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Postal Service Pricing Policies after PAEA

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Executive Summary

The Postal Accountability and Enhancement Act of 2006 (PAEA) fundamentally altered the U.S. Postal Service by introducing enhanced pricing flexibility, profit incentives, and potential antitrust liability. PAEA also mandated a change from breakeven, cost-of-service regulation where revenues must equal costs over time to price cap regulation. The Postal Service can now introduce new or modify existing prices for market-dominant products as long as the price increase does not exceed the growth in the consumer price index.

The combination of pricing flexibility and profit retention is a hallmark of PAEA, and it ushered in a new landscape of economic incentives facing the Postal Service. The consequences and impact of these incentives remain to be seen; hence, the United States Postal Service, Office of Inspector General (OIG) retained John C. Panzar, Ph.D., to perform foundational research on the economic incentives facing the Postal Service.[1] The research offered key insights to understanding Postal Service pricing and marketing initiatives under price cap regulation, and discussed potential antitrust implications.

Dr. Panzar documented his research in the attached report entitled “Postal Service Pricing Policies after PAEA.” The research analyzed pricing initiative implications for market dominant products under price cap regulation and offered the following findings in three areas – worksharing discounts, quantity discounts, and channel-based discounts.

1. Worksharing Discounts – the Postal Service faces a strong economic incentive to set worksharing discounts *below* the costs those activities avoid. Although permissible under PAEA, this would break with long-standing efficiency arguments and invite antitrust scrutiny because it would exclude more efficient providers of worksharing activities. Setting worksharing discounts below the costs avoided would also be controversial because most mail is workshared.

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2. Quantity Discounts – these types of discounts have an important role under PAEA. There are generally two applicable areas – one where customers do not compete with each other and their demand for postal products is independent and one where customers are competitors with each other and their demand for postal products is interdependent.

    a. Independent demands – a classic "win-win" situation, the Postal Service and those customers offered quantity discounts are better off while other customers are no worse off. Notably, the price cap automatically protects other customers, so there is no need for heavy regulation. Although there are likely finite opportunities, the Postal Service faces a strong incentive to enter into as many independent demand quantity discounts as possible.

        An example of this situation would be quantity discounts offered to customers specializing in advertising using letter mail and customers specializing in catalogs. Another would be discounts offered to bill presentment mailers and discounts offered to advertisers.

    b. Interdependent demands – the quantity discounts benefit the parties to the agreement at least partially at the expense of other customers. The price cap is not sufficient to protect competitors of favored customers; hence, disadvantaged customers may seek relief under antitrust provisions. Regardless, the Postal Service faces an economic incentive to negotiate quantity discount arrangements with individual customers.

        An example of this situation would be quantity discounts offered to intra mail class competitors such as advertisers.

3. Channel-Based Discounts – PAEA allows cost-based discounts based on alternative distribution channels such as window and internet transactions. These types of discounts are likely to be attractive to the Postal Service. The economic incentive is stronger when (i) the channel is new and previously unavailable; (ii) the channel exhibits very different costs; or (iii) the total demand for the existing and alternative channels is inelastic. Generally, the Postal Service is better off the more it discriminates its prices based on costs, but this is likely to produce both winners and losers among customers.

Postal Service Pricing Policies after PAEA

by

John C. Panzar*

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1. INTRODUCTION AND SUMMARY

The primary goal of this paper is to conduct a theoretical analysis of the impact of the Postal Accountability and Enhancement Act of 2006 (PAEA) on the pricing incentives facing the United States Postal Service.[2] In addition, I devote considerable

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*Professor of Economics, University of Auckland and Louis W. Menk Professor Emeritus, Northwestern University. This paper was commissioned by the Office of the Inspector General of the United States Postal Service. The views expressed are those of the author and do not necessarily reflect those of either the Office of the Inspector General or the United States Postal Service. I would like to thank, without implicating, Lawrence Buc, Robert Cohen, Felicia Hawkins, Robert Mitchell, Matthew Robinson, John Waller, and David Yacobucci for helpful comments and suggestions.

[2] See Bradley, *et. al.* (2008) for a more extensive discussion of the provisions of PAEA. They also present the results of a calibration model that attempts to quantify the likely impact of the legislation of Postal Service prices.

attention to the antitrust issues that may arise should the Postal Service follow such incentives.[3]

The basic framework used in this study is the analysis of the behavior of a profit seeking enterprise.[4] However, the objective is not to attempt to suggest new profit making pricing innovations for the Postal Service (or to offer advice to its Marketing Department). Rather, I seek to understand the market implications of giving the Postal Service enhanced pricing flexibility and profit incentives. One of the primary goals of PAEA was to enhance the incentives for the Postal Service to operate efficiently and profitably. The mandated change from the cost of service regulation instituted by the Postal Reform Act (PRA) to PAEA "price cap" regulation has been subsequently implemented through various decisions of the Postal Regulatory Commission (PRC). Of course, the mere ability of the Postal Service to actively pursue profit opportunities

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[3] For further discussions of the interaction between regulatory and antitrust policy in the postal sector, see Panzar (2008). Portions of the model used in Section 2 appear there.

[4] There is considerable debate in the literature concerning the appropriate objective function to use when modeling the behavior of the Postal Service and other public enterprises. Several authors have suggested that *revenue maximization* may be a more realistic hypothesis than profit maximization for such organizations. See, for example, Bradley *et. al.* (2004), (2008) and Sappington and Sidak (2003a), (2003b). In general, the choice of objective function can have both positive (descriptive) and/or normative (welfare) implications for the results of the model. However, these issues are of lesser concern in the post PAEA environment because (i) PAEA allows the Postal Service to retain some profits, making the profit-seeking assumption more plausible and (ii) PAEA price cap regulation mitigates the theoretical problems that may arise under the assumption of revenue maximization.

through its pricing policies does not automatically convert it into a profit maximizing enterprise. However, PAEA does allow the Postal Service limited ability to retain the profits resulting from productivity and pricing innovations it may undertake.

Pricing flexibility and potential antitrust liability go hand in hand. PAEA granted the Postal Service limited pricing flexibility through the move to price cap regulation, but also subjected it to antitrust scrutiny for the first time in its history. Indeed, pricing flexibility gives the Postal Service the ability to *directly* impact customers and competitors in ways that may give rise to antitrust liability. While its pricing flexibility is limited by PRC decisions, it is far less likely to be able to claim to damaged competitors that "the Commission made me do it." Thus, I will devote considerable attention to potential antitrust implications of post PAEA Postal Service pricing innovations. Of course, under the Supreme Courts decision in *Trinko*,[5] PRC actions may also impact the extent of antitrust liability faced by the Postal Service.

Section 2 presents an analysis of a simple model of worksharing incentives under PAEA price cap regulation. Starting from an initial situation in which the worksharing discount is set equal to avoided cost, the pricing flexibility permitted by price cap regulation gives the Postal Service the incentive to decrease both the worksharing

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[5] *Verizon Communications, Inc. v. Law Offices of Curtis V.* Trinko*, LLP* 540 U.S. 398 (2004). See Brennan (2008) for a detailed discussion and critique of the *Trinko* decision for the future of antitrust and regulatory policies in network industries.

discount and the basic rate. Because the resulting worksharing discount would be *below* avoided cost, efficient competitors would be excluded from the upstream market for sorting services. Such exclusion may give rise to antitrust concerns, even though the resulting changes may tend to increase total surplus.

