Environmental cost and universal service obligations in the postal sector

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Introduction

- New trend in the postal sector: the increasing importance of "sustainable growth" and environmental policy
- Postal sector affects the environment through at least two channels:
  - consumption of paper
  - CO_2 (and other) emissions due to transportation and buildings' energy consumption
- Which process responsible for most significant emissions? Difficult question, but one way or the other transportation is a major polluter (buildings represent only 20% of emissions)

- Environmental debate impact on
  - operators' policies (for instance members of International Post Corporation (IPC) have pledged to reduce their carbon emissions by 20% by 2020)
  - regulatory policies, in particular USO which have impact on environment ($D+1$ processing, 6 weekly deliveries, etc.)
- This paper: USO and specifically $D+1$ processing (often at uniform rate)
- Transportation costs incurred to ensure next day delivery (private and external costs) tend to increase quite significantly with distance

- For instance, with the *D+1* constraint, long distance mail may have to be carried by plane, while more environmentally friendly means of transportation could be used for less urgent mail
- Show that, when environmental considerations are ignored, regulators may impose a larger than otherwise optimal USO
- Study how the USO should be designed to properly account for the environmental cost in a variety of situations ranging from a first-best world to a (Ramsey-type) second-best world with uniform prices

Model

- Representative sender who sends mail to addressees located at a distance $\delta \in [0, 1]$
- δ is uniformly distributed and there is a total mass one of addressees
- There are two mail products:
  - x_1 which is processed and delivered at $D + 1$ in area $A_1 \subset [0, 1]$
  - x_2 which is delivered at $D + 2$ in area $A_2 \subset [0, 1]$

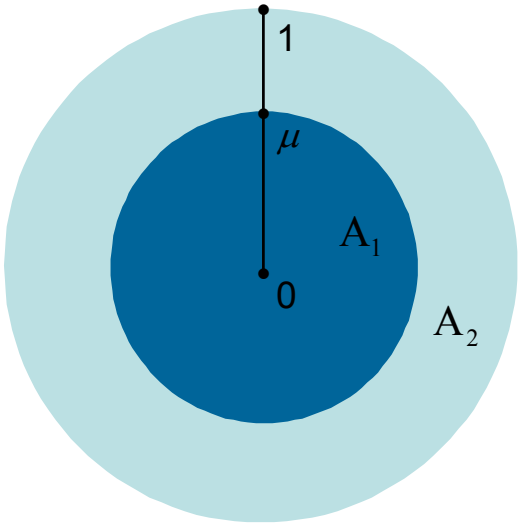

Figure 1:

- Utility of representative sender:

$$U = \int_{A_1} [u_1(x_1) - p_1 x_1] d\delta + \int_{A_2} [u_2(x_2) - p_2 x_2] d\delta$$

- Transportation costs $T_1(x_1, \delta)$ for $D + 1$ mail of volume x_1 at distance δ and $T_2(x_2, \delta)$ for $D + 2$ mail at volume x_2
- Fixed cost $F(\mu)$, constant marginal delivery cost k
- Social benefits of USO $S(\mu)$
- Social welfare (total surplus):

$$\begin{aligned} W \;=\; & \mu u_1(x_1) + (1-\mu) u_2(x_2) + S(\mu) - F(\mu) - k[\mu x_1 + (1-\mu) x_2] \\ & - \int_0^{\mu} [T_1(x_1, \delta) + \varphi_1(x_1, \delta)] d\delta - \int_{\mu}^{1} [T_2(x_2, \delta) + \varphi_2(x_2, \delta)] d\delta \end{aligned}$$

First-best

- Define

$$\overline{T}'_1 = \frac{\int_0^{\mu} \frac{\partial T_1(x_1,\delta)}{\partial x_1} d\delta}{\mu} \qquad \overline{\varphi}'_1 = \frac{\int_0^{\mu} \frac{\partial \varphi_1(x_1,\delta)}{\partial x_1} d\delta}{\mu}$$

$$\overline{T}'_2 = \frac{\int_{\mu}^{1} \frac{\partial T_2(x_2,\delta)}{\partial x_2} d\delta}{1-\mu} \qquad \overline{\varphi}'_2 = \frac{\int_{\mu}^{1} \frac{\partial \varphi_2(x_2,\delta)}{\partial x_2} d\delta}{1-\mu}$$

  marginal costs per addressee in relevant area

- The first-best solution can be decentralized by the following prices

$$p_1 = k + \overline{T}'_1 + \overline{\varphi}'_1,$$
$$p_2 = k + \overline{T}'_2 + \overline{\varphi}'_2.$$

  marginal cost pricing with Pigouvian taxes

- Optimal level of μ:

$$\frac{\partial W}{\partial \mu} = [u_1(x_1) - kx_1 - T_1(x_1, \mu)] - [u_2(x_2) - kx_2 - T_2(x_2, \mu)]$$
$$- [\varphi_1(x_1, \mu) - \varphi_2(x_2, \mu)] + [S'(\mu) - F'(\mu)].$$

  tradeoff between benefits and cost. May yield $\mu = 1$ or $\mu < 1$

Second best

Environmental taxes are refunded to operator

- Budget constraint, multiplier λ

$$\mu p_1 x_1 + (1-\mu) p_2 x_2 - k[\mu x_1 + (1-\mu) x_2]$$
$$- \int_0^{\mu} T_1(x_1, \delta) d\delta - \int_{\mu}^{1} T_2(x_2, \delta) d\delta - F(\mu) \geq 0$$

