounded above by the single-piece rate. Under DAP, access prices to high-cost delivery zones can in fact be equal to the single-piece rate, in contrast to the situation where access prices are set by upstream, e.g., presort, discounts off single-piece rates. In sections 2 and 3 below, we argue that "discount approaches" to access pricing, such as those modeled after the Efficient Components Pricing Rule (ECPR), are inefficient relative to DAP and, furthermore, may encourage sabotage by the PO.

The access issues in the postal sector are significantly different from those faced in fixed network industries. In fixed networks, e.g. local telecommunications, there are not many readily available alternatives,[6] whereas in the postal sector POs do not have any obvious advantages when it comes to providing access, but they still have to comply with the USO. In view of this, our simulations in section 2 will address primarily the case where the PO is the only provider of access for letter mail. In the case of parcels, freedom of entry is assumed and the prices charged can be set in a compensatory manner. While this is not complete liberalization, the access policies examined here go a long way in the direction of opening up the markets while at the same time offering the prospect of maintaining a meaningful USO.

2. MODELING THE CONSEQUENCES OF ENTRY AND DOWNSTREAM ACCESS

As articulated by the now extensive literature on access[7], the basic principles underlying efficient access pricing are: firstly, that incentives should be aligned in such a way that the producer with the highest quality/cost ratio of producing certain services, whether it is the PO or an entrant, should be the producer that actually provides them; and secondly that the provider of access services (here the PO) should be able to meet the financial obligations arising from its franchise obligations, including the USO. As explored in previous papers, these principles give rise to

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[6] The potential of cable to compete has not yet been realized in telecommunications although it does offer competition in broadband.

[7] For an analysis of the basic issues related to unbundling and access, see Billette de Villemeur et al. (2002), Crew and Kleindorfer (2002), De Donder et al. (2002) and Panzar (2002).

unbundling, and separately pricing, the various components of the value chain. However, properly designed access prices to strike the balance between efficiency incentives and PO viability to provide the USO requires considerable care in allocating the costs of the USO.

In the Appendix we develop a model with entry where entrants compete with the PO for end-to-end service in both letters and parcels. The model allows for three types of entry:

1. Entrants provide end-to-end service for selected customers and perhaps for only a subset of their mail;
2. Entrants hand selected mail to the PO, which then provides end-to-end service for this mail, possibly discounted based on upstream work performed by entrants;
3. Entrants hand presorted mail to the PO for local delivery by the PO, the downstream access option.

In Crew and Kleindorfer (2001) we considered the possible problems raised by 1 and 2. We argued that entrants would only provide end-to-end service on the lowest cost, highest profit routes. Other mail, especially mail destined for higher cost delivery areas, they would hand back to the PO. In our original analysis, mirroring current practice in many POs, we assumed that such mail would be charged a uniform rate based only on the amount of upstream work embodied in the mail (e.g., presorted, prebarcoded, and so forth). Under the model developed in Crew and Kleindorfer (2002), and expanded to cover parcels in the Appendix, we consider more precisely addressed pricing signals, which allow the incumbent, through publicly posted tariffs, to charge entrants for access as a function of the ultimate destination of their mail. Thus, we are effectively unbundling the option of downstream access and pricing it according to its cost. This enables entrants to access the PO network at two levels, either for delivery only or at the single piece rate (the latter may be discounted as currently.). As we show in the Appendix, this approach is likely to be more efficient than alternatives.

The model assumes a set of potential entrants, operating as a competitive fringe in both sectors: mail (M) and parcel (N = non-mail). These entrants compete for specific customers, providing both end-to-end service for those customers as well as consolidation and remailing through the incumbent PO. There are assumed to be two delivery zones, low-cost (L) and high-cost (H). We assume that M and N operate as follows.

For sector M, we use the model developed in Crew and Kleindorfer (2002). Entrants in sector M provide end-to-end service for customer mail being delivered to both low-cost and high-cost areas, and they also compete with the PO upstream in collecting and consolidating mail, which they remail through the PO for ultimate delivery. Clearly, the latter decision depends directly on the price the PO charges entrants for access to its

delivery network for remailing. It is assumed that the PO can set separate access prices for delivery in *L* and *H*. To assure subsidy-free prices, we assume that the PO is required to finance all letter-specific fixed costs from revenues generated from its letter mail, plus a portion of joint or common costs shared with parcel posts. The precise share of such common costs is the subject of a welfare-maximizing optimization. As noted above, our starting point in this analysis is that growth in B2C revenues in the parcel sector could have a beneficial effect in easing the USO burden for letter mail, by allowing a greater portion of the common costs across letters and parcels to be financed via the parcel sector. The effect of this on efficient pricing in both sectors is the focus of much of what follows.

For sector *N*, we use the model developed in Crew and Kleindorfer (2002) as well, but we allow for non-uniform (or zonal pricing). Thus, in sector *N*, entrants also provide end-to-end service as well as competing with the PO upstream in collecting and consolidating parcel mailings. We assume the PO can set separate access prices for parcel delivery in *L* and *H*. For this sector as well, we require that all parcel-specific fixed costs be covered by revenues from parcel post, plus whatever joint or common costs to provide the USO that are not covered by letter-mail revenues.

We formulate a Ramsey problem in which the incumbent sets prices for letters and parcels, as well as access prices for delivery in its low-cost and high-cost delivery areas. The PO also determines the optimal coverage of joint USO costs across the two sectors (*M* and *N*). Denoting the price vector (including prices for both end-to-end service and access) for sector $m \in \{M, N\}$ by $P(m)$, the problem then becomes:

$$Maximize\ W(P(M),P(N)) = B(P(M);M) + B(P(N);N) - F \quad (1)$$

Subject to:

$$\Pi_I(P(M);M) + \Pi_I(P(N);N) \geq F; \quad \Pi_I(P(m);m) \geq F_m, \ m \in \{M, N\}$$

where $\Pi_I(P(M);M)$ are the gross profits (excluding fixed costs) from product $m \in \{M, N\}$; $B(P(m);m)$ are the net benefits (exclusive of fixed costs) associated with product type $m \in \{M, N\}$, as measured by the traditional welfare function of consumer plus producer profits arising from the respective sectors *M* and *N* at prices $P(m)$; and $F = F_M + F_N + F_J$ is the fixed cost of the USO, consisting of, respectively, the period fixed costs for letters (*M*), parcels (*N*) and joint or common costs (*J*). The separability of the objective function and constraint in (1) means that we can consider the products *M* and *N* separately, subject only to maintaining the same Ramsey number (or Lagrange multiplier) across both analyses.

Alternatively, and equivalently, we can solve separately for optimal prices for sectors *M* and *N*, together with an assumption of the sharing of fixed costs between *M* and *N*. To spell this approach out concisely, define "s_M" as the share of joint or common costs covered by the letter mail sector *M* and $s_N = (1-s_M)$ as the share of these costs covered by *N*. Then, for each fixed share vector $s \in S = \{(s_M, s_N) * s_m \in [0, 1], m \in \{M, N\}$ *and* $s_M + s_N = 1\}$, solve the following two problems for $W(m, s_m)$, $m \in \{M, N\}$:

$$W(m, s_m) = Maximize_{P(m)} \left[B(P(m); m) - F_m - s_m F_J \right] \qquad (2)$$

Subject to: $\Pi_I(P(m); m) \geq F_m + s_m F_J$, $m \in \{M, N\}$

Define total welfare at any share vector $s = (s_M, s_N) \in S$ as $W(s) = W(M, s_M) + W(N, s_N)$. Then, since $F = F_M + F_N + F_J$, it is clear that the optimal solution to (1) is the combined solution $(P(M), P(N))$ to (2), defined at s = s* solving:

$$s^* \in \arg\max_{s \in S} W(s) = \arg\max_{s \in S} \left[W(M, s_M) + W(N, s_N) \right] \quad (3)$$

Thus, the solution to the overall Ramsey problem (1) separates into two sub-problems, together with the decision as to how much each of the sub sectors *M* and *N* will contribute to covering joint USO costs. The basic structure of each sector-specific problem is identical (with the added flexibility of zonal pricing in the parcel sector). This allows a simplified discussion in what follows, since the entire structure, argument and results obtained in Crew and Kleindorfer (2002) apply here, with only some minor changes required to accommodate the fact that parcels may be priced non-uniformly in the high-cost and low-cost delivery zones. In particular, our previous arguments for the superiority of Delivery-Area Access Pricing (DAP) clearly continue to hold, now moderated by the magnitude of the contribution to joint costs made by each sector $m \in \{M, N\}$.

Let us review briefly the argument for DAP. The PO faces different costs depending on where the mail is delivered. Take the simplest case, where there are two delivery zones, low-cost and high-cost, and a uniform pricing constraint. As analyzed by numerous authors, the uniform price constraint of the USO then makes the PO vulnerable to cream-skimming in the event of entry, in that the uniform price must be set high enough to allow the PO to recover fixed network costs as well as to pay for both low-cost and high-cost delivery areas. The result is that the uniform price arising from the USO in the low-cost area may well exceed the stand-alone cost of delivering to the low-cost area only, leaving all high-cost deliveries to the incumbent PO. As noted in Crew and Kleindorfer (2001, 2002), this problem could be so

severe that allowing entry pushes the PO into a graveyard spiral of increasing prices and decreasing market share as entrants take a larger piece of the lower cost customers and routes until the USO becomes unsupportable. To avoid this, either the USO must be weakened or abandoned, or entry must be restricted in some manner.