Section 3 analyzes quantity discounts in a post PAEA environment. After reviewing the classic, "win-win" argument in support of negotiated quantity discounts, I explain how PAEA price cap regulation enhances their desirability by automatically preventing increases in the level of the base price. However, I also explain the problems that can arise with quantity discounts in situations in which customer demands are interdependent – as is typically the case when customers are competitors in the same final product industry. In that case, small users may be damaged by the mutually beneficial agreements that may be negotiated between large users and the Postal Service. Moreover, these damages can result even when price cap regulation prevents an increase in the basic rate. Such damaged competitors may claim to be victims of *secondary line injury* under the Robinson Patman Act. Nonetheless, analysis shows that, again, *total* surplus increases as a result of the introduction of such discounts.

Section 4 turns to the analysis of *channel based discounts*, situations in which firms may find it profitable to introduce different prices based upon the distribution channel used to sell or deliver a product. For example, it may be cheaper to sell postage to mailers through meters or over the Internet rather than at post office windows. Under

what circumstances will the flexibility provided by PAEA price cap regulation provide incentives for the Postal Service to introduce discounts for mailers that choose to utilize such alternative distribution channels? While there is no definitive answer to this question,[6] the analysis produces significant insights. First, the Postal Service will always have an incentive to introduce a small discount for *new* distribution channels that reduce its costs. Second, the greater the cost savings offered by the distribution channel, the more likely it will be profitable to introduce a small discount. Finally, discounts are more likely to be optimal if their introduction serves primarily to reallocate existing demand between channels rather than stimulating new demand.

Section 5 offers some concluding thoughts. The Appendix provides additional derivations and results beyond those presented in the text. In particular, the welfare effects of the three types of discounts are analyzed and discussed.

2. WORKSHARING

The ubiquitous delivery network of the incumbent is a tempting target for competitors, entrants, and regulators.[7] A variety of empirical studies have shown that

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[6] Ultimately, the issue comes down to the profitability of introducing Third Degree price discrimination. As such, the matter turns on the relationship between price elasticities of demand.

[7] Competitors view the economies of scope resulting from the Postal Service's extensive network for *monopoly products* as giving rise to unfair advantage for its competitive products. For a clear statement of

incumbents' delivery networks exhibit significant economies of scale.[8] Yet, they do not exhibit the substantial sunk costs that characterize the "monopoly bottlenecks" of other network industries such as telecommunications and electric power.

From the regulatory point of view, any activity which exhibits economies of scale has the potential to be efficiently shared with competitors. It does not really matter if the productive resource is "impossible or impractical" to reproduce. If the transactions costs from unbundling are sufficiently low, a policy of compulsory access can be used to open significant portions of the value chain to competition. This argument has little connection with the considerations associated with the typical essential facilities deliberation.

It is perhaps possible to reconcile the regulatory and antitrust views of mandated access in a postal sector, in which the incumbent has a statutory delivery monopoly for at least some products. In that case, one could take the view that the illegality of replicating the incumbent's network plays the same role as technical impossibility. In such circumstances, a regulatory policy of mandated downstream access at regulated rates has been demonstrated to have a significant impact on increasing upstream competition and

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this position, see US Federal Trade Commission, Postal Service Study, Project No. PO71200, Declaration of J. Gregory Sidak (2007).

[8] For example, see Cazals, De Rycke, Florens, and Rouzard (1997); Cazals, Florens, and Soteri (2005); and Cohen and Chu (1997).

overall cost efficiency in the postal sector.[9] However, this harmony begins to be strained once the delivery market is fully opened to competition. In the absence of significant sunk costs, and ample direct and indirect evidence that it *is* possible for entrant's to create duplicate delivery networks, it is difficult to defend a policy of mandated access on the basis of an essential facilities argument.[10]

Nonetheless, it seems likely that regulators will accede to the requests of end-to-end competitors that forced access be granted. The important question, as always, will be determining the *terms* of such access. Once such terms have been established, the competition authority – even one that had no interest in compelling access itself on essential facilities grounds – should find itself interested in the pricing of access. This is so because the spread between the access price and the retail price affects the ability of "equally efficient" competitors to compete with the incumbent in the market for the upstream component.

In particular, such *exclusion* will be a problem whenever the regulatory process leads to the establishment of access prices that *exceed* those that would result from the application of the Efficient Component Pricing Rule (ECPR), i.e. worksharing discounts that are *less* than the upstream costs saved by the incumbent.

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[9] See, for example, the evidence presented in Cohen, Ferguson, Waller and Xenakis (2002) and Cohen, Robinson, Waller and Xenakis (2006).

[10] See Panzar (2002) and de Bijl et al. (2006) for a discussion of the pros and cons associated with mandating unbundled downstream access.

2.1 Worksharing under the PRA

Worksharing was the crowning achievement of postal policy under the PRA. Its use succeeded in "liberalizing" a large share of postal sector value added and created a highly innovative competitive industry. The result was enhanced economic efficiency for both the postal sector and the Postal Service.

The guiding policy principle of the PRC toward worksharing was the Efficient Component Pricing Rule (ECPR). Worksharing discounts were set equal to the (unit) avoided costs of the Postal Service. ECPR decentralizes the minimization of postal sector end-to-end costs between Postal Service and upstream competitive providers. The following simple model illustrates the power of ECPR.

Consider a stylized postal sector in which the Postal Service offers two products: end-to-end service and workshared mail. The rate charged for end-to-end service is given by the stamp price p. The Postal Service also offers a discount of δ for delivering workshared mail. Worksharing services are assumed to be provided to mailers by a perfectly competitive industry. For simplicity, I assume that, as far as consumers are concerned, mail that is workshared is a perfect substitute for that handled end-to-end by the Postal Service. Thus, consolidators collect mail from end-to-end consumers and receive p per piece. After processing it, they hand it over to the Postal Service for delivery, paying the discounted rate $p_D = p - \delta$ per piece. From consolidators point of view, the relevant market price is the worksharing discount δ.

To complete the description of this stylized postal sector, let $D(p)$ denote the total demand for the end-to-end service as a function of the stamp price p and let $S(\delta)$ denote the competitive supply of consolidators' upstream services as a function of the worksharing discount δ. Thus, end-to-end and workshared volumes carried by the incumbent are given by $D(p) - S(\delta)$ and $S(\delta)$, respectively. Let t and c, respectively, denote the incumbent's unit costs of upstream sorting and downstream delivery and let F denote its fixed costs (from all stages).

This simple framework suffices to illustrate the efficiency properties of an ECPR policy for worksharing. The efficiency follows from the well known principle of optimality for a "multi-plant" industry: the marginal costs of all active producers must be equated in order for industry costs to be minimized. In competitive equilibrium, the marginal cost of all active fringe providers is equated to the market price they face: i.e., the worksharing discount δ. Thus, when this discount is set equal to t, the upstream unit costs of the Postal Service *avoided* by worksharing, all upstream marginal costs for the postal sector are equated and upstream sector costs are minimized. Figure 1 illustrates this situation.

