

Who Should Pay for Postal Services? Tax Payers vs. Senders vs. Receivers

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Abstract

Mandating universal service requires the public to decide what services people should have and what prices they should pay. Postal services have traditionally been financed by charging the senders only, while recent steps in the liberalization of the postal sector forced policy makers to find a broader financial basis for postal services. The existence of a receiver externality, the benefits enjoyed by the receiver of a postal item, implies that also they should contribute to the financing of delivery costs. Moreover, since it is rather the operation of a delivery network than an individual sending that contributes to the costs of the postal operator, it is optimal that also the public who profits from its existence bears part of the cost.

We discuss the revenue effects of alternative financing regimes, arguing that introducing the possibility of new levies from the receivers' side may yield adverse effects in terms of operator revenue: Receivers opting for free P.O. box delivery instead of costly doorstep delivery destroy the positive welfare attribute of non-rivalry in last-mile delivery. This lowers the total social value of the postal network (and the services provided by it) to the public and therefore also its willingness to contribute to its financing.

-Classification: H44, L43

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1 Introduction

Ever since Sir Rowland Hill's postal reform in the mid 19th century, it has become custom throughout the world that the postage is entirely prepaid by the sender. However, prevailing pricing schemes are quite different in non-postal network industries, such as telecommunications and electricity, where the receiver pays principle () has gained increasing importance in recent years. In particular, there is often price differentiation with two- or multi-part tariff schemes. This reflects underlying demand and cost considerations: Firms use market segmentation strategies with customer preferences being better reflected in the product portfolio. Then, the presence of high fixed costs often leads to some sort of fixed access fee and variable usage prices.

Recent steps in the liberalization of the postal sector forced policy makers to find a broader financial basis for postal services.¹ A large number of variables influences the choice of the optimal pricing model. For example, there are differences between situations in which either party can initiate a message exchange and those in which only one party can do so. Other modelling features are, whether a set number of messages or items sent and received have the same value for the respective senders and receivers; or whether the receiver – when deciding whether to accept or not an incoming message – knows the value of the message in advance; whether sets of messages sent and received are independent of each other; whether sending a message is costly or not; or whether sender and recipient prices are set equal or unequal. Such model features have important implications on the choice of an optimum pricing model. For example, if an incoming message triggers an outgoing message of the same value in reply, then call externalities will be internalized in the demand of sending messages, if not, then a two-part pricing scheme might be welfare-optimal.

Hence, in the presence of externalities and under a number of assumptions, the can maximize welfare and profits. In addition, menus of pricing options (where consumers can self-select between different schemes) can increase welfare and profits (see e.g. Hermalin and Katz, 2004, Jeon, Laffont and Tirole, 2001, or Kim and Lim, 2000). Felisberto et al. (2006) and Friedli et al. (2006) argue that the introduction of a delivery flat rate () allows to segment the receiver base

¹On the financial viability of universal postal service operations in a liberalized environment, cf. Panzar (2001), Crew and Kleindorfer (2001), Hill, Robinson, and Rodriguez (2001), PriceWaterhouseCoopers (2006), and Jaag (2006).

into those who accept low service levels with delivery only to the nearest post office and those who are willing to pay for tailor-made delivery, typically to the doorstep. Compared to the high-level universal service obligation currently in place, this reduces the proportion of overserved receivers and hence gives rise to a more efficient postal delivery system. This effect relies on the assumption that the reduction in delivery services indeed reduces delivery costs significantly. In the following, we will study the implications of a relaxation of this assumption.

In principle, there are two possible system designs for the introduction of a delivery flat rate. The first allows receivers to avoid paying the reception fee by picking up their postal items themselves. This introduces private transportation cost while it potentially reduces the postal operator's cost. The second is in the same line as public and radio broadcasting are financed in many countries: The introduction of a compulsory flat postal licence on all households receiving postal mail or parcel items. This second system resolves the problem of the first one while also lacking its advantage of a reduction in the overserving of receivers who do not appreciate doorstep delivery.

From a welfare point of view, the latter system is of minor interest, since the introduction of a simply amounts to a lump-sum transfer from receivers to the postal operator. The former, however, gives rise to interesting substitution effects which we will study in this paper. The paper proceeds as follows: In section 2 we present an outline of our model. Section 3 discusses technology and preferences. In section 4, the cost and benefit of various finance regimes are analyzed. Section 5 concludes.