This problem could be further exacerbated if downstream access were allowed, since then the PO not only faces the normal pressures of entry, but also faces the additional problem of having entrants remail the highest-cost mail they consolidate from customers with the PO. The PO then not only loses the revenue from such customers on its low-cost routes, but also suffers the additional problem of retaining from those customers precisely the mail it does not want, namely the mail destined for delivery to high-cost areas. Thus, if anything, downstream access seems to make the graveyard spiral problem more likely. While we have no cure for the general case, we do propose a modification of access pricing that appears to offer some promise of mitigating the effects of cream skimming through remailing. The basic idea, which we refer to as Delivery-Area Access Pricing or DAP, is to charge higher access prices for downstream entry where such entry requires delivery to high-cost areas. Thus, the key is to charge entrants who by-pass upstream operations of the PO not based on the work they have by-passed, but according to the work yet to be performed in delivering the mail they repost with the PO. As we showed in Crew and Kleindorfer (2002), this approach is more efficient than uniform access pricing - the usual approach adopted, following avoided cost or Efficient Component Pricing Rule (ECPR) methods. In addition, it does partially mitigate the problems of a graveyard spiral identified by Crew and Kleindorfer (2001).

To illustrate, consider Table 2, which shows the marginal delivery price and one worksharing price for letter mail destined for one of four delivery areas A, B, C, D. Areas are ranked according to delivery costs. Area A is lowest cost and can be accessed by entrants for 13c. If the entrant's delivery costs are below 13c, he will deliver his own customers' mail. The same considerations apply in the case of Areas B and C. In all three cases the access price is less than or equal to the presort price. For Area D, however, a problem arises. Even though the entrant's costs may be less than those of the PO if they exceed 20c, the price of the single-piece stamp, the entrant will not deliver here, as he will lose money. But the PO is also not interested in giving the entrant a "presort discount" off the single-piece rate, as doing so will simply increase the PO's expenses under the USO, as even the single-piece rate does not recover costs in Area D.

Table 2: Illustrating Delivery Zone-Specific Access Prices
(The DAP Rule)

	PO's Marginal Cost	Access price under DAP	Single piece price	Presort Price under DAP
Area A	10c	13c	20c	18c
Area B	13c	17c	20c	18c
Area C	14c	18c	20c	18c
Area D	25c	20c	20c	20c

A partial answer to this dilemma is the DAP Rule as shown in Table 2. This access tariff involves a number of departures from existing approaches. Under the new structure it is essential that entrants not be given incentives to increase the burden of the USO. The access-pricing tariff must therefore send the right signals to them. From the entrant's point of view for Area D, the fact that he does not receive payment for the worksharing that he has performed may seem unfair and inefficient. In fact, it is neither. It would be both unfair and inefficient were it not for the USO, the burden of which should not be increased by entrants. Under the USO, preventing the incumbent from receiving payment for worksharing in Area D is not unfair to entrants if it is considered part of entrants' share of meeting the USO. In return for being able to access the high cost areas at below cost because of the USO, he must pay a price, namely forego the value of any worksharing since the value of the subsidy he is receiving exceeds the value of the worksharing he is providing.

It is interesting to contrast this approach with the approach of ECPR, frequently recommended for determining access prices. ECPR assumes a single-product world, with access then being priced at the avoided cost of any upstream operations performed by the entrant. The problem in the postal context is that this is not a single-product context. On the contrary, every delivery area constitutes a different product with different cost characteristics for fulfillment. Thus, the simple logic of ECPR breaks down. Consider Table 2 again. Note that access prices and presort prices for Area D are not the same rate as the simple avoided cost implementation of ECPR in which the full (uniform) single-piece rate is simply discounted by the avoided cost of presort discount. Such a simple application of avoided cost logic would lead to a price of 18c for delivery to Area D, which would constitute a further subsidy beyond the 5c subsidy already contained in the single-piece rate for this area. Put differently, the proper access-pricing rule is that the entrant be charged the single-piece rate if the cost of work remaining to be performed to support access exceeds the single-piece price. We refer to this as Delivery-Area Access Pricing or DAP pricing. The simplest implementation of DAP would be to set the access charge for each delivery zone to be the maximum of the traditional ECPR/avoided cost rule

and the marginal cost of delivery to that zone, truncated at the single-piece rate. This simple rule has a number of benefits, including simplicity. As expected, however (see the results below), a full Ramsey formulation of the access pricing problem brings in other factors as well, including demand information and the relative efficiencies of entrants and the incumbent in performing the required elements of the postal value chain. Nonetheless, this simple rule has significant benefits in better alignment of cost with pricing and in avoiding subsidies to entrants that encourage inefficient entry.

The above discussion has been entirely in the context of letter mail in which a uniform pricing constraint is imposed. Will the situation change significantly when, as in parcels, uniform pricing is not imposed?[8] The short answer is clearly yes. Where uniformity in end-to-end prices is not imposed, then ECPR-like rules can provide useful benchmarks for Ramsey pricing under entry. The reason is simple: absent the price uniformity constraint and the starting point for end-to-end service pricing will already reflect marginal cost differences of providing service, including access, to different areas. In this instance, then, computing access prices by discounts off full price for avoided costs associated with work already accomplished will tend to yield the same results as computing costs, plus markups, on remaining work to be done by the PO to deliver to particular regions. However, even when price uniformity is not imposed, some care must be exercised in using ECPR when fixed USO costs are high (as when the parcels sector makes a significant contribution to covering the joint USO costs of letters and parcels), and the incumbent PO is efficient relative to entrants. In this case, the high fixed burden will drive up end-to-end prices for both low-cost and high-cost areas. In these circumstances the ECPR approach, which is based on a discount off the end-to-end price, will give rise to access prices that may exceed both average and marginal costs of entrants in many delivery zones in which the entrants are less efficient than the incumbent PO. Clearly, entrants should not be given access price signals that provide incentives for them to deliver letters or parcels in those zones. This problem would again be avoided by the DAP approach which would focus on work yet to be done in deciding access prices, and would tend to price below the inefficient entrants in zones in which the PO has a cost advantage in delivery.

The illustrative numerical examples in the Appendix underline the basic points made above. In particular, these examples are consistent with the following general conclusions:

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[8] It should be noted that considerable uniformity in pricing of parcels is imposed in certain countries, contrary to what is assumed here. In that case, the full force of the above argument for DAP clearly applies.

1. For letter mail, DAP pricing provides clear efficiency improvements relative to ECPR pricing, both for access as well as for worksharing discounts more generally. This was established in Crew and Kleindorfer (2002), and the conclusion remains valid here, because of the separation property embodied in (1)-(3). The presence of parcels in the product mix may ameliorate the pressure of USO fixed costs somewhat, but DAP remains the preferred access pricing approach.
2. For parcel post, with no uniformity constraint on prices, DAP pricing is well approximated by ECPR rules, except for the case in which fixed USO costs are high (e.g., because at the Ramsey optimum the parcels sector makes a significant contribution to covering joint USO costs), and entrants are relatively inefficient in some zone compared to the PO. Of course, DAP prices are Ramsey prices and incorporate demand elasticities and other elements of efficient breakeven analysis, but assuming that ECPR rules begin from the right level of end-to-end prices, they are a good approximation to DAP/Ramsey prices except in the noted instance in which fixed USO cost coverage by parcels is high and entrants are inefficient.
3. The effect of considering the joint financing of the USO across letters and parcels can be significant in alleviating the USO burden for letter mail, especially if growth in B2C markets promotes growth in the parcel market. Such growth could allow the parcel sector to provide significant contributions to joint or common fixed costs of the USO across both sectors.

The above results, together with the recognized competitive character of the parcel sector, are somewhat promising in using the parcels sector and the anticipated growth in the B2C arena to help support the USO burden. However, regulation will continue to play a critical role in balancing the viability of the PO with efficiency in entry and pricing. We therefore consider some of the details of the regulatory process that will be required to implement these ideas in the changing environment likely to be faced by POs in the next decade.

3. REGULATORY ISSUES IN IMPLEMENTING DAP

Access to PO delivery networks offers some potential benefit but simultaneously raises significant regulatory issues, albeit of a lesser magnitude than fixed network industries as PO networks hardly qualify as essential facilities in contrast to telecommunications. One consequence is that sabotage of an entrant by a vertically integrated access provider is

unlikely to be an issue where a PO provides access to competitors its delivery networks. Regulatory issues then are likely to be different from those in fixed networks industries. These industries have major barriers to entry, whereas the issue for POs is whether it is necessary to maintain some artificial barriers to entry to assure the viability of the USO. Given that some regulation is required, we will argue that it should take the form of a price cap. Sabotage, the extent of regulation and price caps will now be examined.

3.1 Incentives of a Vertically Integrated PO to Discriminate against Entrants when Providing Access

In telecom (Mandy (2000), Weisman and Kang (2001) examine the issue of whether sabotage against entrants is a profitable strategy for profit-maximizing incumbents. Weisman and Kang (2001) examine a Cournot-Nash equilibrium setting with a single vertically integrated incumbent provider and one or more entrants, where the incumbent provides an essential good "access" to entrants. They show that, except under unusual circumstances in which entrants are significantly more efficient than the incumbent and the regulator finds it easy to detect discriminatory access policy, discrimination against entrants is profitable.

Contrast this with postal service. Here the incentives for a profit-maximizing or welfare-maximizing incumbent for sabotage are considerably less. Consider the case of a profit-maximizing PO. Raising the costs of entrants through discriminatory access prices naturally depress entrants demands through the ensuing higher prices. For mail destined for any delivery zone on which the PO's access price is sufficient to recover marginal cost, the PO does not capture any of the benefits of the additional costs arising from sabotage imposed on entrants. Thus, for such zones, if entrants use the PO for downstream delivery, the PO is worse off than it would be if it were to reduce the contrived access costs to entrants and raise their access prices by the same amount. Of course, if entrants do not use the PO for downstream delivery, then the effect of increasing access costs through discriminatory practices has no effect. The key driver that makes sabotage a deadweight loss for all parties for profitable delivery zones in the postal sector, in contrast to telecommunications and electricity, is that entrants can avoid PO facilities entirely by providing their own end-to-end services. This both limits the ability of the PO to engage in discriminatory access practices as well as making them unprofitable for the PO in the first

place. Clearly, a welfare maximizing PO would *a fortiori* not engage in such practices.[9]

Consider the case, however, of mail destined for high-cost delivery zones for which the PO is not covering its marginal delivery cost through access charges. In these cases, it is apparently in the interest of the PO to engage in sabotage to depress entrants' demand for this service. Note that, under DAP, this incentive effectively disappears since the PO would charge an access price in high-cost zones equal to the single-piece price. At this level, the PO would have no incentive to increase entrants' total cost of access artificially, since entrants will then use the PO's end-to-end service at the single-piece price. Note that for other access pricing policies, such as Efficient Component Pricing, there may be an incentive for sabotage resulting from the fact that access prices for high-cost areas are set at levels below marginal delivery cost. Sabotage usually has deleterious effects on welfare or social efficiency in that it always results in deadweight costs, except in rare instances where these are offset by preventing entry by inefficient entrants. However, as argued here, sabotage is unlikely to be a major issue in postal service because of the non-essential nature of the facilities and the nature of the entry arrangement to which we now turn.