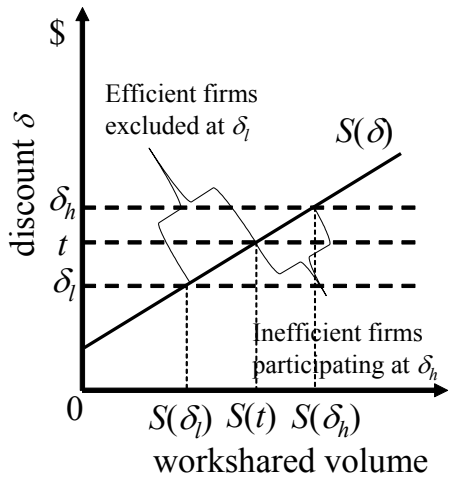

Figure 1

The diagram also makes clear the inefficiencies that result when the worksharing discount is *not* set equal to the avoided upstream unit cost of the Postal Service. When the discount is set equal to $\delta_l < t$, the fringe provides too little worksharing: i.e., only $S(\delta_l)$ units. Firms whose unit costs of providing the upstream service component are less than that of the Postal Service do not fully participate in the market. Similarly, if the discount is set equal to $\delta_h > t$, the fringe provides too much worksharing: i.e., units of upstream service that are more costly than those of the Postal Service are drawn into the market.

2.2 "Exclusionary" Access Charges Resulting from the Introduction of Global Price Cap Regulation

To make this issue concrete, consider the potential antitrust implications of the regulatory changes mandated by PAEA. In an attempt to improve pricing flexibility on the part of the Postal Service, PAEA mandated that the Postal Regulatory Commission

implement a price cap regime to control the prices of the Postal Service's market dominant services. While the details of this price cap regime are still evolving, in its initial application, the prices of workshared and non-workshared products were treated symmetrically under the cap.[11] The foregoing example can be used to illustrate the possible "exclusionary" effects of this regulatory policy change.

As above, the Postal Service provides two market dominant services: an end-to-end service and a workshared (or "access") service. In the case of the workshared service, competitive consolidators provide upstream, sorting functions and the incumbent provides only delivery. Assume that, initially, the incumbent was regulated to break-even by cost of service regulation and the worksharing discount was set equal to the upstream unit costs of the incumbent; i.e., according to the ECPR. Now suppose a price cap regime is introduced to control the prices of the incumbent and that, as is common, the price weights are set equal to the actual market quantities in the previous period.

In terms of the model, let p^0 and δ^0, respectively, denote the stamp price and worksharing discount established by the regulator before the move to price cap regulation. Then, the initial quantities of end-to-end and workshared mail are given by $D(p^0) - S(\delta^0)$ and $S(\delta^0)$, respectively.

Under these circumstances, the profits of the incumbent postal operator are given by

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[11] That is, the regime is one of "global" price cap regulation. See De Donder et al. (2006) for a discussion.

(1) $$\pi(p,\delta) = (p\text{-}t\text{-}c)[D(p)\text{-}S(\delta)] + (p\text{-}\delta\text{-}c)S(\delta) - F$$

The global price cap regulation subjects the incumbent's choice of stamp price and workshare discount to the following constraint:

(2) $$p(D^0\text{-}\ S^0) + (p\text{-}\delta)S^0 \leq\ p^0(D^0\text{-}\ S^0)+(p^0\text{-}\delta^0)S^0.$$

This condition requires that, *when evaluated at last period's volumes*, the stamp price and discount chosen by the incumbent cannot be expected to yield more than last period's revenues.[12] When the constraint is binding, it can be solved to yield an expression relating the allowed levels of the stamp price and worksharing discount: i.e.,

(3) $$p^c(\delta) = p^0 + (\delta - \delta^0)(S^0/D^0)$$

Equation (3) has the intuitive interpretation that the price cap constraint allows the incumbent to increase its stamp price *only if* it also increases its worksharing discount.

It is now possible to evaluate the incentives facing a firm which has been subjected to price cap regulation in these circumstances. In order to examine the effects

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[12] This is the basic *Laspeyres price cap index formula* most commonly used in the practice of price cap regulation. The need for some index formula arises whenever price cap regulation is applied to a group (or *basket*) of products. Here, and elsewhere in this paper, I am holding all other prices of the Postal Service constant. This allows me to express the price cap constraint only as a function of the variables of interest. Obviously, *all* the rates of interest can be increased under a price cap as long as the impact is offset by decreases in other rates. However, under the assumption that other rates are held constant, the relevant constraint facing the Postal Service is the simple one used here.

on Postal Service profits of a small change in the worksharing discount, substitute equation (3) into equation (1) and differentiate with respect to δ to obtain:

$$(4) \qquad \frac{d\pi[p^c(\delta),\delta]}{d\delta} = \frac{\partial\pi}{\partial p}\frac{dp^c}{d\delta} + \frac{\partial\pi}{\partial\delta} = \frac{[(p^c - t - c)D' + D]S^0}{D^0} + (t-\delta)S' - S$$

Evaluating this expression at $\delta = \delta^0 = t$ and $p = p^*(t) = p^0$ yields:

$$(5) \qquad \frac{d\pi[p^c(t),t]}{d\delta} = \frac{(p^0 - t - c)D'(p^0)S(t)}{D(p^0)} < 0$$

Thus, in this situation, the Postal Service would have a profit incentive to *reduce* the worksharing discount below its initial ECPR level.

Under ECPR (avoided cost) worksharing discounts, all upstream competitors that were at least as efficient as the incumbent were active in the market. After the change in regulatory policy, the incumbent would have a profit incentive (and regulatory "permission") to exclude some of them. Presumably, this outcome would be of concern to the competition authorities. That is, even if application of essential facility considerations does not dictate that there *must be* an upstream market for competition policy reasons, once such a market has been created by the regulatory process, competition policy criteria would apply. Usually, such potential conflicts can be avoided through adjustments in regulatory policy: e.g., in the present example, one could change the form of the price cap and/or impose the added constraint that worksharing discounts satisfy ECPR. However, this just reinforces the point that regulatory policies may sometimes conflict with competition policy in this important area.

3. QUANTITY DISCOUNTS UNDER PAEA

Before PAEA, Negotiated Service Agreements (NSAs) involving *quantity discounts* were introduced as an opportunity to both increase economic efficiency and improve Postal Service profits. Despite their theoretical advantages, these contracts were subject to detailed scrutiny by the PRC. In this Section, I review the theory of quantity discounts and examine how PAEA can be expected to influence their use. This involves an analysis of both the post PAEA incentives of the Postal Service to *introduce* such discounts as well as its incentives to adjust existing discounts under the pricing flexibility newly provided by PAEA price cap regulation.

3.1 Quantity Discounts in pre PAEA NSAs

3.1.1 The "Win-Win" Theory of Quantity Discounts

Over the past few decades, "quantity discounts" implemented through optional tariff schemes have won increasing acceptance from economists and regulators alike.[13] The basic intuition is quite simple. The firm offers "large users" a discount on all units purchased above a certain threshold volume. "Small users" are free to continue to purchase at the original, undiscounted rate. Clearly, any user that takes advantage of the discounted rate does so because it perceives itself to be better off. Users that do not take

[13] Both the rigorous theoretical justification and the intuitive motivation were provided in the seminal contribution of Willig (1978).

advantage of the discount can be no worse off as long as the original rate remains available. And, finally, the increase in volume increases the firm's profit as long as the optional (discounted) rate is above its unit cost.