2 Model Outline

We assume that there is a certain social value from the existence of a universal postal service obligation () imposed on the monopolistic postal operator. Hence, the public – represented by its government – has a certain willingness to pay for it via a lump-sum transfer to the operator. Also, senders and receivers contribute to finance postal services.

The sequence of decisions is as follows (cf. figure 1): First, the government raises taxes from all households and pays the revenue to the postal operator. Then, the postal operator or its regulator sets the stamp price so as to just break even,

Figure 1

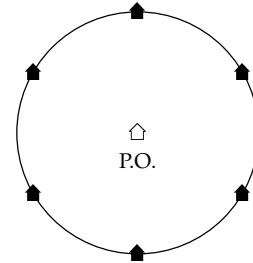
Timeline of decisions in the model.

- 1 Government pays transfer T ;
- 2 Postal operator sets delivery flat rate r ;
- 3 Regulator sets stamp price p ;
- 4 Receivers choose delivery mode; senders choose quantity.

given the senders' demand for postal items. In order to find a subgame perfect equilibrium, the model is solved backwards, starting with the senders' demand. In the baseline model, total cost to be covered by these contributions consists of fixed cost F only, which results from the collection, processing and delivery of postal items. The delivery route can be imagined as along the solid line in figure 2, such that total cost of last-mile delivery is independent of the number of doorstep delivery customers, since the delivery route stays the same. This is a rather accurate description of the cost mail delivery, where every household is served (almost) daily without household-specific variable cost. Hence, delivery is non-rival with respect to the number of receiving households. This assumption will be relaxed in a model extension, where we introduce household-specific delivery cost (section 4.6), reflecting actual costs for parcel delivery.

Figure 2

The location of receiving households in the circular model.



In the following we distinguish between two scenarios: The first one is accurately described by the above sequence of decisions. The second scenario allows the postal operator in an intermediate step to raise a fixed delivery cost after having received the government's transfer. Hence, the postal operator's cost and revenue can be summarized by

$$\begin{aligned} \text{Total cost: } & F \\ \text{Revenue sources: } & T + R + P \end{aligned}$$

where T denotes the government transfer, and $R = h \cdot r$ is the revenue from the delivery flat rate () times the number of paying customers, P is revenue from senders, stamp price p times total quantity q : $P = p \cdot q$. It will be convenient to keep in mind that each of the three sources of revenue comes at a specific cost to society:

- Government funds T must be raised through distortionary taxes, hence creating a shadow cost of public funds.
- Payments R from receiving customers reduce the number of households requesting doorstep delivery and picking up postal items themselves. This increases overall transportation cost.
- Payments P from sending customers in the form of the stamp price reduces mail demand to an inefficient extent: Due to the high portion of fixed cost in postal operation, average cost pricing results in prices well above marginal cost.

The introduction of a delivery flat rate r affects the social benefit from the existence of the postal system and hence the optimum tax contribution. The benefit accruing to senders and receivers of the postal system will be discussed in the next section.

3 Technology and Preferences

The total benefit from the postal system arises via four channels: First, senders derive utility from sending postal items. Second, receivers incur transportation costs if they opt for P.O. box delivery. Third, the postal operator makes a profit, and fourth, distortive taxation introduces a deadweight loss. By the break-even constraint, the postal operator's profit contribution is set to zero. We also normalize the utility of receiving customers choosing doorstep delivery to zero. For simplicity, we assume that mail demand treats letters of different weight and size as homogeneous. When discussing market opening by letter category below, we simply assume that different portions of a homogeneous market are being opened. x is total sender budget, z is quantity of goods basket other than letters sent, the price of which is normalized to unity. The representative sender maximizes utility

$$\max_{q,z} U(q,z) = \delta^{-\frac{1}{\gamma}} \frac{q^{1+\frac{1}{\gamma}}}{1 + \frac{1}{\gamma}} + z \quad \text{s.t.} \quad pq + z \leq x \quad (1)$$

by means of the Lagrangean

$$\mathcal{L} = \delta^{-\frac{1}{\gamma}} \frac{q^{1+\frac{1}{\gamma}}}{1 + \frac{1}{\gamma}} + z - \lambda(pq + z - x) \quad (2)$$

yields iso-elastic demand

$$q(p) = \delta \cdot p^\gamma \quad (3)$$

with price elasticity $\gamma < 0$. The break-even constraint implies that indirect utility from sending postal items is

$$V(p) = \delta^{-\frac{1}{\gamma}} \frac{(\delta \cdot p^\gamma)^{1+\frac{1}{\gamma}}}{1 + \frac{1}{\gamma}} - \delta \cdot p^{1+\gamma}. \quad (4)$$

The break-even stamp price p^* is calculated in the next section.