3.2 Entry Regulation

As it is not possible, at least currently, to demonstrate that opening up the letter market entirely to competition would be feasible under efficient access pricing subject to a USO, the issue of entry regulation arise. Although, as we argued above and in Crew and Kleindorfer (2002), DAP access pricing promotes efficiency and enables a PO to be more competitive because it takes advantage of the scale economies in delivery and economies of ubiquity that POs enjoy, it does not eliminate the adverse selection problem entirely. The uniform pricing constraint for single-piece mail continues to promote adverse selection for mail where the uniform pricing constraint is binding under DAP, i.e., in the high-cost areas. Thus, without a monopoly on access, the PO may not be able to generate enough revenue to cross subsidize the high-cost routes that are left after the entrants have taken control of large customer mailings for the low-costs routes. This could happen not just in the traditional context of single piece, where the entrant

[9] It is sometimes argued, e.g. Sappington and Sidak (2003), that public enterprises are neither profit-oriented nor welfare-oriented, but rather attempt to maximize their revenue or their size. Even here there do appear to be minimal incentives for such a PO to engage in sabotage, except perhaps in order to discourage entrants from entering the market altogether.

gets the profitable mail and with the high-cost mail remaining with the PO, but also in the access market. Indeed, in the access market entrants could undercut the PO by providing access to other entrants perhaps on a reciprocal basis. The question then is whether an access monopoly is required if a PO is to remain viable and support a USO. In particular, in the interests of preserving the USO, would it be feasible for competitors to provide end-to-end delivery to wherever points they chose but make the PO the only carrier's carrier, the only provider of access? Let us illustrate the problem with some likely scenarios.

Take the case of three principal delivery areas, A, B and elsewhere. PO delivers in all places. Firm A delivers only in A and Firm B delivers only in B. Firm A has lower costs than the PO for delivery in A. Firm B has lower costs than the PO in B. For all other areas, only the PO delivers as it is lowest cost producer. The outcomes of a case like this include the following:

1. Firm A will provide end-to-end service in A and uses Firm B to deliver its mail in B. Firm B will provide end-to-end service in B and uses Firm A to deliver its mail in A. PO provides end-to-end service in A and B and access everywhere except A and B (since no access is required there by entrants; they use one another's services for delivery).
2. The same as 1 except that A uses PO in B and B uses PO in A to provide deliveries.
3. The same as 1 except that A uses B in B and B uses PO in A to provide deliveries and vice versa.

How are 2 and 3 possible?[10] It may be the PO can receive mail in B for delivery in A at lower cost than B can transport it to A sufficient to make its net cost lower than if it uses A and vice versa. Thus, there may be economies of collection and transportation available only to PO that arise from ubiquity.

It is certainly not possible to exclude the prospect that the PO may find itself forced out of the low-cost delivery areas. Except for the requirement to collect and any scope economies of ubiquity, it would also achieve its lowest cost to have A deliver its mail in A and B deliver it in B if A and B deliver ubiquitously in A and B. The problem with this arrangement is that A might not deliver everywhere in A and the same for B in B, in which case the USO would require the PO to deliver to part of A and B. It may be that

[10] The third scenario may seem unlikely but might turn out to be quite common. Take the case where A is very small but uses B to deliver in B because B is cheaper than the PO. By contrast B does not use A in A as A is too small to provide B with sufficient coverage.

the costs of doing this exceed the costs of performing all its own deliveries in A and B.

Scenarios such as the above lead us to conclude that complete freedom in access may result in the PO facing the traditional adverse selection problem under a USO. Ultimately, this is an empirical question.[11] Supporters might argue that it will squeeze the PO's costs and make it more efficient. This may be true, but it will also force the PO's profits in the low-cost areas toward zero potentially eliminating the profits from low-cost areas needed to support the high-cost areas as mandated for the USO. Thus, it may find itself delivering only where competitors do not wish to serve and may lose money on its formerly low-cost routes, which are made uneconomic because of loss of density and scale economies.

Although an open access policy is usually efficiency enhancing, these kind of adverse selection issues raise the question of whether entry restrictions are required. A phased approach to entry liberalization may be appropriate. The ultimate objective might be that the PO has a USO and a monopoly on single piece mail up to a small monetary amount. The process might begin with the PO having a larger monetary limit and a monopoly on access. In this situation entrants would have two options. They could deliver mail other than single piece or they could engage in cost-effective worksharing, e.g., presorting, and hand their mail to the PO. They would not be allowed to make arrangements with other entrants for delivery, as this would infringe the PO's access monopoly. This would probably be a relatively short transition to an ultimate objective of a monopoly only on single piece. The problem with the transition phase is that enforcing the restrictions on entry into the access market would be very difficult. If firm A is delivering its own customers' mail in area A, it is going to be very difficult to detect that it is also carrying mail for firm B. Dependent on the entry regime, a different price cap arrangement will be required, which we now address.

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[11] Cohen et al. (2003) could lead in either direction, although they argue that USPS should be able to support a meaningful USO without a reserved area. Interesting, they showed that losses from high cost routes were $2.6 billion in 1999 while profitable routes generated $6.5 billion but that $3.2 billion came from the top 10 per cent of routes. Others might conclude just the opposite since the profits are highly concentrated in a few routes making them very vulnerable to competition.

4. PRICE-CAP REGULATION

Although price cap regulation (PCR) seemed to provide a considerable advance over cost-of-service regulation in terms of superior efficiency properties, implementation has proved to be somewhat problematical (Littlechild 1983, Crew and Kleindorfer 2003). Applying PCR to POs is not without problems, but it may be preferred for a number of reasons to possible alternatives and DAP does have some desirable properties including the possibility of replicating Ramsey optimal results (Billette de Villemeur et al., 2002). However, its primary benefit is its simplicity under liberalized entry, the final stage of the regulatory transition examined.

Under the free entry scenario, the PO's monopoly would only consist of single-piece mail up to a small monetary amount (i.e., not access, and certainly not parcels, which would be considered competitive products). The price cap would then only apply to the first weight step (ounce or grams) and subsequent weight steps for single-piece mail. We follow the notation in the Appendix, defining:

Z_k as single-piece mail serviced by the PO, destined for zone $k \varepsilon \{L, H\}$

Y_k as mail services by entrants, destined for zone $k \varepsilon \{L, H\}$

Q_k as the entrants' mail that is delivered by entrants, so that Y_k - Q_k is the amount of entrants' mail using the PO's network for local delivery for zone $k \varepsilon \{L, H\}$.

With this notation, the price cap under the free entry scenario would take the following form:

$$\sum_k P_{Zk}^t Z_k^{t-1} \leq (RPI - X) \sum_k P_{Zk}^{t-1} Z_k^{t-1} \tag{4}$$

All the other products, access for letters, access for USO parcels and USO parcels would be unregulated.

In moving to the liberalized scenario, the transition price cap would take the form of a global price cap (Crew and Kleindorfer, 1994; Laffont and Tirole, 1996):

$$\sum_k P_{Zk}^t Z_k^{t-1} + \sum_k P_{Ak}^t \left(Y_k^{t-1} - Q_k^{t-1}\right) \leq (RPI - X)\left[\sum_k P_{Zk}^{t-1} Z_k^{t-1} + \sum_k P^{t-1}_{Ak}\left(Y_k^{t-1} - Q_k^{t-1}\right)\right] \tag{5}$$

where the access good is also subject to the price cap. In both instances, the PO would have considerable price flexibility. In the liberalized scenario, it would have complete freedom to price its competitive products. In the transition scenario the single-piece products and the access products would be in different baskets again providing considerable pricing flexibility.

PCR has a number of desirable properties, particularly on the grounds of transparency and flexibility, and is a major tool in the regulator's arsenal in the transition toward greater liberalization of the postal market.

5. SUMMARY AND CONCLUSIONS

The addition of USO parcels to the analysis of the problems facing a PO with a USO and a policy allowing increased freedom of entry at first sight seems like a minor addition given the relatively small role (about ten percent of revenue for USPS) played by parcels and packets. However, with the impact of e-commerce and the internet, there may be an opportunity for POs to gain revenue and market share in parcels providing a valuable contribution toward covering the costs of the USO. This paper has examined access policies for both letters and parcels for a PO and developed optimal prices. We show, in further support of our argument in Crew and Kleindorfer (2002), that providing access benefits the PO and entrants where markets are opened to competition. We consider a PO with a USO in letters and parcels, but a reserved area or regulated monopoly in single-piece mail only. Our analysis does not enable us to conclude that such a policy would be sustainable in the sense that the PO can provide the USO and be financially viable without direct subsidy from the government. We do conclude that it has a greater chance of success than other policies that do not involve the PO providing access and attempting to compete.

We envisage three basic scenarios under entry:

S1: Survival of the Fittest: the PO derives enough value from being the universal provider of access to assert itself against entrants and maintain viability at roughly current price and service quality levels.

S2: The Small and High Cost PO: the PO serves mainly the high-cost areas, but manages to survive with a high single-piece price and significant cuts in service quality.