The argument can be illustrated using a simple diagram (Figure 2). Assume that there are two types of users: high demand, type 2 users and low demand, type 1 users. Their demand curves are given, respectively, by $D_2(p)$ and $D_1(p) < D_2(p)$, where p is the price of the service. Suppose p^0 is the initial uniform price charged to all users. At that price the initial quantities purchased by large and small users are given by $q_2^0 = D_2(p^0)$ and $q_1^0 = D_1(p^0)$. Now the firm offers the following quantity discount option: any consumer who purchases at least q_2^0 units at the base price of p^0 can purchase additional units at the price $p^* = p^0 - \delta$.

It is easy to see the effects of this offer in Figure 2. Type 1 consumers have no interest in changing their behavior because their marginal willingness to pay would drop to zero before they consumed the quantity required to be eligible for the discount. Yet, these consumers are no worse off because they are free to continue to purchase their desired quantity at the initial price p^0. Type 2 users would expand their purchases to $q_2^* = D_2(p^*)$, thereby increasing their consumers' surplus by area *abd*. As long as the discounted price is greater than the firm's marginal cost (c), profits go up by area *bdfg*. Offering an *optional* tariff that includes a quantity discount has resulted in a *Pareto improvement*: some market participants (i.e., the firm and large users) are strictly better

off and the others (i.e., small users) are no worse off than before the new option was introduced.

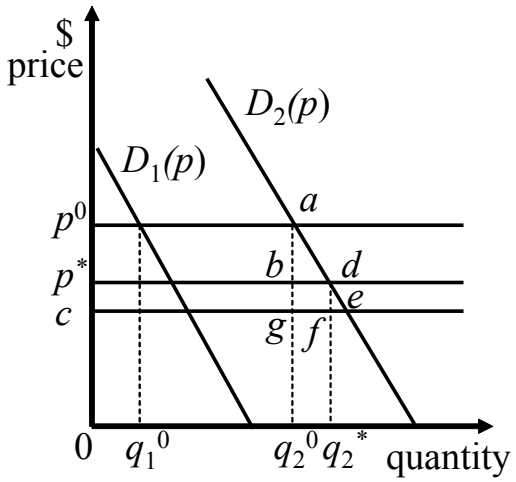

Figure 2

3.1.2 Factors resulting in PRC scrutiny of quantity discounts in pre-PAEA NSAs

If quantity discounts can lead to a Pareto improvement, why were NSAs so closely scrutinized by the PRC? There were basically two areas of concern: (1) the impact on Postal Service profits; and (2) fairness to other Postal Service customers. First, if the Postal Service were to make "money losing" deals with large customers, general mailers would be adversely affected under break-even regulation. Second, unlike in the example above, customer demand curves may be *interdependent* because Postal Service customers are primarily businesses. Hence, a true Pareto improvement may not be

possible due to feedback effects between "favored" customers and their competitors who are not eligible for the discount.[14]

The first concern received considerable attention because, under the PRA regulatory regime, there was little reason to suppose that the Postal Service was a profit maximizing entity – for the simple reason that there was no mechanism for the Postal Service to retain (let alone distribute) any profits it might earn. Also, any deficits resulting from loss-making NSAs would be recovered from the overall revenue requirement.[15]

The PRC was open to the second concern but, to the best of my knowledge, no complaining competitors came forward. Of course, given the Postal Service's antitrust immunity at the time, the PRC was the only forum available. Under PAEA, such "damaged competitors" are eligible to file suits under the *secondary line injury* provisions of the Robinson Patman Act.

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[14] See Ordover and Panzar (1980) and (1982) for theoretical analyses of this situation. For a discussion of these concerns in the context of postal NSAs, see US Postal Rate Commission, Docket MC2002-2, Testimony of John C. Panzar (JCP-T-1) (2003).

[15] See Panzar and Sidak (2006) for an analysis of these and related issues.

3.2 Analysis of Quantity Discount incentives under Price Caps

3.2.1 Quantity Discounts with Independent Demands

I begin by analyzing the incentives of the Postal Service to *introduce* quantity discounts when subject to PAEA-style price cap regulation. Again, I consider a simple model with Type 1 and Type 2 users, as above. At the initial price, $p = p^0$, base volume for the service in question is $B^0 = D_1(p^0) + D_2(p^0)$. Initially, the discounted service was not offered, so the base *discounted volume* is given by $V^0 = 0$. Assuming that all other prices are held constant, the price cap constraint facing the Postal Service is given by $pB^0 \leq p^0B^0$ or $p \leq p^0$. Thus, under PAEA, other customers are *automatically* protected by price cap. This is true even regardless of whether or not the Postal Service can be assumed to be a profit-seeking enterprise. Thus, one of the primary concerns regarding quantity discounts has been mitigated by PAEA price caps.

Therefore, the introduction of quantity discounts under a price cap constraint results in a contribution maximizing Postal Service producing a Pareto Improvement.[16] The problem is both simpler and more complicated than was illustrated in Figure 2. There, it was demonstrated that *any* discount $\delta > 0$ was *guaranteed* to lead to a Pareto improvement as long the quantity threshold Q required to obtain the discount was set

[16] At least for the case of independent customer demands. See below for an analysis of the issues that arise in the case of interdependent demands.

equal to $D_2(p^0)$, the large user's demand at the initial price. One could then proceed to calculate the contribution maximizing discount, holding Q fixed. However, it turns out that the Postal Service and the large user can always negotiate a better deal if they are allowed to choose Q as well.

Figure 2 can be used to illustrate the argument. At the initial uniform rate of p^0, there are "unexploited gains from trade" between the Postal Service and the Type 2 user. All of the points between *a* and *e* along demand curve D_2 represent units of output for which the Type 2 user's valuation of the unit (willingness to pay) exceeds *c*, the marginal cost of producing the unit. The total amount of initial unexploited gains from trade is given by the area of the *deadweight loss* triangle *aeg*. Notice that a deadweight loss equal to area *def* persists even after quantity discounts are introduced at the discounted rate p^* for purchases greater than the threshold $D_2(p^0)$. From the diagram, it is clear that such deadweight loss triangles can only be eliminated if the discounted rate is set equal to marginal cost: i.e., when $p^* = c$.