4 Tax Payers vs. Senders vs. Receivers

In the model, there are three ways to finance postal services: The tax payer contributes with a total transfer T , senders pay the stamp price p , and receivers pay a delivery flat rate r if they choose doorstep delivery.

4.1 Stamp Price

The stamp price is determined by the postal operator's break-even constraint,² such that – given the total contributions from the tax payers and the receivers – it is given by

$$p^* = \frac{F - T - R}{q}. \quad (5)$$

Hence, indirect utility 4 can be stated as a function of the postal operator's budget gap (fixed cost minus revenue from receivers and the government) $Z = F - T - R$:

$$V(Z) = Z \cdot \left(1 - \frac{\gamma}{1 + \gamma}\right). \quad (6)$$

²The argument is valid for any profit constraint on the postal operator. We choose break-even for notational simplicity.

4.2 Delivery Flat Rate

Due to the break-even constraint imposed in determining the stamp price, profit maximization is futile. The postal operator is therefore assumed to set its delivery flat rate so as to maximize total revenue. Hence, managers strive for maximum power by maximizing the scope of their service in terms of postal items sent over their network. The limitation to the is the number of people who choose P.O. box delivery and thus circumvent paying it.

Receivers are heterogeneous in income. Their budget is $y(v)$ and is used up by their tax contributions τy and the delivery flat rate r . Parameter v is an individual's type in the income dimension and assumed to be distributed $v \sim U[0, 1]$. We choose the functional form

$$y(v) = v. \quad (7)$$

The participation constraint for the pivotal receiver, which is denoted by a tilde, writes as

$$y(\tilde{v}) = \tau \cdot y(\tilde{v}) + r \quad (8)$$

$$\Rightarrow r = (1 - \tau) \cdot y(\tilde{v}). \quad (9)$$

Figure 3

The receivers's choice of optimum delivery method.



The mass of households choosing doorstep delivery is by the distribution of v $h = 1 - \tilde{v}$ and by (9)

$$h = 1 - \frac{r}{1 - \tau}. \quad (10)$$

Hence, all receivers of income type $v > \tilde{v}$ choose doorstep delivery (cf. figure 3). We normalize the total number of receivers to unity. The postal operator is assumed to maximize the net revenue from receivers $R = h \cdot r$: the number of receivers times the . Her optimization problem is then

$$\max_r R(h(r, \tau), r) = h(r, \tau) \cdot r \quad (11)$$

$$= \left(1 - \frac{r}{1 - \tau}\right) \cdot r. \quad (12)$$

The optimum r is by the first-order condition and the regularity of the problem

$$r^*(\tau) = \frac{1 - \tau}{2}. \quad (13)$$

The postal operator's revenue is accordingly

$$R(r^*(\tau)) = \frac{1 - \tau}{4}. \quad (14)$$

Hence, the first result on the impact of the tax rate on the postal operator's revenue from receivers:

Result 1 *An increase in the tax rate reduces the postal operator's maximum revenue from levying a* :

$$\frac{dR(r^*(\tau))}{d\tau} = -\frac{1}{4}. \quad (15)$$

The government therefore faces a trade-off in determining the socially optimum tax rate τ : Increasing it raises the postal operators available funds directly, while it reduces its potential revenue originating from receiving customers. Moreover, the introduction of a leads to a multiplication of total transportation cost to the extent that private households now pick up their postal items at the P.O. box. The private cost is the number of households opting for P.O. box delivery h times individual transportation cost l :³

$$L(r^*(\tau), \tau) = l \cdot (1 - h) \quad (16)$$

$$= \frac{l \cdot r^*}{1 - \tau} = \frac{l}{2}. \quad (17)$$

The postal operator reacts to a change in the tax rate by adjusting the such that the number of households choosing doorstep delivery is constant, $h = 0.5$. Hence, also the social cost of picking up postal items at the P.O. is constant.

4.3 Taxation and Government Transfer

Government funds are financed by income tax revenue from receiving customers. Total revenue is

$$T = \tau \int_0^1 y(v) dv = \frac{\tau}{2}. \quad (18)$$

³Transportation cost is assumed to be non-monetary: It consists of the value of the time needed for picking up postal items at the P.O.

