Externalities in economies with imperfect information and incomplete markets

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Introduction

- General framework to analyze externalities in economies with incomplete markets and imperfect information.
- Distortions in economies with imperfect information and incomplete markets result in real welfare consequences and not purely pecuniary effects.
- This type of economies are not in general constrained Pareto efficient and welfare improving tax interventions almost always exist.

Introduction

- General effects of price changes
  - Distributional effects: usually net out, gains by firms are offset by losses to consumers.
  - Allocations effects: No welfare losses as long as the price changes are small.
- Pecuniary externalities arise in economies with distortions.
- For example, optimal tax on one commodity is indirectly affected by government revenue raised from other taxes.

Households

$$\max_{x^h} u^h(x^h, z^h)$$

$$s.t.\ x_1^h + q \cdot \bar{x}^h \leq I^h + \sum_f a^{hf} \cdot \pi^f \qquad h = 1, ..., H$$

x_1^h : numeraire good, $\bar{x}^h = (x_2^h, ..., x_N^h)$
q : prices
I^h : government lump sum transfer
a^{hf} : share of household h in firm f
π^f : profits of firm f
Compensated demand:

$$\hat{x}_k^h(q, z^h, u^h) \equiv \frac{\partial E^h}{\partial q}|_{z^h, u^h}$$

Firms

$$\pi^f = \max_{y^f} y_1^f + p \cdot \bar{y}^f$$

$$s.t. y_1^f - G^f(\bar{y}^f, z^f) \leq 0$$

- y_1: supply of the numeraire good
- $\bar{y}^f = (y_2^f, ..., y_N^f)$: supply of non-numeraire N-1 goods
- $G()$: Production set

Supply of goods

$$y_k^f \equiv \frac{\partial \pi^f(p, z^f)}{\partial p_k}|_{z^f} \quad \text{k=1,...,N}$$

Government and Market Equilibrium

Net income (R) is defined as:

$$R \equiv t \cdot \bar{x} - \sum_h I^h$$

where taxes (t) are defined as:

$$t = q - p$$

and

$$\bar{x} = \sum_h \bar{x}^h$$

Market clearing condition (with $t = 0$ and $I = 0$):

$$\sum_h \bar{x}^h(q, z^h, I^h) = \sum_f \bar{y}^f(p, z^f)$$

Pareto Optimality

- Pareto optimality can measured as whether there exists a set of taxes, subsidies, and lump sum transfers that would
  - Leave household utility unchanged
  - Increase government revenues (assumed to be consumed in the numeraire good)

$$\max_{t,I} R \equiv t \cdot \bar{x} - \sum_h I^h$$

s.t.

$$I^h + \sum_f a^{hf} \pi^f = E^h(q, z^h, \bar{u}^h)$$

Effect of taxes on households expenditure function

Total differentiation along the constraint

$$\frac{dI^h}{dt} + \sum_f a^{hf} \left[\frac{d\pi^f}{dz^f}\frac{dz^f}{dt} + \frac{d\pi^f}{dp}\frac{dp}{dt} \right] = E_q^h \frac{dq}{dt} + E_z^h \frac{dz^h}{dt}$$

Differentiating $t \equiv q - p$:

$$\frac{dq}{dt} = \frac{dp}{dt} + I_{N-1}$$

Effect of taxes on households expenditure function

$$E_q^h + \left\{ E_q^h - \sum_f a^{hf} \frac{d\pi^f}{dp} \right\} \frac{dp}{dt} = \frac{dI^h}{dt} + \left\{ \sum_f a^{hf} \frac{d\pi^f}{dz^f} \frac{dz^f}{dt} - E_z^h \frac{dz^h}{dt} \right\}$$

redistributive effect externality effect

Adding all households

$$\bar{x} + (\bar{x} - \bar{y}) \frac{dp}{dt} = \sum_h \frac{dI^h}{dt} + \sum_f \pi_z^f \frac{dz^f}{dt} - \sum_h E_z^h \frac{dz^h}{dt}$$

Distributive effect disappears in equilibrium ($\bar{x}=\bar{y}$)

Effect of taxes on government revenue

Compensating payment

$$\sum_h \frac{dI^h}{dt} = \bar{x} - \left(\sum_f \pi_z^f \frac{dz^f}{dt} - \sum_h E_z^h \frac{dz^h}{dt} \right)$$