S3: The Graveyard Spiral: too little too late. Here the PO continues to lose market share, without being able to shed USO responsibilities sufficiently rapidly and becomes financially unviable (as in Crew and Kleindorfer (2001)).

S1 is clearly the desired scenario. Our analysis has shown that competing, providing access and gaining a greater share of the parcels market may make this outcome more likely. However, S1 cannot be guaranteed, as major changes would have to occur in the way a PO does business. The mix would likely require real wage reductions on the part of union employees and the use of more contractors and non-union labor. This is likely to be difficult to achieve in practice. This means that S2 and S3 cannot be ruled out. S2 is arguably more likely than S3 as it involves significant adjustments in the extent of the USO and places a much higher burden on small users with major increases in the single-piece price. This is not too surprising given that deregulation in other industries has usually resulted in price reductions for large users at the expense of small users. It may be that some combination of S1 and S2 would occur, for example, some reduction in the USO and some "tolerable" but not insignificant increase in the single-piece price.

What is clear is that in entering a regime of entry and access, POs are entering uncharted territory that will lead to different POs from traditional ones. Indeed, one possibility under S3 is the demise of the PO and the USO as we have known them. Perhaps this will be the ultimate consequence of the electronic age to which industrialized economies have moved. An alternative, as we have argued here, is that POs adopt more commercially oriented strategies and regulators encourage PO flexibility plus experimentation by both POs and entrants. This could lead to a new and more efficient industry structure in which POs depend less on revenues from their traditional letter-mail markets and increasingly move to become vibrant 3rd Party Logistics providers in the B2C area.

A. TECHNICAL APPENDIX

A.1 Entry and Downstream Access for Letters and Parcels

A set of potential entrants competes for specific customers, providing both end-to-end service for those customers as well as consolidation and remailing through an incumbent Postal Administration (referred to as the PO). Entrants and the PO provide two products, "letter mail" and "parcels". Entrants provide end-to-end service for customer mail and parcels being delivered to low-cost areas and they also compete with the PO upstream in collecting and consolidating mail and parcels, which they remail through the PO for ultimate delivery. Clearly, the latter decision depends directly on the

price the PO charges entrants for access to its delivery network for remailing.

We employ the following notation:

M = Letter Mail

N = Non-letter Mail, i.e., parcels, small packets, etc.

$y(\theta; m) = (y_L(\theta; m), y_H(\theta); m)$ = demand for entrants' products by consumer θ for postal product of type $m \in \{M, N\}$ and delivery zone L = low-cost and H = high-cost

$z(\theta) = (z_L(\theta), z_H(\theta))$ = demand for incumbent's products by consumer θ for postal product of type $m \in \{M, N\}$ and delivery zone L = low-cost and H = high-cost

$Y(m) = (Y_L(m), Y_H(m))$ = aggregate consumption of $y_k(m), m \in \{M, N\}$

$Z(m) = (Z_L(m), Z_H(m))$ = aggregate consumption of $z_k(m), m \in \{M, N\}$

so that, for $k \in \{L, H\}$,

$$Y_k(P;m) = \int_\theta y_k(\theta;m)dF(\theta); \quad Z_k(P;m) = \int_\theta z_k(\theta;m)dF(\theta) \qquad \text{(A1)}$$

where

$dF(\theta)$ = number of consumers of type θ

$Q_k(m)$ = amount of postal product of type $m \in \{M, N\}$ from entrants' customers destined for delivery zone $k \in \{L, H\}$ that is delivered by entrants, so $Y_k(m) - Q_k(m)$ = amount of mail from entrants' customers destined for zone $k \in \{L, H\}$ that is remailed through the PO's network for delivery by the PO; where, of course, $Q_k(m) \leq Y_k(m)$

$P(m) = (P_{YL}, P_{YH}, P_{ZL}, P_{ZH}, P_{AL}, P_{AH})$ = vector of end-to-end prices for products $Y(m)$ and $Z(m)$ and a vector of access prices,

where

$P_{Yk}(m)$ = Price charged by entrants for end-to-end service to delivery zone $k \in \{L, H\}$

$P_{Zk}(m)$ = Price charged by the Incumbent for end-to-end service for delivery zone $k \in \{L, H\}$; for $m = M$, it is assumed that the USO requires uniform pricing, so that $P_Z(M) = P_{ZL}(M) = P_{ZH}(M)$. No such uniformity requirement is imposed for non-mail (N).

$P_{Ak}(M)$ = access price charged by Incumbent to entrants for use of downstream facilities and delivery in zone $k \in \{L, H\}$

$C_{Uj}(m)$ = Incumbent's cost per unit of upstream operations (consolidation, presorting, etc.) for firm $j \in \{E, I\}$ and product $m \in \{M, N\}$, where E = entrants and I = Incumbent

$C_a(m)$ = unit cost for entrants to access Incumbent's downstream facility for product $m \in \{M, N\}$, assumed to be borne by the Incumbent; we think of C_a as the unit cost of metering and accepting a unit of an entrant's product as it enters the Incumbent's downstream facilities

$C_{Djk}(m)$ = unit cost for firm $j \in \{E, I\}$ for $m \in \{M, N\}$ and delivery in zone $k \in \{L, H\}$

F = fixed cost per period for the Incumbent to maintain downstream facilities and other non-volume variable obligations required by the USO; F is the sum of F_M, F_N and F_J, where F_m represents the fixed costs of facilities serving strictly type $m \in \{M, N\}$ products, and F_J represents common costs.

A.1.1 Consumers Choice Problem

We assume the products offered by entrants and the Incumbent are imperfect substitutes. Thus, demands $y(P, \theta; m)$ and $z(P, \theta; m)$ for consumer θ arise from the standard consumer maximization problem:

$$\begin{aligned} \text{Maximize} \sum_{m\in\{M,N\}} \left[V(y(m),z(m),\theta;m)\right] \\ - \sum_{m\in\{M,N\}} \left[\sum_{k\in\{L,H\}} \left(P_{Yk}(m)y_k(m) + P_{Zk}(m)z_k(m)\right) \right] \end{aligned} \quad \text{(A2)}$$

where $V(y, z, \theta; m)$ is the willingness-to-pay (WTP) of consumer θ for products of type $m \in \{M, N\}$ and satisfies the usual concavity and differentiability properties. The separability of WTP across products $m \in \{M, N\}$ implies our assumed independence of the demands for these products. Indeed, we will treat these products as essentially distinct businesses, with some common/joint costs (associated with the USO network) to be covered from the joint revenues of both products. We assume that y and z are substitutes within the same delivery zone (i.e., y_L and z_L and y_H and z_H are substitutes), so that increases in the price of one lead to increases in demand for the other. However, we will assume throughout that demands for L and H zones are independent, for both the incumbent as well as entrants. Denote

the demand functions derived from (A1) as $y(P,\theta;m)$ and $z(P,\theta;m)$, with $Y_k(P;m)$ and $Z_k(P;m)$ defined through (A1). These demand functions satisfy the usual properties.

A.1.2 Entrants Choice Problem

Profits for entrants $\Pi_E(m)$ providing products $m \in \{M, N\}$ are represented as:

$$\Pi_E(P;m) = \sum_{k\in\{L,H\}} \left[\left(P_{Yk}(m) - C_{uE}(m)\right)Y_k(m)\right] - \sum_{k\in\{L,H\}} \left[C_{DEk}(m)Q_k(m) + P_{Ak}(m)\left(Y_k(m) - Q_k(m)\right)\right] \quad \text{(A3)}$$

where $Q_k \leq Y_k$ is required. In particular, entrants are assumed to compete separately in the markets for M and N. We will assume throughout that entrants in both sectors M and N operate as a competitive fringe. Thus, prices will be driven down to least cost levels, i.e. for $k \in \{L, H\}$, $m \in \{M, N\}$:

$$P_{Yk}(m) = Min\left[C_{UE}(m) + C_{DEk}(m), C_{UE}(m) + P_{Ak}(m)\right], \quad \text{(A4)}$$

where $Q_k(m) = 0$ if $C_{UE}(m) + C_{Dek}(m) > C_{UE}(m) + P_{Ak}(m)$ and $Q_k(m) = Y_k(m)$ otherwise, i.e. for $k \in \{L, H\}$, $m \in \{M, N\}$:

$$Q_k(P;m) = Y_k(P;m)\varphi(P_{Ak}(m) - C_{DEk}(m)), \quad \text{(A5)}$$

where $\varphi(p)$ is the real-valued function satisfying $\varphi(p) = 0$ if $p \leq 0$ and $\varphi(p) = 1$ if $p > 0$. The reader can verify that at the prices and quantities defined by (A4)-(A5), $\Pi_E(P;m) = 0$, as required for the competitive fringe.[12]

A.1.3 Incumbent's Choice Problem

The Incumbent's gross profits $\Pi_I(P;m)$, excluding product-specific fixed costs, derived from products of type $m \in \{M, N\}$ are given by

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[12] For $m = N$, the case in which entrants as well as the incumbent enjoy market power is interesting, e.g., where the non-mail sector operates either as a Cournot-Nash duopoly (a single entrant competes with the incumbent PO). This case awaits further research.

$$\Pi_I(P;m) = \sum_{k\in\{L,H\}} \left(P_{Zk}(m) - C_{UI}(m) - C_{DIk}(m)\right) Z_k(P;m) + \sum_{k\in\{L,H\}} \left(P_{Ak}(m) - C_a(m) - C_{DIk}(m)\right)\left(Y_k(P;m) - Q_k(P;m)\right) \quad \text{(A6)}$$

The first term in (A6) represents gross profit derived from end-to-end services of the incumbent's products (Z_L and Z_H), and the second term in (A6) represents gross revenues from downstream access products offered to entrants. Notice that in the case of letter mail, the former would be computed at a uniform price $P_Z(M) = P_{ZL}(M) = P_{ZH}(M)$. Note also that the latter are reduced by the metering and acceptance costs C_a, which are assumed here to be incurred by the incumbent and paid for in the access prices P_{Ak}.