The cost resulting from distortionary taxation is denoted by S . It consists of the direct cost plus the excess burden which is assumed to be proportional to the square of the tax rate:

$$S(\tau) = \frac{\tau}{2} + \lambda \cdot \tau^2. \quad (19)$$

The government maximizes consumer welfare minus the cost of taxation and P.O. box delivery:

$$\max_{\tau} W = U(q^*(p^*(R(r^*(\tau), \tau), T(\tau))), z) - S(\tau) - L \quad (20)$$

The first-order condition writes as

$$\begin{aligned} \frac{dU}{d\tau} - \frac{dS}{d\tau} &= 0 \\ \Rightarrow \frac{dU}{dR} \frac{dR}{d\tau} + \frac{dU}{dT} \frac{dT}{d\tau} - \frac{dS}{d\tau} &= 0 \\ \Rightarrow \frac{dU}{dR} \left(\frac{\partial R}{\partial \tau} + \frac{\partial R}{\partial r^*} \frac{dr^*}{d\tau} \right) + \frac{dU}{dT} \frac{dT}{d\tau} - \frac{dS}{d\tau} &= 0 \\ \Rightarrow \frac{dU}{dT} \frac{dT}{d\tau} - \frac{dS}{d\tau} &= - \frac{dU}{dR} \left(\frac{\partial R}{\partial \tau} + \frac{\partial R}{\partial r^*} \frac{dr^*}{d\tau} \right) \end{aligned} \quad (21)$$

It is easiest to interpret the last equation: On the left-hand side, there is the direct effect of marginally increasing the tax rate, namely, the increase in sender utility through larger resources in the hands of the postal operator and a lower stamp price minus the social cost of taxation. On the right-hand side, there is an additional indirect effects: The households' change in the choice of reception channel resulting from the change in their budget and its effect on the postal operator's total revenue.

Note that $\frac{\partial R}{\partial r^*} = 0$ by the postal operator's revenue maximization in (11). The solution to the government's problem is then

$$\frac{dU}{dT} \frac{dT}{d\tau} - \frac{dS}{d\tau} = - \frac{dU}{dR} \frac{\partial R}{\partial \tau}. \quad (22)$$

See the appendix for the derivatives taking account of the chosen functional forms. If the postal operator is not allowed to levy a , the government takes into account only direct effects (hence, the right-hand side of (22) is equal to zero), which results in an optimum income tax rate $\tau^\dagger$. If, however, the postal operator subsequently charges a , the government takes into account also the indirect

effect and the optimum tax rate becomes $\tau^\dagger$.

$$\tau^\dagger = -\frac{1}{4\lambda} \frac{\gamma}{1+\gamma}, \quad (23)$$

$$\tau^\ddagger = -\frac{1}{8\lambda} \frac{\gamma}{1+\gamma} - \frac{1}{8\lambda}. \quad (24)$$

Assuming that demand is inelastic, we obtain a further result on the optimum tax rates in the regulatory regimes with and without the availability of a .⁴

Result 2 *Iff demand is inelastic,*

$$\tau^\ddagger > \tau^\dagger. \quad (25)$$

4.4 Available Funds

Total available funds of the postal operator without and with R are

$$\Phi^\dagger = T^\dagger = \frac{\tau^\dagger}{2} = -\frac{1}{8\lambda} \frac{\gamma}{1+\gamma} \quad (26)$$

$$\Phi^\ddagger = T^\ddagger + R = -\frac{1}{16\lambda} \frac{\gamma}{1+\gamma} - \frac{1}{16\lambda} + \frac{1 - \tau^\ddagger}{4} \quad (27)$$

$$= -\frac{1}{32\lambda} \frac{\gamma}{1+\gamma} - \frac{1}{32\lambda} + \frac{1}{4} \quad (28)$$

These computations allow the derivation of a result comparing the postal operator's disposable revenue under both policy scenarios.

Result 3 *The postal operator's total revenue from receivers and tax payers is larger without the possibility to raise a delivery flat rate iff*

$$\Phi^\dagger > \Phi^\ddagger \Leftrightarrow \lambda < \frac{1}{8} - \frac{3}{8} \frac{\gamma}{1+\gamma}. \quad (29)$$

⁴In an empirical study for Switzerland, Trinkner and Grossmann (2006) find a long-run price elasticity between -0.22 and -0.27. From his survey of studies, Robinson (2007) concludes that price elasticity measures for mail products typically range between -0.2 and -0.8 (Cf. also Fève et al., 2006, for a recent study on mail price elasticities). In a similar exercise as ours, D'Alcantara and Amerlynck (2006) choose a value of -0.3; Dietl et al. (2005) use values between -0.3 and -0.4. Also, Jaag (2006) uses a value of -0.3 to evaluate the impact of letter market liberalization on the financial viability of universal service obligations.

