E-commerce and parcel delivery: environmental policy with green consumers

Claire Borsenberger, Helmuth Cremer, Denis Joram,
Jean-Marie Lozachmeur and Estelle Malavolti

Toulouse School of Economics

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Introduction

- E-commerce has been growing significantly, and its expansion has been raising many regulatory issues, ranging from competition policy questions to issues of profit shifting.
- But in addition to these "traditional" issues, the environmental impact of the sector has been subject to ever increasing scrutiny and the appeals for policy intervention have become increasingly pressing.

- In an earlier paper we have taken first pass at studying the design of environmental policy in the e-commerce sector.
- Vertical structure: tax delivery (operator), output (retailer) and/or emissions?
- We have shown that a Pigouvian emissions tax is always necessary and under perfect competition it sufficient to achieve first best.
- Under imperfect competition other instruments, targeting output and units delivered are also necessary.
- Design depends on industry structure.

- We have ignored consumers' environmental awareness (CEA) which has been increasing considerably over the last decades.
- It appears to affect demand behavior in all sectors and particularly in e-commerce where debate about carbon footprint has been particularly intense.
- In this paper, we study how CEA affects the design of environmental policy.
- We also examine if there is a need for regulation requiring delivery operators to reveal the environmental footprint of their activity.

Model

- Consider an e-commerce sector with two products $i = 1, 2$ which are substitutes and differentiated by their environmental impact.
- For simplicity, we assume that this impact is determined by the emissions of the delivery operator.
- There are two operators, delivering each a single product, so that the index $i = 1, 2$ can also be used for of delivery operators.
- There are two retailers, indexed A and B, which sell both products.

- Preferences are represented by

$$u(x_1, x_2) - p_1 x_1 - p_2 x_2 - \sigma x_1 e_1 - \sigma x_2 e_2,$$

  where x_1 and x_2 denote consumption of the two goods, p_1 and p_2 the prices charged by the retailers, while e_1 and e_2 are the (per unit) emissions associated with their delivery.

- Environmental concern, CEA, is expressed in monetary terms, with σ representing the perceived cost of one unit of emissions.

- Demand functions $x_1(q_1, q_2)$ and $x_2(q_1, q_2)$,where $q_i = p_i + \sigma e_i$ is the "full price" including environmental damage.

- The costs of delivery operator $i = 1, 2$ are given by $c_i(z_i, e_i)$, where z_i is the number of parcels delivered and e_i is emissions per parcel delivered. Each operator delivers a single good. Assume for simplicity that:

$$c_i(z_i, e_i) = C_i(z_i) - \gamma_i(e_i)z_i,$$

where $\gamma_i''(e_i) < 0$ and

$$\gamma_i'(e_i) > 0 \quad \text{for } e_i < \overline{e}_i \quad \text{and} \quad \gamma_i'(e_i) = 0 \quad \text{for } e_i \geq \overline{e}_i.$$

- This assumption represents the property that delivering in a less polluting way is more costly. Formally this means that increasing emissions decreases cost at least up to some level $\overline{e}_j$.
- Total emissions, E, have a social cost $\psi(E)$.

- Different scenarios reflecting the type of competition and the vertical structure of the industry.
- Reference scenario: pseudo-perfect competition *à la* Mussa and Rosen: prices are set at marginal cost both for quantity and quality competitively so that retail prices and delivery rates are set at marginal costs.

$$p_i = k + r_i,$$
$$p'(e_i) = r'(e_i).$$

- Then we consider a setting where all firms remain independent but where there is imperfect competition.
- Finally, we assume that there is vertical integration between one of the retailers and one of the delivery operators.

Efficient solution

- Not affected by CEA; laundering out.
- Requires $\gamma_i'(e_i^*) = \psi'(E^*)$.
- We assume $\sigma < \psi'(E^*)$; monetary value of CEA is smaller than marginal social damage.

Equilibrium when consumers observe emissions

- Under pseudo-perfect competition we obtain

$$\gamma_i'(e_i) = \sigma.$$

- Consequently, we have $e_i < \overline{e}_i$ as long as $\sigma > 0$, while $\sigma = 0$ yields $e_i = \overline{e}_i$.
- Either way with $\sigma < \psi'(E^*)$ we have $e_i > e_i^*$.
- CEA is efficiency enhancing; discipline device which reduces emissions, but not sufficient to achieve efficiency.

