Targeting taxes on local externalities

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June 12, 2023

Motivation

- How to account of the (high) taxes on fuel ?
  - Efficiency. Low price sensitivity of fuel demand
  - Equity. Fuel is consumed by those who have a low social importance, say high income earners in big cities
  - Environmental concerns, e.g. global warming or pollution
- Do environmental concerns fall on other commodities (play with substitution or complementarity with fuel) ? Targeting principle.
- If the damages from fuel consumption do not depend on the identity of the consumer, then targeting usually applies (Sandmo, 1975). Global warming from greenhouse gas emissions.
- Focus on the case where fuel consumption of different consumers cause different damages. Pollution from urban/rural car drivers.

Theoretical setup

- n^h consumers with preferences $u^h(\mathbf{x}, y, \ell) - \varphi^h(\mathbf{e})$.
  - $\mathbf{x}$ = bundle of 'clean' goods
  - y = quantity of a 'dirty' good (fuel)
  - ℓ = labor used to produce these goods (linear technology)
- Externalities in $\mathbf{e} = (e^h)$ with $e^h = n^h y^h$.
  The damage caused a type h consumer to a type k is

$$\frac{\partial \varphi^k}{\partial e^h}(\mathbf{e}).$$

- In the case of a 'global' externality, every type h causes the same damage (the marginal damage does not depend on h). Global warming through aggregate greenhouse gas emissions.
- The externality is 'local' if the identity of the consumer of the dirty good matters. Pollution from automobile-based fuel consumption may cause more damages in a urban area, i.e., to urban consumers.

First-best taxes

- A given social weight β^h in the SWF applies to every consumer of type h.
- The authority has to collect some tax resources (ρ multiplier).
- The first-best optimum can be decentralized using personalized income transfers (T^h),

  $$t_j = 0 \text{ for every clean good } j,$$

  and personalized Pigovian taxes on the dirty good,

  $$t_y^h = \sum_k n^k \frac{\beta^k}{\rho} \frac{\partial \varphi^k}{\partial e^h}.$$

  t_y^h is the social valuation of the marginal pain caused by one type h.

Second-best taxes

- Anonymous taxes, $T^h = T$ and $t_y^h = t_y$ for all h.
- Consumption (ξ_j^h) and ξ_y^h, and utility v^h function of $(\mathbf{q}, T)$.
- The optimal income transfer T must be such that

$$\sum_h n^h b^h = 1,$$

where

$$b^h = \frac{\beta^h}{\rho}\frac{\partial v^h}{\partial T} + \sum_i t_i \frac{\partial \xi_i^h}{\partial T} - t_y^h \frac{\partial \xi_y^h}{\partial T}$$

is the social valuation of a type h consumer.

- The first-order condition in q_i can be written

$$\sum_j t_j \frac{\partial \hat{\xi}_i}{\partial q_j} + t_y \frac{\partial \hat{\xi}_i}{\partial q_y} = \mathrm{cov}(\mathbf{b}, \xi_i) + \sum_h n^h t_y^h \frac{\partial \hat{\xi}_y^h}{\partial q_i}.$$

  (compensated demand denoted by a hat)
- Demand for good i should be discouraged if those who like this good (high consumption of good i) have low social valuations (low b^h).
- Externalities magnify the discouragement (RHS gets more negative) if the dirty good is a complement to good i for types causing the greatest damages.
- In the absence of externality ($t_y^h = 0$), Ramsey taxes (t_i^{R}) satisfy

$$\sum_j t_j^{\mathrm{R}} \frac{\partial \hat{\xi}_i}{\partial q_j} + t_y^{\mathrm{R}} \frac{\partial \hat{\xi}_i}{\partial q_y} = \mathrm{cov}(\mathbf{b}, \xi_i)$$

Reaching the greatest polluters through taxes

- Refer to the sufficient statistics $\phi_i = \operatorname{cov}(\mathbf{t}_y, \mathbf{s}_i)$ where

$$s_i^h = \frac{\partial \hat{\xi}_y^h}{\partial q_i} \Big/ \frac{\partial \hat{\xi}_y}{\partial q_i}$$

  is a (relative) sensitivity of fuel demand when the price of good i varies.
- Intuition from some good i complement to fuel for all types (so $s_i^h > 0$ for all h). Then $\phi_i > 0$ if a higher tax on good i leads to a greater decrease in fuel consumption from those causing the greatest damages (t_y^h is high).