Result 3 can be interpreted as follows: With low social costs of public funds, postal operation optimally receives high subsidies – compared to the other sources of revenue – since public service is valued highly relative to its cost. The introduction of a λ , which induces receivers to resort to P.O. box delivery and reduces the social value of postal operation, induces the government to cut back the subsidy to postal operation significantly. Hence, low social costs of public funds render other means of financing relatively unattractive.

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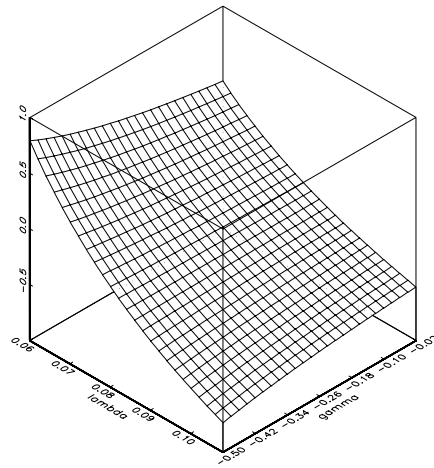


Figure 4
Comparison of
the postal
operators
revenues
without and with
a λ : $\Phi^+ - \Phi^\dagger$.

Figure 4 shows the difference between the postal operator's revenues without and with the possibility to raise a λ in a calibrated setting. At first sight, it seems obvious that an increase in the set of possible financing possibilities increases the postal operator's revenues. However, the introduction of a λ introduces additional cost to society in the form of a private loss from P.O. box delivery due to increased transportation cost. Choosing her optimum contribution to financing the postal system, the government takes into account the indirect effect of its transfer via the optimal λ on the number of households choosing P.O. box instead of doorstep delivery and reduces its contribution, possibly outweighing the revenue generated by the λ .

4.5 Welfare

Overall welfare consists of the senders' utility minus the cost from taxation and P.O. box delivery. Hence, without the possibility to raise a τ , welfare is

$$W^\dagger = U(\Phi^\dagger) - S(\tau^\dagger) \quad (30)$$

$$= \left(\frac{\gamma}{1+\gamma} \right)^2 \left(\frac{2-\lambda}{16\lambda} \right). \quad (31)$$

With the possibility of raising a τ , overall welfare also includes the private transportation cost of delivery. Hence,

$$W^\ddagger = U(\Phi^\ddagger) - S(\tau^\ddagger) - L. \quad (32)$$

4.6 Model Extension

This section discusses the implications of non-zero variable last-mile delivery cost. Calculations are given in the appendix. The extension implies that the break-even stamp price has to satisfy

$$p^* = \frac{F + C - T - R}{q} \quad (33)$$

where $C = c \cdot h$ (cf. figure 6 in the appendix). This cost model is rather accurate as concerns the parcel market, where households are served only if there are parcels to deliver, whereas in the market of mail conveyance, every household is served (almost) daily. In analogy to result 1, the postal operator's net revenue $\Pi = R - C$ depends on the tax rate in place.

Result 4 *An increase in the tax rate reduces the postal operator's maximum net revenue from levying a τ :*

$$\frac{d\Pi(r^*(\tau))}{d\tau} = \frac{(1-\tau-c)^2}{4(1-\tau)^2} - \frac{1-\tau-c}{2(1-\tau)} < 0. \quad (34)$$

The optimum tax rate in this extended model is the same as in the baseline model (cf. appendix). Comparing again the postal operator's net revenue without and with the possibility to raise a τ yields

$$\Phi^{\dagger'} = T^\dagger - C^\dagger; \quad (35)$$

$$\Phi^{\ddagger'} = T^\ddagger + R - C^\ddagger = T^\ddagger - R - \frac{C^\ddagger}{2}. \quad (36)$$

Note that the optimum tax rates are unaffected by the size of household-specific delivery cost (cf. the appendix). From a welfare point of view, the introduction of a τ is more attractive with positive household-specific delivery costs than without because these can be reduced through inducing the consumers to opt for P.O. box delivery.

$$W^{\dagger'} = U(\Phi^{\dagger'}) - S(\tau^{\dagger'}) - C^{\dagger} < W^{\dagger} \quad (37)$$

$$W^{\ddagger'} = U(\Phi^{\ddagger'}) - S(\tau^{\ddagger'}) - L - \frac{C^{\dagger}}{2} \geq W^{\ddagger}. \quad (38)$$