- Remark: p_i is consumer price which includes environmental tax t_i. Since proceeds go to operator, no need to introduce explicitly (t_i can be set at any arbitrary level)

- We may have $\lambda = 0$: proceeds from Pigouvian tax are sufficient to cover fixed cost $\Longrightarrow$ first-best can be achieved even with budget constraint

- Otherwise $\lambda > 0$ and

$$\begin{aligned}\frac{p_1 - k - \overline{T}'_1}{p_1} &= \alpha\frac{1}{\varepsilon_1} + (1-\alpha)\frac{\overline{\varphi}'_1}{p_1},\\ \frac{p_2 - k - \overline{T}'_2}{p_2} &= \alpha\frac{1}{\varepsilon_2} + (1-\alpha)\frac{\overline{\varphi}'_2}{p_2}\end{aligned}$$

  where $\alpha = \lambda/(1+\lambda)$,while ε_i is (absolute value of) demand elasticity of product $i = 1, 2$.

- Level of μ

$$\begin{aligned}\frac{\partial \mathcal{L}}{\partial \mu} =&[u_1(x_1) - (1+\lambda)kx_1 - (1+\lambda)T_1(x_1,\mu)] - [u_2(x_2) - (1+\lambda)kx_2 - (1+\lambda)T_2(x_2\\ &+ \lambda(p_1x_1 - p_2x_2) - [\varphi_1(x_1,\mu) - \varphi_2(x_2,\mu)] + S'(\mu)\\ &- (1+\lambda)F'(\mu)\end{aligned}$$

Environmental taxes are not refunded to operator

- Now t_i is no longer redundant variable
- Taxes are deducted in budget constraint (and have weight $\lambda + 1$) and are returned to consumers (weight 1)
- Optimal policy: $t_i = 0$ (recall that p_i's are controlled) and we return to the previous subsections

Numerical simulations

- *Not* been calibrated to reflect any specific situation
- Useful for intuitive understanding and to compare the *levels* of the different variables (prices and μ) across scenarios
- Functional forms:
  - $T_1(x_1, \delta) = cx_1\delta^2$ and $T_2(x_2, \delta) = \alpha cx_2\delta^2$
  - Similarly, $\varphi_1(x_1, \delta) = ex_1\delta^2$ and $\varphi_2(x_2, \delta) = \beta ex_2\delta^2$
  - Quadratic utility functions $u_1(x_1) = a_1x_1 - (b/2)x_1^2$ and $u_2(x_2) = a_2x_2 - (b/2)x_2^2$ which give rise to linear demand functions $x_1(p_1)$ and $x_2(p_2)$
  - Assume $S(\mu) - F(\mu) = (\text{Log}(\mu))/s$ with $s > 0$.

- First-best allocation: $x_1 = 4.702$, $x_2 = 4.527$ and $\mu = 0.858$
- Decentralized by

$$\begin{aligned} p_1 &= k + \overline{T}'_1 + \overline{\varphi}'_1 = 0.2 + 0.049 + 0.049 = 0.298, \\ p_2 &= k + \overline{T}'_2 + \overline{\varphi}'_2 = 0.2 + 0.13 + 0.043 = 0.373. \end{aligned}$$

  observe $p_2 > p_1$
- Optimal allocation when the planner does **not** take the environmental costs into account: $x_1 = 4.667$, $\mu = 1$ and thus $x_2 = 0$

Second-best approach

- First-best allocation ($p_1 = 0.298, p_2 = 0.373$) gives a profit before fixed cost $F(\mu)$ of 0.226
- If the fixed cost at the optimal value of μ, $F(0.858)$, is smaller than 0.226, these prices are also the second-best (Ramsey) optimal prices
- Otherwise, we have a "true" second best