Targeting principle

- There is no reason to play with taxes on goods other than fuel if one cannot reach the greatest polluters better than by taxing fuel alone. 'Sensitivity-neutral' condition.
- Proposition. Targeting. If $\phi_i = \phi$ for every good i, then $t_j = t_j^{\mathrm{R}}$ for every clean good j, and

$$t_y = t_y^{\mathrm{R}} + \sum_h n^h t_y^h + \phi.$$

  The optimal fuel tax is the sum of the Ramsey tax and the average Pigovian tax adjusted for the possibility of reaching the greatest polluters.
- The fuel tax should be set above the average social damage if the fuel consumption of the households implying the greatest social damage is the most sensitive to a higher fuel tax, $\phi > 0$.

Illustration roadmap

- In 2010 the fuel taxes (VAT + TICPE) is between 115% for diesel and 160% for (unleaded) petrol. The average tax rate is 131%.
- Estimate an Almost Ideal Demand System (AIDS) on 10 broad categories of goods using the 2010-11 'Budget de famille' survey.
- The damages (t_y^h) and valuations (b^h) are set so that the conditions for optimal taxes are met by the actual consumption taxes in 2010,

$$\sum_h n^h b^h = 1,$$

and for every good i,

$$\sum_j t_j \frac{\partial \hat{\xi}_i}{\partial q_j} + t_y \frac{\partial \hat{\xi}_i}{\partial q_y} = \mathrm{cov}(\mathbf{b}, \xi_i) + \sum_h n^h t_y^h \frac{\partial \hat{\xi}_y^h}{\partial q_i}.$$

- Check that targeting holds, so that one can decompose the actual fuel tax in two parts, Ramsey and Pigou adjusted for heterogeneity in damages.

Demand for consumption goods

- 'Urban' in areas with more than $500,000$ inhabitants; others are 'rural.'

Table: Consumption budget shares[1]

	rural	urban
Food and non-alcoholic beverages (01)	25.5	24.4
Alcoholic beverages, tobacco and narcotics (02)	5.3	4.3
Clothing (03)	7.2	7.5
Furnishings (05)	3.0	3.4
Transport (except fuel) (07 except 0722)	5.0	7.2
Fuel (0722)	9.2	6.2
Communication (08)	5.2	5.2
Recreation and culture (09)	9.9	10.7
Restaurants and hotels (11)	8.8	11.1
Miscellaneous goods and services (12)	20.9	20.0

1. Shares in total expenditures for flexible categories.

- Fuel is a Hicksian substitute to the other goods in each area (price elasticities are not reported here).

Social valuations and personalized Pigovian taxes

Table: Social valuations and personalized Pigovian taxes

	rural	urban
Social valuation ($\hat{b}_h$)	1.18	0.81
Intrinsic valuation[1]	1.04	0.70
Effect through collected taxes	0.17	0.15
Pigovian component	0.03	0.04
Pigovian tax rates ($\hat{t}_y^h/p_y$)	78 %	163 %

Social valuation b_h = Intrinsic valuation + Income effect − Pigovian part

- Similar Pigovian components: urban people cause the greatest damages but display a lower income-sensitivity of their fuel consumption.
- The average social damage from fuel equal to

$$\sum_h n^h \frac{\hat{t}_y^h}{p_y} = 115\,\%.$$

Assessing the validity of targeting

- We have

$$\phi_i = \phi \Leftrightarrow \sum_h t_y^h \frac{\partial \hat{\xi}_y^h}{\partial q_i} = \left(\phi + \sum_h n^h t_y^h \right) \frac{\partial \hat{\xi}_y}{\partial q_i}$$

- The targeting principle is considered as met is the OLS regression

$$\sum_h t_y^h \frac{\partial \hat{\xi}_y^h}{\partial q_i} = \varphi_0 + \varphi_1 \frac{\partial \hat{\xi}_y}{\partial q_i}$$

gives $\varphi_0 = 0$ and φ_1 significant enough.