Let us now consider the Ramsey-optimal prices for this problem. We do this under the assumption that entrants in the non-mail market are a competitive fringe (where total entrant profits are zero). The optimal prices are obtained from maximizing the traditional welfare function, subject to $\Pi_I(P) = \Pi_I(P;M) + \Pi_I(P;N) \geq 0$, as determined by (A6), where we denote total fixed costs below as $F = F_M + F_N + F_J$. Thus, denoting by $W(P)$ total welfare, we obtain the following statement of Ramsey problem:

A.1.4 Ramsey Problem with Competitive Fringe

$$\begin{aligned} \text{Maximize } W(P) = & \sum_{m\in\{M,N\}} \left[\int_\theta V(y(P,\theta;m), z(P,\theta;m), \theta; m) dF(\theta) \right] \\ & - \sum_{m\in\{M,N\}} \left[\sum_{k\in\{L,H\}} \left(C_{UI}(m) + C_{DIk}(m)\right) Z_k(P;m) \right] \\ & - \sum_{m\in\{M,N\}} \left[\sum_{k\in\{L,H\}} \left(C_a(m) + C_{DIk}(m)\right)\left(Y_k(P;m) - Q_k(P;m)\right) \right] \\ & - \sum_{m\in\{M,N\}} \left[\sum_{k\in\{L,H\}} \left[C_{UE}(m) Y_k(P;m) + C_{DEk}(m) Q_k(P;m)\right] \right] - F \end{aligned} \quad \text{(A7)}$$

Subject to: $\Pi_I(P) = \Pi_I(P;M) + \Pi_I(P;N) \geq F$; $\Pi_I(P;m) \geq F_m$, $m \in \{M, N\}$

The Ramsey solution to the above problems is derived in the usual manner (see, e.g., Crew and Kleindorfer (1986), Chapter 2). This yields in the present a number of sub-cases of interest, as noted below. Each of these are obtained by substituting for $Q_k(P)$ the appropriate expression from (A5) (where, in each instance, the Ramsey number $r = \lambda/(1+\lambda)$, with $\lambda \geq 0$ the Lagrange multiplier on the profit constraint) and deriving the first-order conditions (FOCs) for the resulting problem. The basic structure of the Ramsey problem (A7) is as follows:

$$Maximize\ W(P(M),P(N)) = B(P(M);M) + B(P(N);N) - F \quad \text{(A8)}$$

subject to: $\Pi_I(P(M);M) + \Pi_I(P(N);N) \geq F = F_M + F_N + F_J$

where $B(P(m);m)$ is the net benefit associated with product type $m \in \{M, N\}$, i.e. the terms in (A7) identified with the respective sectors M and N. The separability of the objective function and constraint in (A8) means that we can consider the products M and N separately, subject only to maintaining the same Ramsey number (or Lagrange multiplier) across both analyses. Alternatively, and equivalently, one may solve the above problem by defining "s_M" as the share of joint or common costs covered by the letter mail sector M and $s_N = (1-s)$ as the share of these costs covered by N. Then, for each fixed share vector $s \in S = \{(s_M, s_N) * s_m \in [0, 1], m \in \{M, N\}\ \&\ s_M + s_N = 1\}$, solve the following two problems for $W(m, s),\ m \in \{M, N\}$:

$$W(m, s_m) = Maximize\ \ B(P(m);m) - F_m - s_m F_J \quad \text{(A9)}$$

Subject to: $\Pi_I(P(m); m) \geq F_m + s_m F_J$

Define total welfare at any share vector $s = (s_M, s_N) \in S$ as $W(s) = W(M, s_M) + W(N, s_N)$. Then, noting that $F = F_M + F_N + F_J$, it is clear that the optimal solution to (A7) is the combined solution $(P(M), P(N))$ to (A9), defined at $s = s^*$ solving:

$$s^* \in \arg\max_{s \in S} W(s) = \left[W(M, s_M) + W(N, s_N)\right] \quad \text{(A10)}$$

We note in passing that it straightforward to find the optimal shares s^*, as the functions $W(m, s_m)$ are concave in sm as long as $B(P(m); m)$ and $\Pi_I(P(m); m)$ are concave in $P(m)$. Thus, a straightforward search procedure on the unit interval leads to the optimal s^*.

From this we see that the solution to the combined problem (A7) separates into two sub-problems, together with the decision as to how much each of the sub sectors will contribute to covering joint USO costs. In

particular, the basic structure of each problem is identical (with the added flexibility of zonal pricing in the parcel sector). This allows a simplified discussion in what follows. In particular, the entire structure and argument of results obtained in Crew and Kleindorfer (2002) applies here, with only some minor changes required to accommodate the fact that parcels may be priced non-uniformly in the high-cost and low-cost delivery zones. We provide, therefore, only complete derivations for cases (i) and (ii) below, which are contrasting cases in the use by entrants of the incumbent's downstream delivery facilities. An abbreviated description of the other two cases is also provided. The reader is referred to Crew and Kleindorfer (2002) for a complete analysis of the first-order conditions applying to these cases for letter-mail only.

(i) Ramsey Prices when $P_{Ak}(m) > C_{DEk}(m)$, $k \in \{L, H\}$ and $m \in \{M, N\}$

In this case, $Q_k = Y_k$ for $k \in \{L, H\}$. Access price is so high that entrants find it cheaper to deliver all product m themselves, even in the high-cost delivery zones. Under these circumstances, $P_{Yk} = C_{UE} + C_{DEk}$, for $k \in \{L, H\}$, and the only price that matters in the Ramsey problem is P_Z (which is a single price for $m = M$ and a vector $(P_{ZL}(N), P_{ZH}(N))$ for the case $m = N$. The resulting FOCs characterizing the solution to (A9) for M and N respectively are given as follows (where we suppress the argument m in the expressions below):

Case (i): Mail (All Variables Evaluated at $m = M$; e.g. $P_Z = P_Z(M)$)

$$\sum_{k\in\{L,H\}} \left(P_Z - C_{UI} - C_{DIk}\right)\frac{\partial Z_k}{\partial P_Z} = -r\left(Z_L + Z_H\right) \qquad \text{(A11)}$$

Case (i): Non-Mail (All Variables Evaluated at $m = N$; e.g. $P_Z = P_Z(N)$)

$$\left(P_{Zk} - C_{UI} - C_{DIk}\right)\frac{\partial Z_k}{\partial P_{Zk}} = -rZ_k; \quad k \in \{L, H\} \qquad \text{(A12)}$$

Note that (A11) is the standard Ramsey result for a uniformly priced set of products (in this case end-to-end service to L or H), while (A12) provides individual pricing conditions for the non-mail market, as prices are allowed to be non-uniform across delivery zones in this market. If case (i) were to apply to both M and N, then (A11)-(A12), together with the zero-profit condition $\Pi_I(P) = 0$, would determine the optimal prices $P_Z(M)$, $P_{ZL}(N)$ and $P_{ZH}(N)$ and the optimal value of the Ramsey number r.

One may inquire as to when case (i) could occur in practice. This might be the case when the cost C_a of accepting mail from entrants is very high, as well as when the fixed costs of the USO are high and entrants are relatively

efficient in delivering mail and parcels in both *L* and *H* zones. This case might, of course, obtain for mail (*M*) and not for parcels (*N*).

(ii) Ramsey Prices when $P_{AL} < C_{DEL}$ and $P_{AH} > C_{DEH}$

In this case, $Q_L = 0$ and $Q_H = Y_H$. Substituting for Q_k in (A7), and noting in this case that $P_{YL} = C_{UE} + P_{AL}$, so that $\partial Y_k/\partial P_{YL} = \partial Y_k/\partial P_{AL}$, we obtain the following two sets of FOCs for the prices of interest for mail *M:* ($P_Z(M)$ and $P_{AL}(M) = P_{YL}(M) - C_{UE}(M)$) and parcels *N:* ($P_{ZL}(N)$, $P_{ZH}(N)$ and $P_{AL}(N) = P_{YL}(N) - C_{UE}(N)$):

Case (ii): Mail (All Variables Evaluated at $m = M$; e.g. $P_Z = P_Z(M)$)

$$\left(P_{YL} - C_{UE} - C_a - C_{DIL}\right)\frac{\partial Y_L}{\partial P_Z} + \sum_{k\in\{L,H\}}\left(P_Z - C_{UI} - C_{DIk}\right)\frac{\partial Z_k}{\partial P_Z} = -r\left(Z_L(P) + Z_H(P)\right) \tag{A13}$$

$$\left(P_{YL} - C_{UE} - C_a - C_{DIL}\right)\frac{\partial Y_L}{\partial P_{YL}} + \left(P_Z - C_{UI} - C_{DIL}\right)\frac{\partial Z_L}{\partial P_{YL}} = -rY_L(P) \tag{A14}$$

Case (ii): Non-Mail (All Variables Evaluated at $m = N$; e.g. $P_Z = P_Z(N)$)

$$\left(P_{YL} - C_{UE} - C_a - C_{DIL}\right)\frac{\partial Y_L}{\partial P_{ZL}} + \left(P_{ZL} - C_{UI} - C_{DIL}\right)\frac{\partial Z_L}{\partial P_{ZL}} = -rZ_L(P) \tag{A15}$$

$$\left(P_{ZH} - C_{UI} - C_{DIH}\right)\frac{\partial Z_H}{\partial P_{ZH}} = -rZ_H(P) \tag{A16}$$

$$\left(P_{YL} - C_{UE} - C_a - C_{DIL}\right)\frac{\partial Y_L}{\partial P_{YL}} + \left(P_Z - C_{UI} - C_{DIL}\right)\frac{\partial Z_L}{\partial P_{YL}} = -rY_L(P) \tag{A17}$$

Note also that in deriving these conditions we have used the independence of demands across zones so that, in particular, $\partial Z_H/\partial P_{YL} = 0$.