Policy

- FB can be implemented by setting emissions tax τ

$$\tau = \psi'\left(E^*\right) - \sigma.$$

- No other instrument is needed $t_j = \delta_i = 0$ (zero taxes on output and delivery).
- When $\sigma = 0$ we obtain the traditional Pigouvian rule: the tax must reflect the marginal social damage.
- With CEA the rule is amended and now requires that the tax reflects the part of the marginal social damage which is not perceived by consumers.

Observability of emissions

- When emission they are not observable we return to an equilibrium with $e_i = \overline{e}_i$; since e_i is not observed by consumers their willingness to pay is zero.
- Then, there is no incentive for delivery operators to reduce emissions. This leads of course to a lower level of welfare.
- Consequently, a regulation requiring delivery operators and/or retailers to reveal the level of emissions is welfare improving.

- Question: will firms spontaneously have an incentive to reveal e_i?
- In the competitive scenario: yes!
- Delivery operators want to communicate their e, because this shifts the inverse demand curve upwards so that (with increasing marginal costs) equilibrium profits will increase.
- This suggests that no regulation is necessary. However absent of a regulatory, and possibly certifying authority it is not clear if the operators can credibly announce their e_i.

Imperfect competition in the delivery sector

- Assume that delivery operators move first and play a two stage game: first they choose e and then r.
- The retailers continue to set prices at marginal costs.
- As long as $\sigma > 0$, e is like quality in vertical differentiation models.

Equilibrium and policy

- When $\sigma = 0$ emissions continue to be set at their maximum levels $e_i = \bar{e}_i$; their sole effect on the equilibrium is to reduce costs.
- A positive value of σ (the presence of CEA) tends to mitigate this inefficiency and we *may* get smaller emission levels and an interior solution provided that σ is large enough.
- In that case, e has also an effect on demand (perceived as quality) which induces delivery operators to limit their emissions.

- To implement the first best
- Emissions tax is lower than under perfect competition.
- Now a tax per unit delivered δ_i is also required, and the sign of total tax per-unit $\delta_i + \tau_i e_i$ is ambiguous; distortions due to imperfect competition in addition to emissions.
- Expressions are the same under vertical integration (one retailer and one delivery operator).

Heterogeneity in the level of environmental concern

- Consider heterogenous consumers who differ only in their σ's.
- For simplicity assume that a proportion μ of the total population of consumers values the environment at $\sigma > 0$ while the remaining part, $1 - \mu$ has no concern for the environment ($\sigma = 0$).
- Results obtained for equilibrium under imperfect competition continue to apply except that demand has to be redefined as aggregated demand

- Implementing the FB is now more problematic, because it requires personalized taxes, which depend on an individual's σ.
- These are feasible only when individual σ's are observable.
- Then a simple way to achieve the FB is to impose first of all per unit taxes at rates σe_1 and σe_2 on the consumers who do not have any environmental concern.
- This brings us back to the model considered.

Revelation of emissions levels

- Introduce an extra stage into our game: in Stage 0, delivery operators simultaneously decide whether they reveal their level of e_i or not.
- When a delivery operator does not reveal its emissions, consumers assume that they are at their maximum level.
- Since no action is taken and no information revealed between the added Stage 0 and Stage 1, for an operator not revealing its emissions is equivalent to choosing maximum emissions in Stage 1.
- But this option already existed in the original game and we have shown that as long as σ is large enough it will not be relevant in equilibrium.
- Consequently, the equilibrium in Stage 0 involves revelation of emissions by both operators.

Concluding comments

- CEA mitigates the inefficiency of the equilibrium by bringing the level of emissions closer to its optimal level.
- CEA also affects the design of the appropriate emissions tax, which leads to an amended Pigouvian rule.
- Under perfect competition the tax is reduced by exactly the monetary level of CEA, σ.
- Under imperfect competition the taxation rule is more complicated and the reduction exceeds σ.

- In our setting delivery operators find it beneficial to reveal their level of emissions.
- In practice it may be difficult to do this in a credible way.
- Consequently, a regulatory intervention associated with some kind of certification is certainly desirable.