Harnessing Bertrand competition on behalf of the environment

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• Taxation of environmental externalities:
  - Perfect competition - tax equal to marginal damage (so called Pigouvian tax)

• IN GENERAL, MONOPOLIES ARE FRIENDS OF ENVIRONMENT
Motivation

- Bonus-malus system and clean car industry in France
- Stringency of policy:
  - under imperfect competition the regulator should be laxer
  - but if there is a rival, laxer policy deters the boosting of the clean variety
- Questions we address:
  - If there is a green competitor, is it optimal to make people switch to green variety?
  - Under which conditions should the policy be laxer or stringent?
Model

- Traditional a la Lee and Barnett
  - Second best tax
  - More stringent policy in some cases

- Hotelling line with consumers located along a segment of unit length

\[ c_1 < c_2 \]

\[ D(\delta X) \]

\[ X: \quad v - p_1 - x\beta - tx = v - p_2 - (1 - x)t \]

Demand:

\[ X_1 = \frac{t + p_2 - p_1}{2t + \beta}, \quad \frac{\partial X_1}{\partial \beta} < 0 \]

\[ X_2 = \frac{t + \beta + p - 1 - p_2}{2t + \beta}, \quad \frac{\partial X_2}{\partial \beta} > 0 \]
Model-cont

Hotelling line

Conventional Monopoly
MC $c_1$
Price $p_1$

Green Monopoly
MC $c_2$
Price $p_2$

$U = v - p_1 - (t + \beta) x$
$U = v - p_2 - t (1-x)$

Consumers uniformly distributed buy each one unit of a good
x - distance from the monopoly that measures how far is the consumer from its ideal product
v - is a surplus of a good itself
Both firms maximize profits:

conventional variety: \((p_1 - c_1 - \tau \delta) \frac{\partial X_1(p)}{\partial p_1} + X_1(p) = 0\)
green variety: \((p_2 - c_2) \frac{\partial X_2(p)}{\partial p_2} + X_2(p) = 0\)

yielding Lerner indexes

\[\frac{(p_1 - c_1 - \tau \delta)}{p_1} = \frac{1}{\epsilon_1(p)} \quad \text{and} \quad \frac{(p_2 - c_2)}{p_2} = \frac{1}{\epsilon_2(p)}\]

where \(\epsilon_1(p) = \frac{p_1}{t + p_2 - p_1}\) and \(\epsilon_2(p) = \frac{p_2}{t + \beta + p_1 - p_2}\)

Note that the increase in environmental concern strengthens the market power of the green variety.
**Lemma 1** Under some assumptions, a rise in environmental concern increases equilibrium profits for both varieties, and relatively more for the green one.

**Lemma 2** Under some assumptions, a rise in environmental tax softens price competition at the expense of the conventional producer.
Unregulated market

- Two reaction function solved for Nash equilibrium prices yield:

\[ p_1(\tau) = \frac{c_2 + 2c_1 + \beta + 2\tau\delta + 3t}{3}, \quad p_2(\tau) = \frac{c_1 + 2c_2 + 2\beta + \tau\delta + 3t}{3} \]

- Both \( \frac{\partial p_1(\tau)}{\partial \beta} > 0 \), \( \frac{\partial p_2(\tau)}{\partial \beta} > 0 \), \( \frac{\partial p_1(\tau)}{\partial \tau} > 0 \) and \( \frac{\partial p_2(\tau)}{\partial \tau} > 0 \)

  - but environmental concern raises green price more
  \( \frac{\partial p_2(\tau)}{\beta} > \frac{\partial p_1(\tau)}{\beta} \)

  - and tax mitigates price advantage given to conventional variety

\[ p_2(\tau) - p_1(\tau) = \frac{(c_2 - c_1 + \beta - \tau\delta)}{3} \]

- Profit responses:

\[ \frac{\partial \Pi_i(p(\tau))}{\partial \beta} > 0 \text{ for } \tau = 0; \quad \frac{\partial \Pi_1(p(\tau))}{\partial \tau} < 0 \text{ and } \frac{\partial \Pi_2(p(\tau))}{\partial \tau} > 0 \]
Property 1

A higher market power gives the producer of one variety a higher market share than has the other one. The gap between market powers has the following expression:

\[
\frac{p_2(\tau)}{\epsilon_2(p(\tau))} - \frac{p_1(\tau)}{\epsilon_1(p(\tau))} = 2(t + \beta)\left(\frac{1}{2} - X_1(p(\tau))\right) = \frac{2(c_1 - c_2) + \beta + 2 \tau \delta}{3}
\]
Lemma 3

In absence of regulation, Bertrand equilibrium outcome is characterized by:

- \( p_2(0) > p_1(0) \)
- \( \frac{p_1(0)}{\epsilon_1(p(0))} > \frac{p_2(0)}{\epsilon_2(p(0))} \) and \( \frac{1}{2} < X_1(p(0)) \) if \( 2(c_2 - c_1) > \beta \)
- \( \frac{p_1(0)}{\epsilon_1(p(0))} < \frac{p_2(0)}{\epsilon_2(p(0))} \) and \( \frac{1}{2} > X_1(p(0)) \) otherwise
Benchmark-first best

- Should the regulator take into account personal trouble? Should he recognize that pollution is partially internalized?

- Optimal split: $c_2 - c_1 = T'(X_1(p(\tau^*))) + \delta D'(X_1(p(\tau^*)))$
  where $T(X)$ is the social matching cost measured by the distance between preferred and actual variety choice

- i.e., marginal savings in production costs of a buyer purchasing the polluting variety = marginal social cost of imperfect fit and environmental damage;
Proposition 1

The optimal tax $\tau^*$ satisfies:

$$
\tau^* = D'(\delta X_1(p(\tau^*))) + \frac{p_2(\tau^*)}{\epsilon_2(p(\tau^*))} - \frac{p_1(\tau^*)}{\epsilon_1(p(\tau^*))} + \frac{p_1(\tau^*) - p_2(\tau^*)}{\delta} + \frac{2t(X_1(p(\tau^*)) - \frac{1}{2})}{\delta}
$$

The difference between standard Lee-Barnett and $\tau^*$ is:

$$
\frac{p_1(\tau^*) - p_2(\tau^*)}{\delta} + \frac{2t(X_1(p(\tau^*)) - \frac{1}{2})}{\delta} = -\beta X_1(p(\tau^*))
$$

If $\beta > 0$ then $\tau^*$ lies below $\tau^{LB}$. 
## Taxation and channels of dealing with distortions

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<thead>
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<th></th>
<th>( \frac{p_2(\tau^<em>)}{\varepsilon_2(p(\tau^</em>))} - \frac{p_1(\tau^<em>)}{\varepsilon_1(p(\tau^</em>))} )</th>
<th>( p_1(\tau^<em>) - p_2(\tau^</em>) )</th>
<th>( T'(X_1(p(\tau^*))) )</th>
<th>( \tau^* - D'(\delta X_1(p(\tau^*))) )</th>
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<tbody>
<tr>
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<td>1a: low ( \beta )</td>
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<td>1b: medium ( \beta )</td>
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<td>1c: high ( \beta )</td>
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<td>2: ( \delta D'(X_1(p(\tau^*))) &lt; c_2 - c_1 )</td>
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