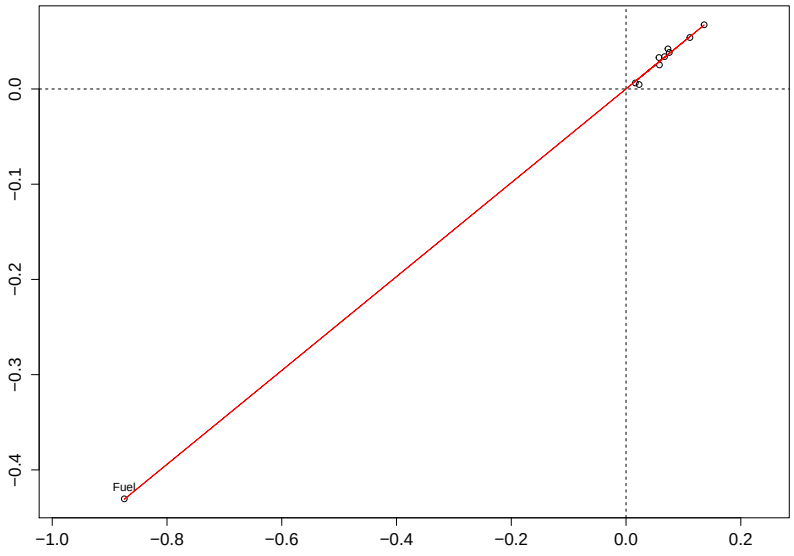

Figure: with fuel

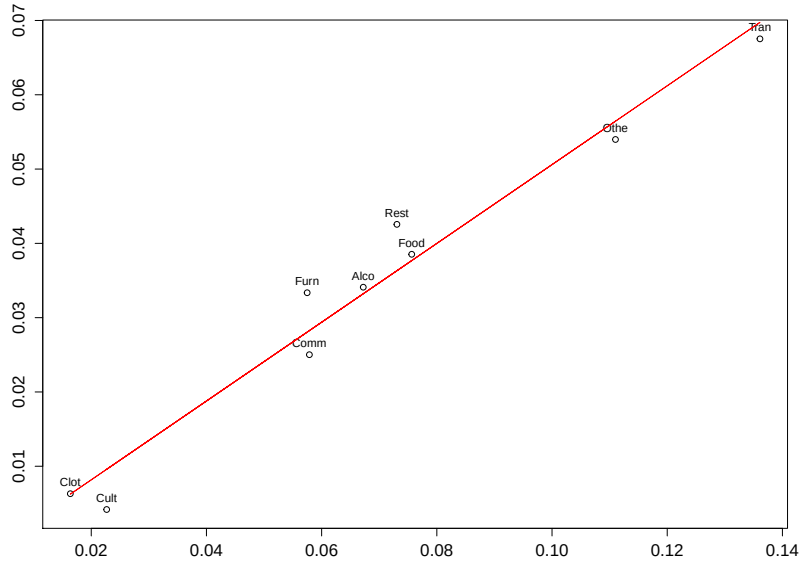

Figure: without fuel

- Gives

$$\frac{\hat{\phi}}{q_y} = -0.3\,\%.$$

Final decomposition

- The theoretical decomposition

$$t_y = t_y^{\mathrm{R}} + \sum_h n^h t_y^h + \phi.$$

gives

$$\frac{\hat{t}_y^{\mathrm{R}}}{p_y} = 1.31 - 1.15 + 0.003 \simeq 0.16.$$

The Ramsey tax on fuel is $16\,\%$, close to the standard rate of VAT ($19.6\,\%$).