Therefore, it seems reasonable to assume that, when fully informed, the Postal Service and the large user would choose to negotiate terms which would make the discounted rate equal to marginal cost. Of course the problem with that result is that, if the discount threshold were left at $D_2(p^0)$, all the gains from eliminating the deadweight loss would accrue to the large mailer. However, in principle, it is a simple matter to remedy the situation by increase the threshold level beyond $D_2(p^0)$. Indeed, the threshold

level determines the amount of a "lump sum," infra marginal transfer between the large user and the Postal Service. The magnitude of the transfer is given by $(p^0 - c)Q$. Thus, the size of the threshold determines the *division* between the Postal Service and the large user of the gains from trade resulting from the introduction of negotiated quantity discounts.[17]

Of course price cap regulation continues to apply after a quantity discount is in place. Changes in the basic rate, threshold and discounts level must continue to satisfy the cap. Therefore, it is of interest to analyze the incentives facing the Postal Service once an initial system of quantity discounts in place. Somewhat surprisingly, whenever the initial discount is negotiated optimally, the Postal Service would not have an incentive to alter either the basic rate or the discount when permitted to adjust its prices under the price cap formula. From a theoretical point of view, this is because the negotiated threshold level (and total Postal Service revenues) will generally be an increasing function of the basic rate.[18] More practically, the PRC has specified a special treatment for revenues associated with discounted volumes under NSAs:

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[17] This explains why the specification of the threshold level is so controversial in NSAs. In practice, the issue is further complicated by the difficulty of forecasting future demands with and without the quantity discount.

[18] As is clear from Figure 2, the higher p^0, the higher are the gains from trade resulting from a negotiated quantity discount. This tends to also increase Postal Service's portion of those gains. While raising the

> "Mail volumes sent at rates under negotiated service agreements are to be included in the calculation of percentage change in rates as though they paid the appropriate rates of general applicability." DOCKET NO. MC2007-1, § 3010.24(a).

The impact of this rule is to restrict the revenue changes associated with discounts in place to those resulting from basic rate reductions. In terms of our example the effective price/revenue cap constraint becomes $p^0(B^0+V^0) \geq p(B^0+V^0)$, or $p^0 \geq p$. Thus, regardless of theoretical incentives, PRC price cap rules prevent the use of negotiated quantity discounts from later leading to an increase in the basic rate, *ceteris paribus*.

3.2.2 Quantity Discounts with Interdependent Demands

As discussed above, the analysis becomes considerably more complicated when the demand curves of Postal Service customers are interdependent because, for example, they are business firms that compete with one another in the same final product market. Since roughly 90% of Postal Service volume is generated by business mailers, this is a very relevant case.

I seek to analyze this situation using the simplest possible model. First, I assume that all customers require one unit of postal services to produce one unit of their final

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basic price would tend to increase contribution, the offsetting reduction in the threshold required under the price/revenue cap would typically more than offset the gain.

output, so that postal volumes and industry output are commeasurable. Second, I assume that the downstream, final output market is perfectly competitive with a demand curve $D(r)$ that is a decreasing function of the industry output price, r. These assumptions allow me to characterize firm behavior in terms of their output supply functions. Furthermore, firms' output supply functions are exactly equal to their demand functions for postal services and both depend only on the effective *net* price, $r - p$, faced by the firms.

I assume that there are two types of business customers: a large number of Type 1 customers, whose aggregate output supply (and postal services demand) curve is given by $S_1(r-p)$; and a single (large) Type 2 customer whose output supply/postal demand curve is given by $S_2(r-p-\delta)$, where δ denotes any quantity discount the large purchaser may receive. As a result, competitive equilibrium in the output market is determined by:

$$(7) \qquad S_1(r^e-p) + S_2(r^e-p+\delta) = D(r^e)$$

Equation (7) implicitly determines the equilibrium output price as a function of the basic rate and quantity discount: i.e., $r^e = r^e(p,\delta)$. As one would expect intuitively, it is shown in the Appendix that the equilibrium output price is an increasing function of the base price and a decreasing function of the quantity discount.

The analysis of quantity discounts when customer demands are interdependent is somewhat complex. (The Appendix presents a detailed analysis of the incentives facing

the Postal Service in such situations.) However, I shall attempt to illustrate the issues that arise using Figure 3. Let us begin by supposing that, as above, the Postal Service is initially charging a uniform basic rate of p^0 to both types of users. This results in a competitive output price of $r^0 = r^e(p^0,0)$. At this combination of postal price and output price, Type 1 firms purchase the quantity $q_1{}^0$ of postal services (and supply the same amount of final output to the market). In the diagram, this quantity is determined by the intersection of the Type 1 demand curve for postal services, $S_1(r^0–p^0)$, with the basic postal rate.[19]

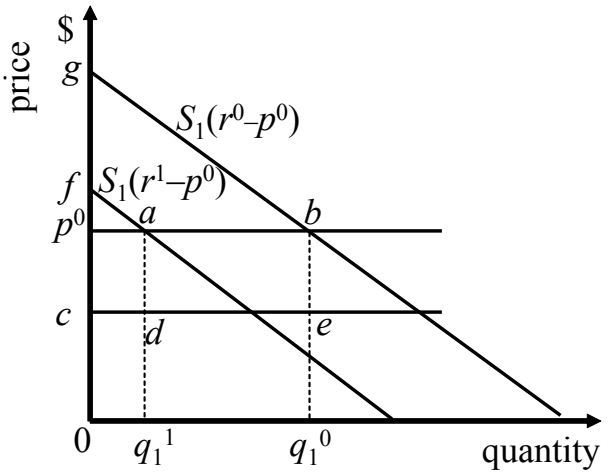

Figure 3

[19] In general, the (derived) demand of competitive firms for any input will depend on both the input price and the market price for their output: e.g., $D_1(p,r)$. Because I have assumed that one unit of postal services is required for each unit of firm output, the input demand function and output supply functions are equal and depend only upon the price difference: i.e., $D_1(p,r) = S_1(r^0–p^0)$.

Next, suppose that the Postal Service negotiates a quantity discount arrangement with the large user, involving a quantity discount of δ for each unit purchased in excess of some specified threshold. In the independent demands case, this deal resulted in gains for both the Postal Service and the large user and, by hypothesis, small users were completely unaffected as long as the basic rate remained unchanged. However, in the current situation, the discount offered to the large user would cause him to increase not only his purchases of postal services, but also the quantity he supplies to the downstream output market. As a result, the equilibrium output price would fall to $r^1 = r^e(p^0,\delta) < r^0$. This would shift the postal service demand curve for Type 1 customers to the left (i.e., to $S_1(r^1–p^1)$), resulting in the smaller quantity, $q_1{}^1$, being purchased at the initial basic rate of p^0.

There are two results of this "feedback effect." First, the profits of the Postal Service are reduced because of the reduction in high mark-up sales to Type 1 users. This amount is given by area *abde* in Figure 3. Second, Type 1 customers are clearly damaged. Since I have assumed that these are competitive firms, the effect on their profits can be measured by changes in the surplus area under their input demand curves. Thus, the decrease in the profits of Type 1 firms resulting from a fall in the equilibrium output price is given by the area *gbaf* in Figure 3. In the case of independent demands, the Postal Service and the large user could negotiate a mutually beneficial quantity discount package without any impact on the non favored users. Here, the situation is

very different: the terms of the NSA will affect both the Postal Service profits *and* the welfare of non participating users *even if the basic rate is unchanged*.

These complications do not eliminate the incentives for the Postal Service and large users to negotiate mutually beneficial quantity discount arrangements. Indeed the Appendix demonstrates that (1) there always exist incentives to introduce such quantity discounts; (2) the optimal discount will involve a discounted rate greater than marginal cost; and (3) introducing the discount will increase total surplus.[20] However, the presence of demand interdependencies dramatically changes the distributional effects of the NSA. Instead of being a Win-Win arrangement solely between the Postal Service and a large customer, the NSAs benefit the parties to the agreement at least partially at the expense of other mailers. Furthermore this "damage to competitors" may occur even if the basic rate remains unchanged. Thus the protection afforded to general mailers by the PRC's interpretation of PAEA price cap rules is not sufficient to protect the competitors of favored customers.