Case (ii) occurs when entrants enjoyed advantages in high-cost areas and disadvantages in low-cost areas, relative to the incumbent. We would expect this to be a rare case in practice.

(iii) Ramsey Prices when $P_{AL} > C_{DEL}$ and $P_{AH} < C_{DEH}$ and $m \in \{M, N\}$

In this case, $Q_L = Y_L$ and $Q_H = 0$. Thus, here we have the expected case in which entrants use the PO's network for high-cost deliveries, but use their own network for low-cost deliveries. Case (iii) occurs when entrants enjoy advantages in low-cost areas and disadvantages in high-cost areas, relative to the incumbent.

(iv) Ramsey Prices when $P_{Ak} < C_{DEk}$, $k \in \{L, H\}$

Finally, consider the case in which access is priced sufficiently low relative to entrants' downstream delivery costs that entrants only consolidate and presort but do no final delivery. In this case $Q_k(P) = 0$, $k \in \{L, H\}$.

In general, it is not possible to rule out any of the above cases at the Ramsey optimum. In our numerical analysis, we therefore compute the optimal solution for each of the cases (i)-(iv), imposing constraints appropriate to that case. The *optimum optimorum* is then the best solution from among the optima of the 4 cases. We accomplish the numerical solutions provided in the text as follows:

For a fixed $s \in S$, solve the two problem $W(M, s_M)$, $W(N, s_N)$ in (A9). For each sector, this is accomplished by solving each of the 4 cases noted above, with the solution for that sector being the maximum of the 4 cases (if any case is infeasible, its welfare value is considered to be 0).

Using binary search, on $[0, 1]$, determine s^* solving (A10). The prices corresponding to the solutions $W(M, s_M^*)$ and $W(N, s_N^*)$ are the respective optima for the Mail and Parcels sectors respectively, and $s_m^* F_J$ represents the amount of joint costs covered by each sector $m \in \{M, N\}$.

A.2 Illustrative Numerical Examples

Let us now provide some illustrative numerical results. Concerning the cost structure, we investigate several scenarios that build on the following cost parameters:

Table 3M: Cost Parameters for Letter

	Base-case Values	Range
C_{UE}	4	-
C_{UI}	6	-
C_a	1	-
C_{DIL}	15	-
C_{DIH}	30	-
C_{DEL}	13	13 - 18
C_{DEH}	60	-
F_M	1000	-
F_J	400	400 - 800

Table 3N: Cost Parameters for Parcel

	Base-case Values	Range
C_{UE}	40	-
C_{UI}	60	-
C_a	10	-
C_{DIL}	100	-
C_{DIH}	300	300 - 600
C_{DEL}	80	80 - 130
C_{DEH}	600	-
F_N	400	200 - 400

Concerning demand, we assume a single representative consumer with the following structure for the WTP function $V(y, z, \theta) = V(Y, Z)$ in (A2):

$$V(Y,Z) = \sum_{m\in\{M,N\}}\left[\sum_{k\in\{L,H\}} V(Y_k(m), Z_k(m), k, m)\right] \qquad \text{(A18)}$$

where, for $k \varepsilon \{L, H\}$ and $m \varepsilon \{M, N\}$

$$V(Y_k, Z_k, k, m) = a_{km}Y_k^2 + b_{km}Z_k^2 + c_{km}Y_kZ_k + d_{km}Y_k + e_{km}Z_k \qquad \text{(A19)}$$

where $a_{km} < 0$, $b_{km} < 0$, $c_{km} < 0$, $d_{km} > 0$, $e_{km} > 0$. Taking FOCs implied by (A2) and inverting the resulting linear system then gives rise to the following linear demand structure (which because of the separability of the WTP function $V(Y, Z)$ in (A18) is independent across postal products for the L and H delivery zones, but with imperfect substitution between the Entrants and Incumbent products within each zone):

$$Y_k(m) = A_{Yk}(m) - B_{Yk}(m)P_{Yk}(m) + C_k(m)P_{Zk}(m), \quad \forall k,m \qquad \text{(A20)}$$

$$Z_k(m) = A_{Zk}(m) - B_{Zk}(m)P_{Zk}(m) + C_k(m)P_{Yk}(m), \quad \forall k,m \qquad \text{(A21)}$$

The results reported below are for the WTP parameters and corresponding demand structure shown in the Tables 4-5 below. The demand functions in Table 5 are evaluated at the price vectors given in Table 6 below, which provide the Ramsey-optimal price vectors for the base-case parameters given in Tables 3M-3N above.

Table 4M: WTP Parameters for the WTP Structure for Letter

Low-Cost Zone WTP Parameters		High-Cost Zone WTP Parameters	
a_L	-0.06	a_H	-1.5
b_L	-0.08	b_H	-1.6
c_L	-0.01	c_H	-0.02
d_L	30	d_H	60
e_L	60	e_H	75

Table 4N: WTP Parameters for the WTP Structure for Parcel

Low-Cost Zone WTP Parameters		High-Cost Zone WTP Parameters	
a_L	-7	a_H	-750
b_L	-20	b_H	-475
c_L	-1	c_H	-10
d_L	425	d_H	750
e_L	525	e_H	900

Table 5M: Demand Functions for Letter

Entrants Demand			Incumbent Demand		
	Low-Cost Zone	High-Cost Zone		Low-Cost Zone	High-Cost Zone
A_Y	219.895	19.845	A_Z	361.257	23.313
B_Y	8.377	0.333	B_Z	6.283	0.313
C_Y	0.524	0.002	C_Z	0.524	0.002
Y	91.488	9.652	Z	202.140	15.020

Table 5N: Demand Functions for Parcel

Entrants Demand			Incumbent Demand		
	Low-Cost Zone	High-Cost Zone		Low-Cost Zone	High-Cost Zone
A_Y	29.902	0.494	A_Z	12.751	0.942
B_Y	0.071	0.001	B_Z	0.025	0.001
C_Y	0.001	0.000	C_Z	0.001	0.000
Y	21.508	0.232	Z	7.788	0.499

The full Ramsey-optimal solution for the base-case values is reported in various ways in Tables 6 and 7 below. In Table 6, we report the Ramsey results in which the letter-mail sector carries the full burden of the joint USO costs ($s_M = 1$, $s_N = 0$ in (A9) above). We do so both for the optimal non-uniform prices (column 1 of Table 6) as well as for the optimal uniform prices (column 2 of Table 6). Table 7 reports the full Ramsey solution for the base case values at the optimal sharing rule s* = (.75, .25), in which the parcel sector bears about a quarter of the total joint USO costs (as well as its own sector-specific fixed costs). Note that the ECPR prices for access ($P_{Ak} = P_{Zk} - C_{UI} + C_a$) are also recorded in these tables.

As we reported results earlier for letter mail in Crew and Kleindorfer (2002), we begin by focusing on the optimal results for parcel post, taking the base case values of Table 3 above, and varying C_{DIH} (from 300 to 600) for low (80) and high values (120) of C_{DEL} and low (200) and high values of F_N (400). The results are shown in Figures 3-6 below. Note that for all such values the expected pattern of prices occurs. As entrants become relatively less efficient (note that $C_{DIL} = 100$), the incumbent's access price in the low area rises, reflecting the increasing ability of low-cost service area products to provide some contribution to overall fixed costs as entrants become less efficient. As fixed costs increase overall price levels increase.

Table 6: Ramsey solutions for Base Case Values and $s_M = 1, s_N = 0$

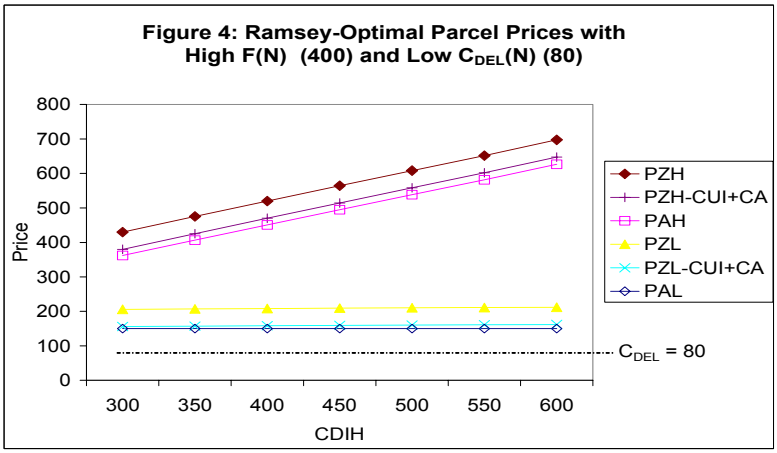
	Letters	Parcels (differential pricing)	Parcels (uniform pricing)
C_{DEL}	13.0	80.0	80.0
P_{YL}	17.0	120.0	120.0
P_{YH}	33.1	403.0	272.9
P_{ZL}	29.1	205.9	232.9
P_{ZH}	29.1	429.5	232.9
P_{AL}	13.1	80.0	80.0
P_{AH}	29.1	363.0	232.9
Y_L	92.7	21.5	21.5
Y_H	8.9	0.2	0.3
Z_L	187.4	7.7	7.0
Z_H	14.3	0.5	0.7
Profit	0	0	0
Welfare	3,947	4,666	4,619
$P_{ZL}-C_{UI}+C_A$	24.1	155.9	182.9
$P_{ZH}-C_{UI}+C_A$	24.1	379.5	182.9
s_M, s_N	1.00	0.00	0.00
Total Welfare (differential pricing)	= 3,947 + 4,666 = 8,613		
Total Welfare (uniform pricing)	= 3,947 + 4,619 = 8,566		

Table 7: Full Ramsey Solutions for Base Case

	Letter	Parcel
C_{DIH}	13.0	80.0
P_{YL}	17.0	120.
P_{YH}	32.5	417.
P_{ZL}	28.5	220.
P_{ZH}	28.5	451.
P_{AL}	13.1	80.0
P_{AH}	28.5	377.
Y_L	92.4	21.5
Y_H	9.1	0.2
Z_L	191.	7.4
Z_H	14.5	0.5
Profit	0	0
Welfar	4,07	4,54
$P_{ZL}-C_{UI}+C_a$	23.5	170.
$P_{ZH}-C_{UI}+C_a$	23.5	401.
s_M, s_N	0.75	0.25
Total	= 4,073 + 4,546 = 8,619	

We note that the ECPR level of prices (which in this case would set access prices equal to $P_{Ak} = P_{Zk} - C_{UIk} + C_a$) are, in most instances, a

reasonable approximation to the Ramsey-optimal DAP prices.[13] Because elasticity in the high-cost areas is somewhat in excess of the low-cost demand elasticities for these demand functions, the ECPR approach does not provide as high a discount as the Ramsey optimal DAP rule, but the results are close (for parcels). We note in passing that the Ramsey-optimal price P_{AL} in Figures 3-4 can be any price larger than C_{DEL} (and not just the value shown on these Figures); that is, any price that assures that the more efficient entrants will deliver their own parcels in low-cost areas is equally efficient.