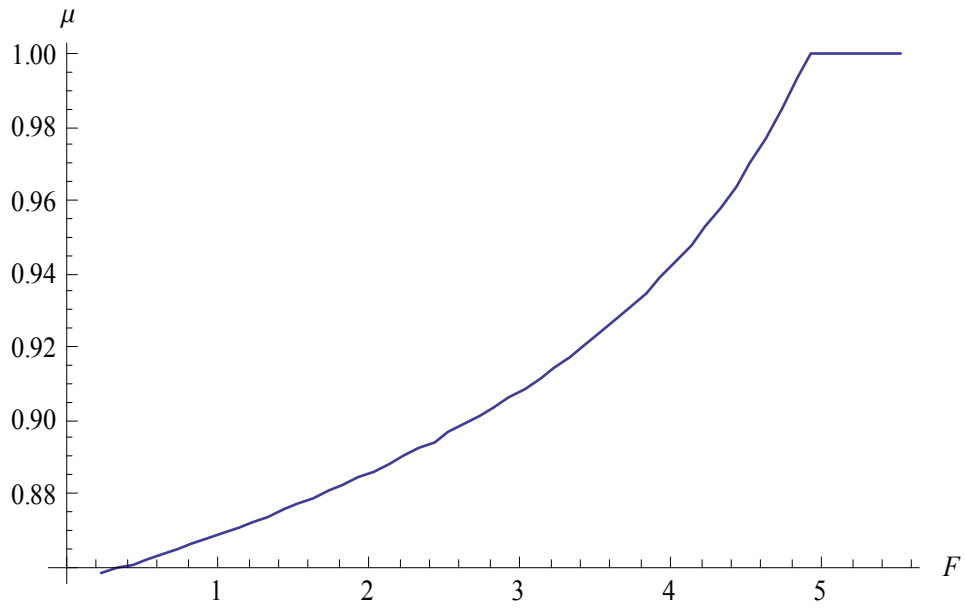

Figure 2:

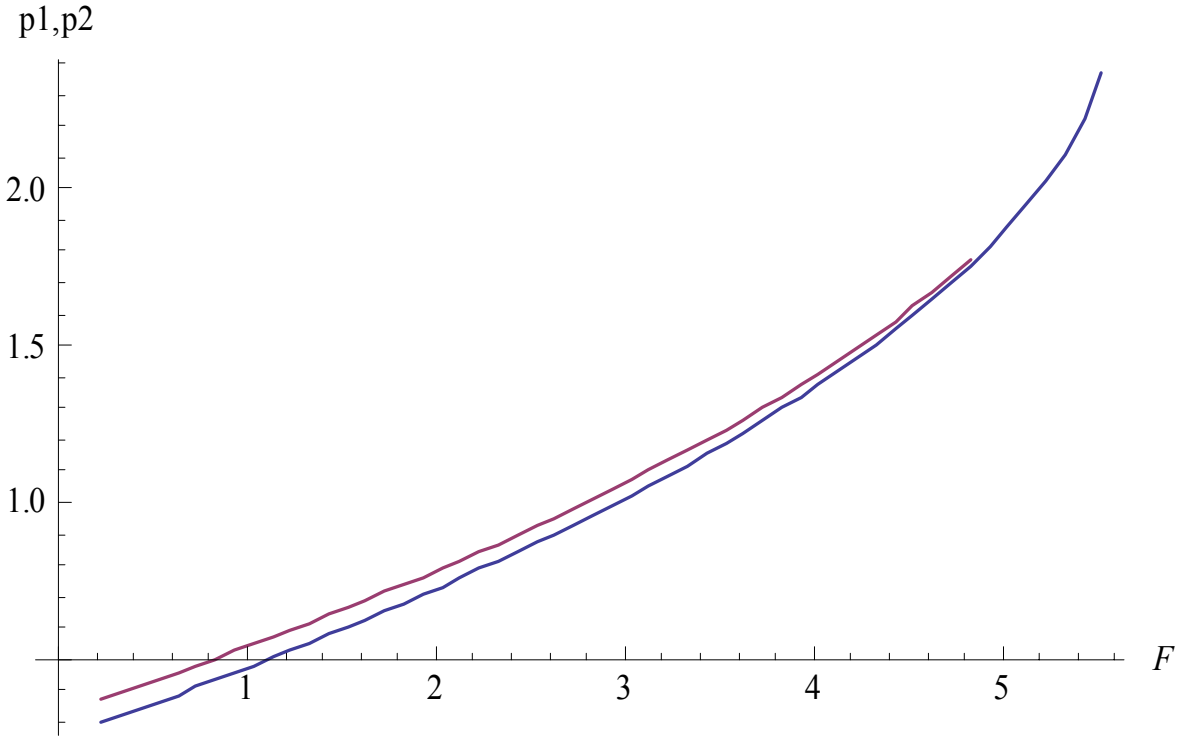

Figure 3:

Concluding comments

- Environmental policy: crucial issue for the future of postal service
- This paper: relationship between universal (public) service and environmental policy
- USO has social and private costs and benefits. Environmental impact has been neglected so far
- First step: $D + 1$ mail

Main points

- Neglecting environmental aspects may result in too stringent public service obligations
- Prices should reflect marginal social damage.
  - Pigouvian rule in the first-best
  - Corrected rule in the second-best
- Second-best level of μ vs first-best level