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[20] The intuition behind these results is straightforward. The first result is due to the fact that the direct ("first order") effect from introducing the discount (shown in Figure 2) always outweighs the indirect ("second order") effect on Postal Service profits (shown in Figure 3) when the discount is close to zero. The optimal negotiated discount is greater than marginal cost because the direct effect of further rate reductions approaches zero as the discounted rate approaches marginal cost, while the negative feedback effect on Postal Service profits remains "large." Therefore, balancing the two effects occurs at a $\delta > p–c$. Total surplus in the market goes up the expansion of total of final output benefits ultimate consumers more than it hurts Type 1 producers.

It was this type of *secondary line injury* resulting from quantity discounts that the Robinson Patman Act was passed to prevent. Since PAEA subjects the Postal Service to the antitrust statutes, competitors of firms that receive quantity discounts through NSAs may seek damages.[21] Economists have always taken a dim view of the Robinson Patman Act, and the government rarely initiates cases nowadays.[22] However, private parties continue to bring actions under the Act.

4. CHANNEL BASED DISCOUNTS

Selling stamps at a post office window is costly. Other distribution channels (online sales, postal meters, etc.) may involve significant cost savings. Thus, for many postal services, contribution can probably be increased by giving consumers incentives to utilize alternative distribution channels. Channel based discounts may facilitate this. In this section I examine the implications that price cap regulation under PAEA may hold for such a strategy. I begin by analyzing the incentives to introduce channel based discounts under the pricing flexibility permitted by PAEA price cap regulation.

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[21] The classic case involving secondary line injury is *Federal Trade Commission v. Morton Salt Co.* 334 U.S. 37 (1948).

[22] For a discussion of the economic issues involved in the Robinson Patman Act, see Viscusi, et. al., Chapter 9.

4.1 A Simple Model of Alternative Distribution Channels

I assume that the Postal Services uses two distribution channels for selling postage. A number of stamps W are sold "at the window" at the price p. A number of stamps I are sold over the Internet at a price $p_I = p-\delta$, where δ is the amount of any channel discount Let c and c_I denote the unit cost of window and Internet distribution, respectively. Let $\Delta = c - c_I$ denote the difference in channel unit costs.

Window and Internet sales of stamps are obviously close substitutes. However, given differences in consumers' access to the Internet and other characteristics, they are probably not perfect substitutes. That is, a small difference in price will not eliminate the demand for the more expensive channel. Therefore, I assume that the market demand functions are given by $W = W(p,p_I)$ and $I = I(p_I,p)$, with each demand function being a decreasing function of its own price and an increasing function of the price of the alternative distribution channel. In addition, the following assumptions are plausible for demands of close substitutes: (i) An increase in the price of *either* product does not increase *total* demand; and (ii) An equal increase in the price of *both* products decreases the demand of *each*. Letting subscripts denote partial differentiation, these assumptions imply $W_I + I_I \leq 0$; $W_W + I_W \leq 0$; $W_I + W_W \leq 0$; and $I_I + I_W \leq 0$.

The contribution that the Postal Service earns from the service in question is given by:

$$(8) \qquad \Pi(p,p_I) = \pi(p,\delta) = (p-c)W(p,p-\delta) + (p-\delta-c_I)I(p,p-\delta) = (p-c)(W+I) + (\Delta-\delta)I$$

4.2 Analysis of Channel Discount Example

In the initial situation without any channel discount, we have $W^0 = W(p^0,p^0)$ and $I^0 = I(p^0,p^0)$. (I allow for the possibility that the low cost channel may already be in existence and utilized without any discount.) Under the flexibility provided by price cap regulation, the Postal Service may have the incentive to introduce a channel discount where none existed before. For any specified levels (p^0,δ^0) of base price and channel discount, the Laspeyres price cap constraint on the next period base price and discount would be given by

$$(9) \qquad p^0 W^0 + (p^0 - \delta^0) I^0 \geq p W^0 + (p - \delta) I^0$$

When the price cap constraint is binding, solving equation (9) yields the following formula for the constraint on the base price as a function of the channel discount:

$$(10) \qquad p^c(\delta) = p^0 + (\delta - \delta^0) I^0/(W^0 + I^0) = p^0 + (\delta - \delta^0) s_I^0$$

Introducing a discount creates "slack" to raise basic rate.

Is there an incentive to *introduce* discount (and raise basic rate)? To answer this question, I proceed by examining the impact on Postal Service contribution from introducing a "small" channel discount, taking into account the effect of the price cap constraint. To begin, substitute equation (10) into equation (8) in order to define the level of Postal Service contribution as a function of a single variable, the channel discount:

(11) $$\Psi(\delta) \equiv \pi(p^c(\delta),\delta) = (p^c - c)[W(p^c, p^c - \delta) + I(p^c - \delta, p^c)] + (\Delta - \delta)I(p^c - \delta, p^c)$$

Differentiating equation (11) with respect to the discount yields

(12) $$\Psi'(\delta) = \{W + I + (p^c - c)[W_I + W_W + I_I + I_W] + (\Delta - \delta)[I_I + I_W]\}s_I^0 - I - (\Delta - \delta)I_I$$

Upon rearrangement, equation (12) can be rewritten as

$$\Psi'(\delta) = \left\{\frac{(W + I)I^0}{(W^0 + I^0)} - I\right\} + \left\{\frac{(p^c - c)[W_I + W_W + I_I + I_W] + (\Delta - \delta)[I_I + I_W]I^0}{(W^0 + I^0)}\right\} - (\Delta - \delta)I_I$$

In order to determine the effect on contribution of *introducing* a channel based discount under the price cap, evaluate the above expression at $\delta = \delta^0 = 0$ (which also implies that $p^c(\delta) = p^0$, $I = I^0$ and $W = W^0$):

(13) $$\Psi'(0) = (p^0 - c)[W_I + W_W + I_I + I_W]s_I^0 + \Delta[I_W s_I^0 - I_I(1 - s_I^0)]$$

The derivative in equation (13) cannot be signed in general. The second term is unambiguously positive when Δ is positive. However, the bracketed portion of the first term measures the effect on total demand of a simultaneous increase in both prices. It has been assumed to be non positive, and is likely to be somewhat negative.

Nonetheless, the result in equation (13) does provide several important insights. First, it implies that the Postal Service always has the incentive to introduce a cost based, channel discount for a *new*, previously unavailable distribution channel. In that case, said

channel's base period share is zero by definition and the first term in equation (13) vanishes. This leaves only the unambiguously positive final term, $-\Delta I_I$. Second, the equation makes clear that the incentive to introduce a channel based discount is larger (and more likely to be positive), the larger is Δ, the cost advantage of the Internet channel. Indeed, if the new channel is more expensive, the sign of the derivative in (13) is unambiguously negative, and the Postal Service will have a clear incentive to charge a premium price for that channel.