[13] This contrasts with the results for uniform pricing for sector M where (as shown in Crew and Kleindorfer (2002)) the Ramsey-optimal DAP prices typically exceed the avoided cost/ECPR price $P_Z - C_{UI} + C_a$. This is especially important for high fixed costs and large differences between low-cost and high-cost delivery.

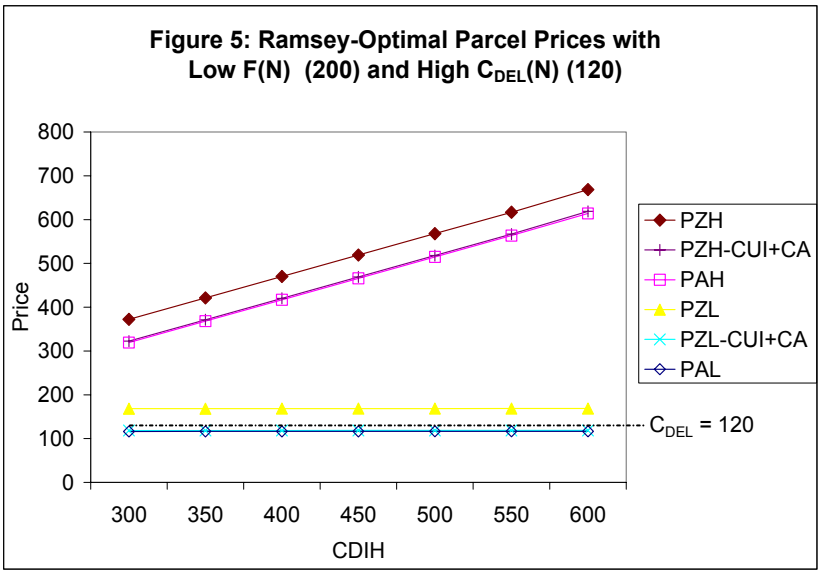


Figure 5: Ramsey-Optimal Parcel Prices with
Low F(N) (200) and High C_{DEL}(N) (120)
800
700
600
500
400
300
200
100
0
Price
300
350
400
450
500
550
600
CDIH
PZH
PZH-CUI+CA
PAH
PZL
PZL-CUI+CA
PAL
C_{DEL} = 120

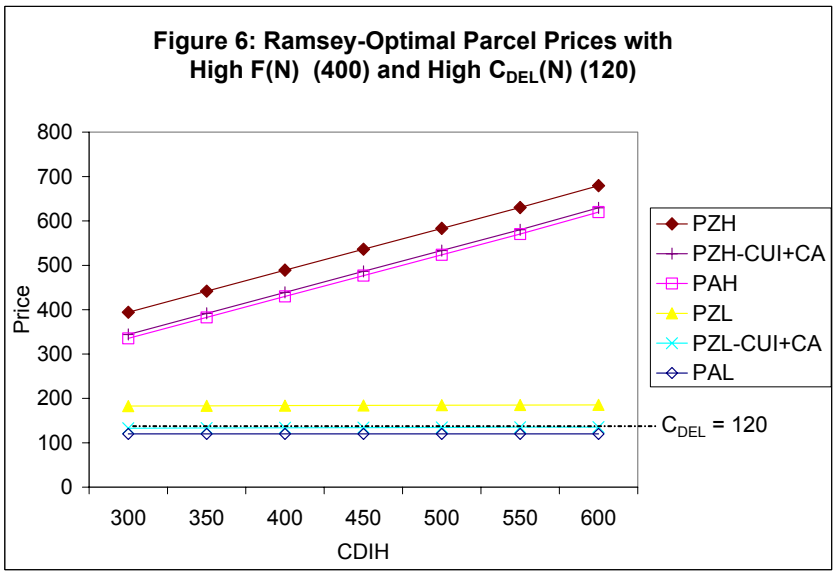


Figure 6: Ramsey-Optimal Parcel Prices with
High F(N) (400) and High C_{DEL}(N) (120)
800
700
600
500
400
300
200
100
0
Price
300
350
400
450
500
550
600
CDIH
PZH
PZH-CUI+CA
PAH
PZL
PZL-CUI+CA
PAL
C_{DEL} = 120

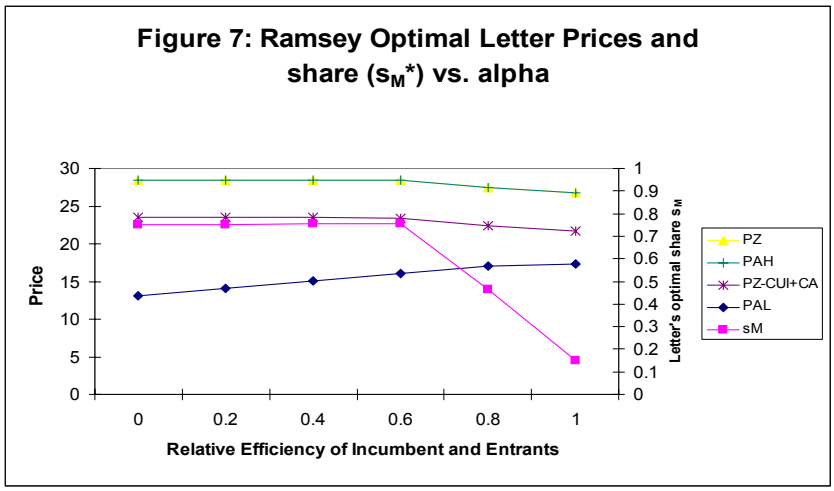
We now consider the joint impact of DAP pricing across letters and parcels. This is explored for variations on the base case parameters in Figures 7-10. All of these figures show the optimal prices for specific sectors as labeled, together with the optimal proportion s_m* of joint costs borne by that sector.

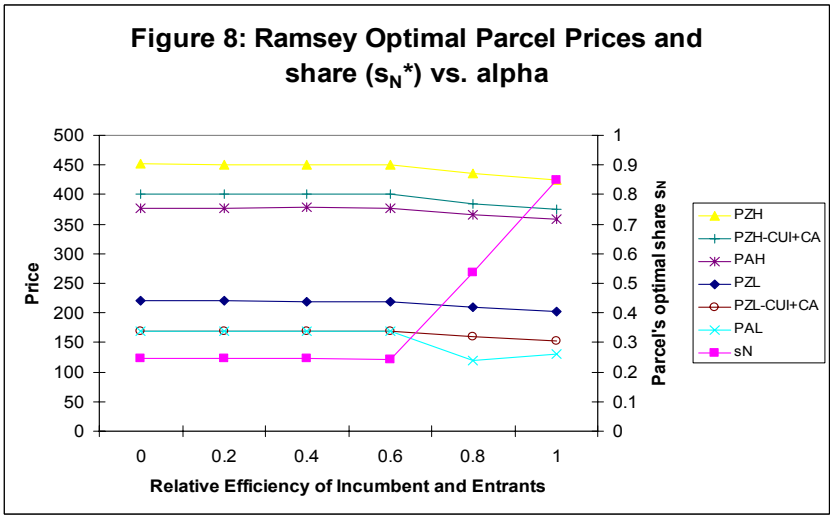
Figures 7-8 show the effect of increasing inefficiency of entrants, where we plot against the parameter $\alpha \in [0, 1]$, where for each designated α, the values of all base-case parameters were as given in Table 3, except for $C_{DEL}(M)$ and $C_{DEL}(N)$, the delivery costs of entrants for M and N in the low-cost area; for these costs we used a convex combination of the highest and lowest cost figures given in Table 3, with coefficients α and 1- α, i.e.:

$$C_{DEL}(M,\alpha) = \alpha(18) + (1-\alpha)(13)$$
$$C_{DEL}(N,\alpha) = \alpha(130) + (1-\alpha)(80) \qquad \text{(A20)}$$

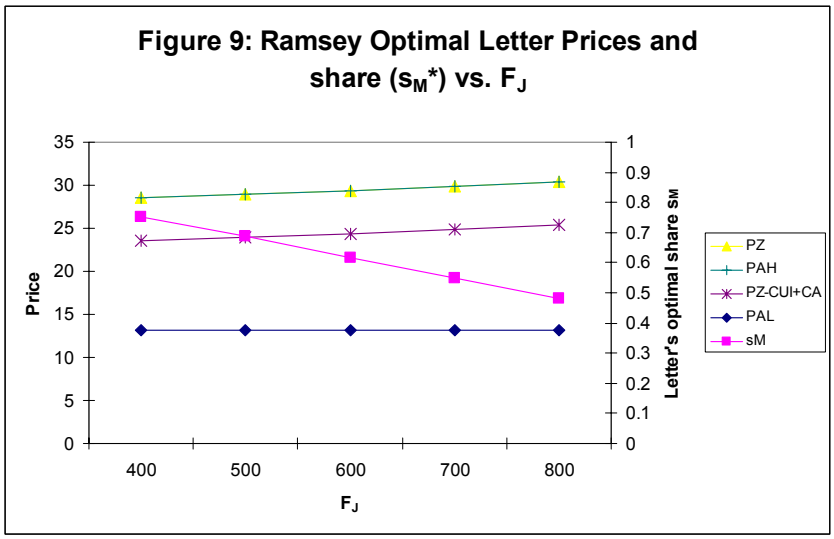
Thus, as α increases, entrants become relatively less efficient as compared to the incumbent. The cutoff value at which entrants are equally efficient (including the cost C_a of accommodating their access to the incumbent's network) is $\alpha = .60$. As expected, as entrants become less efficient in the low-cost sectors, pricing is eased across the board for both sectors, and the parcel sector is able to provide an increased contribution to joint fixed costs at the Ramsey optimum.