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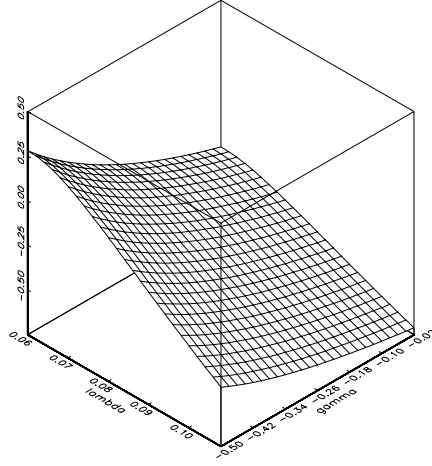


Figure 5
Comparison of
total welfare
without and with
a τ : $W^{\dagger'} - W^{\ddagger'}$.

Figure 5 shows the difference between the postal operator's revenues without and with the possibility to raise a τ in a calibrated setting: The lower the social costs of public funds are, the less attractive is the introduction of a τ : Postal services are financed more efficiently by tax payers than by the receivers.

5 Conclusion

In this paper, we have discussed the welfare effects of the three potential financing contributions for postal services, namely government funds, stamp price and a delivery flat rate (τ) paid by receivers. It turns out that in the case of mail delivery (where household-specific delivery cost is basically zero), the postal

operator's right to introduce a not necessarily increases its financial basis. On the contrary, it may yield adverse effects in terms of operator revenue: Receivers opting for free P.O. box delivery instead of costly doorstep delivery destroy the positive welfare attribute of non-rivalry in last-mile delivery. This lowers the total social value of the postal network to the public and its willingness to contribute to its financing. Introducing the case of non-zero household-specific delivery cost in a model extension yields lower social cost of introducing a such that the condition for the postal operator's net revenue with a being higher than without is less restrictive. Hence, if receivers should pay for postal services, a is to be introduced where the customers' evading reaction affects social cost the least.

6 Apendix: Derivatives in the Government Problem

$$\frac{dU}{dR} = \frac{dU}{dT} = 1 - \frac{\gamma}{1 + \gamma} \quad (39)$$

$$\frac{\partial R}{\partial \tau} = \frac{(r^*)^2}{(1 - \tau)^2} \quad (40)$$

$$\frac{dS}{d\tau} = \frac{1}{2} + 2\lambda \cdot \tau \quad (41)$$

$$\frac{dr^*}{d\tau} = -\frac{1}{2} \quad (42)$$

$$\frac{dT}{d\tau} = \frac{1}{2} \quad (43)$$

7 Appendix: Non-Zero Variable Delivery Cost

Adding non-zero household-dependent delivery cost can be illustrated as in figure 6 where there is an additional way from the direct circular delivery route to individual households (dotted lines). Total cost and revenues now write as

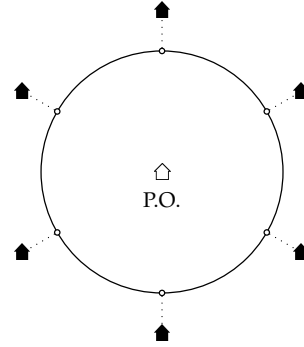


Figure 6

The location of receiving households in the circular model.

$$\text{Total cost} = F + C,$$

$$\text{Revenue sources} = T + R + P,$$

where last mile delivery cost $C = c \cdot h = \frac{c}{2}$ and revenue is $R = r \cdot h = \frac{r}{2}$ as above. The postal operators' optimization problem is then

$$\begin{aligned} \max_r \Pi(h(r, \tau), r) &= R(h(r, \tau), r) - C(h(r, \tau)) = h(r, \tau) \cdot (r - c) \\ &= \left(1 - \frac{r}{1 - \tau}\right) \cdot (r - c) \end{aligned} \quad (44)$$

and optimum r is by the first-order condition and the regularity of the problem

$$r^* = \frac{1 - \tau + c}{2}. \quad (45)$$

Net revenue is accordingly

$$\Pi(r^*(\tau)) = \frac{(1 - \tau - c)^2}{4(1 - \tau)}. \quad (46)$$

The government maximizes consumer welfare minus the cost of taxation and additional transportation cost due to P.O. box delivery:

$$\max_{\tau} W = U(q^*(p^*(C, R(r^*(\tau), \tau), T(\tau))), z) - S(\tau) - L - C \quad (47)$$

The solution to the government's problem is the same as in the main text since C is independent of the tax rate.

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