Finally, suppose that the *total* demand for the service is essentially price inelastic. Consumers switch between distribution channels based upon price differences, but the total number of stamps purchased is relatively fixed. Under this plausible assumption, there is also an incentive for the Postal Service to introduce a small channel discount. For, in that case, the price effects in the first bracketed term will be very close to zero, and the positive second term will determine the direction of the incentive.

To sum up these results, channel based discounts are likely to be attractive the Postal Service under PAEA price cap regulation. However, their introduction is likely to produce both winners and losers among customers. To the extent that the losers can allege that they are the victims of some form of "price discrimination," there may be antitrust consequences.

5. CONCLUDING REMARKS

This paper has analyzed the incentives of the Postal Service to introduce or modify various types of discounts under the pricing flexibility permitted under PAEA price cap regulation. Under PAEA, antitrust liability goes hand in hand with pricing flexibility. Therefore, I have also discussed potential antitrust implications associated with Postal Service discount policy. In this Section I briefly review the findings of my analysis.

(1) Worksharing Discounts. Worksharing discounts have been the hallmark of postal sector liberalization policy in the United States. Under the PRA, PRC regulatory policy attempted to set worksharing discounts equal to the unit costs avoided by the Postal Service for the service component in question. The introduction of PAEA price cap regulation gives the Postal Service the flexibility to simultaneously adjust both the discount and the end-to-end service rate. My analysis shows that, starting at a discount level equal to unit avoided cost, the Postal Service will tend to have an incentive to decrease both the worksharing discount and the basic rate. This would have the effect of reducing the market share of upstream competitors. In antitrust parlance, the effect of the reduction in the worksharing discount would be to "exclude equally or more efficient competitors." Nonetheless, my analysis shows that the reduction in discounts are likely to be welfare increasing.

(2) Quantity Discounts. In recent years, quantity discounts have featured prominently in NSAs between the Postal Service and large mailers. Despite their theoretical and practical appeal, these agreements have been closely scrutinized by the PRC. The impact of PAEA price cap regulation should alleviate the concern that the general mailing public may be adversely affected by such negotiated agreements because of suboptimal or myopic actions of the Postal Service, for the simple reason that the price cap constraint prevents an increase in the basic rate. However, when consumer demand curves are interdependent, users that are competitors of the large mailers will be disadvantaged, even if the basic rate they pay is unchanged. Such competitors may seek to claim compensation under the *secondary line injury* provisions Robinson Patman Act, which prohibits quantity discounts where the effect is to damage competition in the output market of the favored customer. Nonetheless, quantity discounts have an important role to play under PAEA price cap regulation. While they may not lead to a Pareto improvement, my analysis shows that their introduction is beneficial to the Postal Service and lead to an increase in total surplus.

(3) Channel Based Discounts. The cost to the Postal Service of providing a service or service component may vary depending upon the *distribution channel* used to market the service to the public. My analysis finds that the pricing flexibility provided by PAEA price cap regulation is likely to give the Postal Service the incentive to introduce channel based pricing to better exploit such cost difference. The incentive to introduce a channel based discount is greater when the channel (i) has a smaller pre discount market

share; (ii) exhibits a greater cost advantage; or (iii) the total demand for the service is relatively price inelastic. In addition, the analysis shows that, if introduced, such discounts tend to be welfare improving.

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Appendix

SECTION 2: Welfare effects of reducing worksharing discounts below avoided costs.

Total surplus, $T(p,\delta)$, is given by the sum of Postal Service profits, consumers' surplus, and upstream competitors' profits. In this example, consumers care only about the price of end to end service: i.e., they are indifferent as to whether it is sorted by the Postal Service or the competitive fringe. Therefore, consumers' surplus can be written as a decreasing function of the end-to-end price, $CS(p)$. As noted in the text, the behavior of the fringe depends only on the worksharing discount, δ. Thus their competitive profits can be expressed as an increasing function of that single argument, $\pi_f(\delta)$.

As in the text, solving the price cap constraint defines the increasing function $p^c(\delta)$ which expresses the maximum end-to-end price allowed for any worksharing discount. Substituting this relationship into the expression for total surplus yields:

(A2.1) $$T[p^c(\delta),\delta] = \pi[\, p^c(\delta),\delta] + \pi_f(\delta) + CS[p^c(\delta)]$$

Totally differentiating equation (A2.1) with respect to δ, we obtain

(A2.2) $$\frac{dT[p^c(\delta),\delta]}{d\delta} = \frac{\partial \pi}{\partial p}\frac{dp^c}{d\delta} + \frac{\partial \pi}{\partial \delta} + S(\delta) - D[\,p^c(\delta)]\frac{dp^c}{d\delta}$$

(The above expression makes use of the Chain Rule, *Hotelling's Lemma*,[23] and *Antonelli's Lemma*.[24]) Substituting in the results from equations (3) and (4) in the text yields the following formula:

$$\frac{dT[p^c(\delta),\delta]}{d\delta} = \frac{[p^c(\delta)-t-c]D'[p^c(\delta)]S^0}{D^0} + (t-\delta)S'(\delta)$$

Evaluating this expression at $\delta = \delta^0 = t$ and $p = p^c(t) = p^0$ yields the desired result:

(A2.3) $$\frac{dT[p^c(t),t]}{d\delta} = \frac{[p^0-t-c]D'[p^0]S^0}{D^0} < 0 .$$

SECTION 3: Quantity discounts with interdependent demands.

I begin by using comparative statics analysis to determine the effects of changes in the basic rate and quantity discount on the equilibrium price in the downstream industry. Differentiating equation (7) in the text with respect to the base price yields:

(A3.1) $$S_1'\frac{\partial r^e}{\partial p} - S_1' + S_2'\frac{\partial r^e}{\partial p} - S_2' = D'\frac{\partial r^e}{\partial p} \quad \Rightarrow \quad 1 > \frac{\partial r^e}{\partial p} = \frac{S_1' + S_2'}{S_1' + S_2' - D'} > 0$$

Similarly, differentiating with respect to the quantity discount yields:

(A3.2) $$S_1'\frac{\partial r^e}{\partial \delta} + S_2'\frac{\partial r^e}{\partial \delta} - S_2' = D'\frac{\partial r^e}{\partial \delta} \quad \Rightarrow \quad 0 > \frac{\partial r^e}{\partial \delta} = \frac{-S_2'}{S_1' + S_2' - D'} > -1 .$$

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[23] The derivative of the profits of a competitive industry with respect to price is equal to the quantity supplied.

[24] The derivate of consumers' surplus with respect to price is equal to the negative of the quantity demanded.

Thus, any increase in the discount offered the large firm results in a lower market price facing *all* firms. This has the effect of shifting the Type 1 customers postal demand curves to the left.

Next, I characterize the terms of the "best deal" that the Postal Service could hope to negotiate with the large user in terms of the basic rate and the quantity discount. This lump sum payment,[25] $e(p,\delta)$, can be no larger than difference in the (maximized) profits the large firm can earn with and without the discount. That is,

(A3.3) $$e(p,\delta) = \pi_2(r^e - p + \delta) - \pi_2(r^e - p)$$

Using (A3.3), it is possible to express Postal Service contribution as a function of the initial basic rate and the negotiated quantity discount rate:

(A3.4) $$\pi(p^0,\delta) = (p^0 - c)S_1(r^e - p^0) + \pi_2(r^e - p^0 + \delta) - \pi_2(r^e - p^0) + (p^0 - \delta - c)S_2(r^e - p^0)$$

This is the expression that the Postal Service is assumed to maximize when negotiating a quantity discount subject to the price cap constraint that the basic rate cannot be increased.