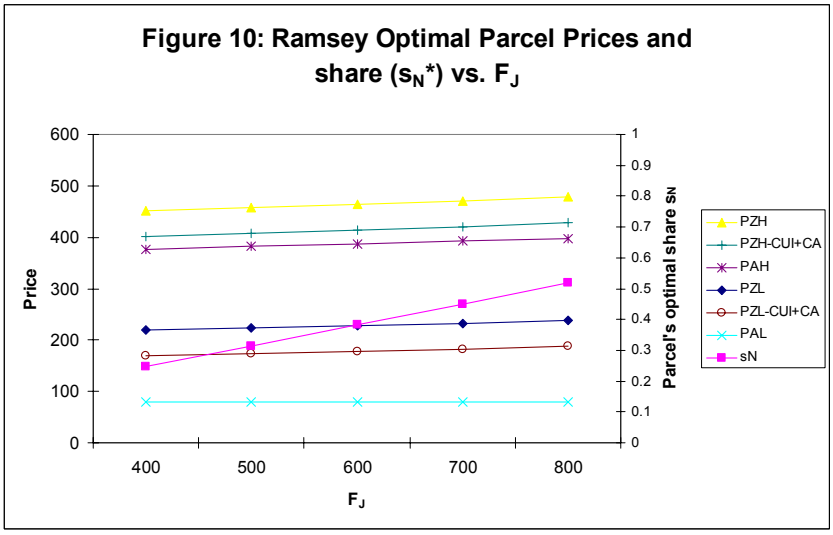
Figures 9-10 show similarly the values of optimal prices and sectoral participation in financing joint costs with varying levels of the joint costs F_J. Note that in this case, the ECPR approach remains a reasonable approach except for the case in which fixed USO costs are high and the parcels sector (at the Ramsey optimum) makes a significant contribution to covering these. In this case, the DAP approach is quite different since it allows for the incumbent PO to price delivery in the low-cost area at a level that reflects "work yet to be done" and the optimal access price is just low enough to under price the inefficient entrants. Under ECPR, by contrast, inefficient entrants are allowed to capture the downstream market in the low-cost area, clearly an inefficient outcome.





Summarizing these results, we see that DAP is an essential ingredient in the letter mail sector, and is quite different than ECPR. For the parcels segment, which in our analysis does not face a uniform pricing constraint, ECPR provides a reasonable approximation to the Ramsey optimal DAP rule except when the parcels sector assumes a heavy fixed cost burden and





entrants are relatively inefficient. The Avoided Cost/ECPR Rule suffers considerable efficiency losses in the letter mail sector where USO fixed costs are high and there are significant differences between C_{DIL} and C_{DIH}. As noted, in parcels, ECPR is a reasonable approximation across a broad set of scenarios, assuming that the end-to-end prices, which serve as the foundation for the rule, are set properly.

It is instructive to provide a brief formal synthesis of the DAP Rule via an approximation that fits the above examples well. Such an approximate DAP rule for access pricing is the following (we suppress the sector variable *m* here):

$$\begin{aligned} P_{Ak} = {} & Min\left[P_{Zk}, Max\left(P_{Zk} - C_{UI} + C_a, C_a + C_{DIk}\right)\right] \times \\ & \left[1 - \varphi\left(C_{DEk} - C_a - C_{DIk}\right)\right] \\ & + Min\left[P_{Zk}, C_{DEk} - \varepsilon, Max\left(P_{Zk} - C_{UI} + C_a, C_a + C_{DIk}\right)\right] \times \\ & \varphi\left(C_{DEk} - C_a - C_{DIk}\right) \end{aligned} \tag{A23}$$

recalling that $\varphi(p) = 0$ if $p \leq 0$ and 1 otherwise, where $\varepsilon > 0$ is suitably small. The essence of this summary rule is to separate two case, one in which the incumbent is more efficient than entrants (the case where $\varphi(C_{DEk} - C_a - C_{DIk}) = 1$) and the case where the entrants are more efficient than the incumbent (the case where $\varphi(C_{DEk} - C_a - C_{DIk}) = 0$). In the former case, the bottom line of (A23) applies, which assures that access prices will be set so that the more efficient incumbent does final delivery. In the latter case, the top line of (A23) determines the access price for zone k, and the entrants are likely to deliver mail in zone k (unless the ceiling price of the incumbent's end-to-end service becomes active and entrants use the PO's services). The reader can check that the above formula neatly captures the various cases examined in our numerical examples. Indeed, if one uses (A23) instead of the full Ramsey formulation of our examples, solving only for P_{Zk}, but using (A23) to set P_{Ak} for any values of P_{Zk}, then (A23) exactly replicates the Ramsey-optimal solutions for our examples. While this is certainly interesting, a theoretical justification of this approximation awaits further research.

Finally, a little bit of arithmetic establishes the following intuitively appealing results concerning the approximate DAP access prices derived from (A23):

$$\left(C_a + C_{DIk}\right)\varphi\left(P_{Zk} - P_{Ak}\right) \leq P_{Ak} \leq P_{Zk} \tag{A24}$$

Noting the definition of φ, this means that DAP access prices, as determined by (A23), will always cover acceptance and delivery costs, except in the case in which these access prices equal the PO's prices for end-to-end service (i.e. are driven to their upper bound by the DAP logic.)

REFERENCES

Billette de Villemeur, Etienne, Helmuth Cremer, Bernard Roy, and Joelle Toledano, 2003. Optimal Pricing and Global Price Caps in the Postal Sector", forthcoming *Journal of Regulatory Economics*.

Cohen, Robert H., William W. Ferguson, John D. Waller, and Spyros S. Xenakis. 2000. "Universal Service without a Monopoly." In *Current Directions in Postal Reform*, edited by Michael A. Crew and Paul R. Kleindorfer. Boston, MA: Kluwer Academic Publishers.

Cohen, Robert H., Matthew Robinson, John D. Waller, and Spyros S. Xenakis. 2003." The Costs of Universal Service in the U.S. and its Impact on Competition." Washington, DC, United States Postal Rate Commission,

Crew, Michael A., and Paul R. Kleindorfer. 1986. *The Economics of Public Utility Regulation*. Cambridge, MA: MIT Press.

Crew, Michael A., and Paul R. Kleindorfer. 1994. "Pricing, Entry, Service Quality, and Innovation under a Commercialized Postal Service." In *Governing the Postal Service*, edited by J. Gregory Sidak. Washington, DC: The AEI Press.

Crew, Michael A., and Paul R. Kleindorfer. 2000. "Liberalization and the Universal Service Obligation in Postal Service." In *Current Directions in Postal Reform*, edited by Michael A. Crew and Paul R. Kleindorfer. Boston, MA: Kluwer Academic Publishers.

Crew, Michael A., and Paul R. Kleindorfer. 2001. "Whither the USO under Competitive Entry: A Microstructure Approach." In *Future Directions in Postal Reform*, edited by Michael A. Crew and Paul R. Kleindorfer. Boston, MA: Kluwer Academic Publishers.

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

Crew, Michael A., and Paul R. Kleindorfer. 2003. "Postal Privatization: in General and for the United States Postal Service." In *International Handbook on Privatization*, edited by David Parker and David Saal, London, U.K.: Edward Elgar, *forthcoming.*

Crew, Michael A., Paul R. Kleindorfer and John Sumpter. 2003."Bringing Competition to Telecommunications by Divesting the RBOCs." Center for Research in Regulated Industries, Rutgers University, Newark, NJ

De Donder, Philippe, Helmuth Cremer, and Frank Rodriguez. 2002. "Access Pricing and Parcels Delivery." In *Postal and Delivery Services: Delivering on Competition*, edited by M.A. Crew and P.R. Kleindorfer. Boston, MA: Kluwer Academic Publishers.

Laffont, Jean-Jacques, and Jean Tirole. 1996. "Creating Competition Through Interconnection: Theory and Practice." *J. of Regulatory Economics* 10 (Nov.): 227-256.

Littlechild, Stephen C. 1983. *Regulation of British Telecommunications' Profitability*. London: Department of Trade and Industry.

Mandy, David M. 2000. "Killing the Goose That May Have Laid the Golden Egg: Only the Data Know Whether Sabotage Pays." *J. of Regulatory Economics* 17 (March): 157-172.

Panzar, John C. 2002. "Reconciling Competition, Downstream Access, Universal Service in Postal Markets." In *Postal and Delivery Services: Delivering on the Competition*, edited by Michael A. Crew and Paul R. Kleindorfer. Boston, MA: Kluwer Academic Publishers.

Postcomm. 2002. Postcomm's Proposals for Promoting Effective Competition in U.K. Postal Services. London, U.K.

Sappington, David E. M. and J. Gregory Sidak. 2003. "Incentives for Anticompetitive Behavior by Public Enterprises". (forthcoming) *Journal of Industrial Organization.*

Weisman, Dennis L., and Jaesung Kang. 2001. "Incentives for Discrimination When Upstream Monopolists Participate In Downstream Markets." *Journal of Regulatory Economics* 20 (no. 2, September): 125-139.