Making use of *Hotelling's Lemma*, differentiating (A4) with respect to the quantity discount level δ yields:

$$\frac{\partial \pi}{\partial \delta} = (p^0 - c)S_1'\frac{\partial r^e}{\partial \delta} + S_2\left[\frac{\partial r^e}{\partial \delta} + 1\right] - S_2^0\frac{\partial r^e}{\partial \delta} - S_2 + (p^0 - \delta - c)S_2'\left[\frac{\partial r^e}{\partial \delta} + 1\right].$$

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[25] As noted earlier, the size of this infra marginal payment can be interpreted as being equal to the threshold value times the basic rate markup over marginal cost.

Here, S_2^0 denotes the supply/demand function of the large firm evaluated at the Postal Service's *undiscounted* price: i.e., $S_2^0 = S_2(r^e - p^0)$. Rearranging, I obtain

$$\frac{\partial \pi}{\partial \delta} = \left[(p^0 - c)S_1' + (S_2 - S_2^0)\right]\frac{\partial r^e}{\partial \delta} + (p^0 - \delta - c)S_2'\left[\frac{\partial r^e}{\partial \delta} + 1\right]. \tag{A3.5}$$

Equation (A3.5) can be used to establish two important results: (R1) The Postal Service always finds it profitable to *introduce* a discount; and (R2) The optimal discounted price, $p^0 - \delta$ is greater than marginal cost.

To establish the first result, all that is required is to evaluate the partial derivative in equation (A5) at $\delta = 0$. Rearranging terms using (A2) yields

$$\left(\frac{\partial \pi}{\partial \delta}\right)_{\delta=0} = (p^0 - c)S_1'\frac{\partial r^e}{\partial \delta} + (p^0 - c)S_2'\left[\frac{\partial r^e}{\partial \delta} + 1\right] = -\frac{(p^0 - c)S_2'D'}{S_1' + S_2' - D'} > 0 \tag{A3.6}$$

The second result follows from setting the partial derivative in equation (A5) equal to zero and solving: i.e.,

$$(p^0 - \delta - c) = -\frac{\left[(p^0 - c)S_1' + (S_2 - S_2^0)\right]\frac{\partial r^e}{\partial \delta}}{S_2'\left[\frac{\partial r^e}{\partial \delta} + 1\right]} = \frac{(p^0 - c)S_1' + (S_2 - S_2^0)}{S_1' - D'} > 0 \tag{A3.7}$$

Of course, the competitors of the favored customer (Type 1) users are damaged by the introduction of a discount. While the price cap prevents the basic rate from changing, the discount to the large users results in a decrease in the equilibrium output price. This,

in turn, lowers the profits of the Type 1 firms. However, it turns out that total surplus increases as a result of the introduction of the discount.

To see this result, note that total surplus associated with this market is the sum of Postal Service contribution, large firm profits (net of lump sum payment *e*), small firm profits, $\pi_1(r^e - p^0)$ and the consumers' surplus in the downstream market, $CS(r^e)$. Making use of equations (A3.3) and (A3.4), we have

$$T(p^0, \delta) = \pi(p^0, \delta) + \pi_1(r^e - p^0) + \pi_2(r^e - p^0) - CS(r^e)$$

Differentiating with respect to the level of the quantity discount yields

(A3.8) $$\frac{dT}{d\delta} = \frac{\partial \pi}{\partial \delta} + S_1 \frac{\partial r^e}{\partial \delta} + S_2^0 \frac{\partial r^e}{\partial \delta} - (S_1 + S_2) \frac{\partial r^e}{\partial \delta} = \frac{\partial \pi}{\partial \delta} - (S_2 - S_2^0) \frac{\partial r^e}{\partial \delta} > \frac{\partial \pi}{\partial \delta}.$$

The derivation of equation (A3.8) makes use of Hotelling's Lemma, Antonelli's Lemma, and the fact that supply equals demand in the final output market.

All that is required to determine the impact of the introduction of a quantity discount is to evaluate the above derivative at $\delta = 0$. But equation (A3.8) establishes the result, because I established in equation (A3.6) that the derivative of Postal Service contribution must be positive when evaluated at $\delta = 0$.

SECTION 4: Welfare effects of introducing channel based discounts.

The approach is the same as that used earlier in this Appendix except that, in this model, total surplus is just Postal Service contribution plus consumers' surplus: i.e.,

$$T[p^c(\delta),\delta] \equiv \pi[p^c(\delta),\delta] + CS[p^c(\delta), p^c(\delta)-\delta] \tag{A4.1}$$

Next, I appeal to Antonelli's Lemma to claim that the derivatives of consumers' surplus with respect to p and p_I are, respectively, $-W(p,p_I)$ and $-I(p_I,p)$, the negative of the quantities demand through each distribution channel. Given this result, we have

$$\frac{dCS}{d\delta} = -\left[W(p^c, p^c-\delta) + I(p^c-\delta, p^c)\right]\frac{dp^c}{d\delta} + I(p^c-\delta, p^c) = -(W+I)s_I^0 + I\ . \tag{A4.2}$$

Differentiating equation (A4.1) with respect to δ and substituting in the results from equation (A4.2) and equation (12) in the text, yields

$$\frac{dT[p^c(\delta),\delta]}{d\delta} = (p^c - c)[W_I + W_W + I_I + I_W]s_I^0 + (\Delta-\delta)[s_I^0 I_W - (1-s_I^0)I_I] \tag{A4.3}$$

Not surprisingly, equation (A4.3) reveals that, in general, the welfare effect of an increase in the level of a channel based discount is ambiguous. (As in the text, the first term is non positive and likely to be negative. The second term is positive whenever the channel cost savings exceed the proposed discount. However, the welfare results are both stronger and clearer than the profit incentive results discussed in the text. Note that

equation (A4.3) holds for *any* level of the proposed channel discount, not just for "small" levels near zero as was the case for equation (13) in the text.

Thus equation (A4.3) provides three important insights. First, it implies that total surplus will always increase when the Postal Service introduces a cost based, channel discount for a *new*, previously unavailable distribution channel. In that case, said channel's base period share is zero by definition and the first term in equation (A4.3) vanishes. This leaves only the term, $-(\Delta-\delta)I_I$, which is unambiguously positive so long as the proposed discount is no larger than the cost savings. Second, the equation makes clear that the welfare benefit to introduce a channel based discount is larger (and more likely to be positive), the larger is Δ, the cost advantage of the Internet channel.

Finally, suppose that the *total* demand for the service is essentially price inelastic. Consumers switch between distribution channels based upon price differences, but the total number of stamps purchased is relatively fixed. Under this plausible assumption, welfare increases whenever the Postal Service chooses to introduce a channel discount no greater than the channel cost savings. For, in that case, the price effects in the first bracketed term will be very close to zero and the positive second term will determine the direction of the change in total surplus.