Effect of taxes on government revenue

$$\frac{dR}{dt} = \bar{x} + \frac{d\bar{x}}{dt} \cdot t - \sum_h \frac{I^h}{dt}$$

$$\frac{dR}{dt} = \frac{d\bar{x}}{dt} \cdot t + \sum_f \pi_z^f \frac{dz^f}{dt} - \sum_h E_z^h \frac{dz^h}{dt} \equiv \frac{d\bar{x}}{dt} \cdot t + \Pi^t - B^t$$

Redistributive effect ($\bar{x}dt$) net out, we are left with pecuniary ($tdx/dt$and technological externalities ($\Pi^t - B^t$)

Optimal taxes

For the initial equilibrium to be Pareto optimal at t=0,

$$\frac{dR}{dt} = 0$$

$$\Pi^t - B^t = 0$$

In a general case, optimal taxes satisfy the following condition

$$\begin{aligned} \frac{d\bar{x}}{dt} t &= -\left(\Pi^t - B^t\right) \\ t &= -\left(\Pi^t - B^t\right)\left(\frac{d\bar{x}}{dt}\right)^{-1} \end{aligned}$$

Marginal deadweight loss from tax equals marginal benefit due to a reduction in the externality.

Application: Tax Distortion

Commodity one is taxed at a rate of t_1 and a constant fraction β^h of the tax revenue is redistributed to household h.

$$z_1^h = \beta^h t_1 x_1$$

where

$$\sum_h \beta^h = 1$$

Effect on government revenue

$$\frac{dR}{dt_i}\Big|_{t_i=0} = t_1 \sum_h \beta^h \left(\frac{dx_1}{dt_i}\right)_{\bar{u}} = t_1 \left(\frac{dx_1}{dt_i}\right)_{\bar{u}}$$

If goods are substitutes, $dx_i/dt_1 > 0$, then the tax is welfare enhacing.

Application: Adverse selection

One commodity and one unobserved characteristic (quality, θ).

$$E^h = E^h(q, \bar{\theta})$$

$$\pi^f = \pi^f(p, \bar{\theta})$$

Effect of a small change in taxes:

$$\frac{dR}{dt} = \left[\sum_f \frac{d\pi^f}{d\theta} - \sum_h \frac{dE^h}{d\theta}\right] \frac{d\bar{\theta}}{dt}$$

- Higher average quality
  - Increases firms' profits $d\pi^f / d\theta > 0$
  - Reduces households' expenditure $dE^h / d\theta < 0$
- Higher taxes are beneficial if and only if $d\bar{\theta} / dt$

Application: Signaling/ Screening

- Single signal purchased at a cost
- Mean quality with signal, $\bar{\theta}_1$
- Mean quality without signal, $\bar{\theta}_2 < \bar{\theta}_1$

$$\frac{dR}{dt} = \sum_i \sum_f \frac{\partial \pi^f}{\partial \bar{\theta}_i^f} \frac{d\bar{\theta}_i^f}{dt}$$

for a large number of workers $\bar{\theta}_i^f = \bar{\theta}_i$

$$\frac{dR}{dt} = \sum_i \frac{d\bar{\theta}_i}{dt} \sum_f \frac{\partial \pi^f}{\partial \bar{\theta}_i}$$

If $\partial \pi^f / \partial \bar{\theta}_i > 0$, any tax that increases average quality of the signal is welfare improving.

Application: Signaling/ Screening

Output

$$y_0^f = \sum_i n_i^f y_{0i}(\hat{y}_i^f, \bar{\theta}_i)$$

$$\frac{dR}{dt} = n_1 \frac{\partial \bar{\theta}_1}{dt} \frac{\partial \bar{y}_{01}}{\partial \bar{\theta}_1} + n_2 \frac{\partial \bar{\theta}_2}{dt} \frac{\partial \bar{y}_{02}}{\partial \bar{\theta}_2}$$

If we assume that the average quality is fixed,

$$\frac{dR}{dt} = n_1 \frac{\partial \bar{\theta}_1}{dt} [\frac{\partial \bar{y}_{01}}{\partial \bar{\theta}_1} - \frac{\partial \bar{y}_{02}}{\partial \bar{\theta}_2}] - \frac{\partial n_1}{\partial t} \frac{\partial \bar{y}_{02}}{\partial \bar{\theta}_2} (\bar{\theta}_1 - \bar{\theta}_2)$$

Sorting effect: improvement of quality in signaling pool increases output of signaling reative to non-signaling pool.

Application: Incomplete Markets

- Two period model: k possible states in period 2
- Single store of value: good zero, whose relative price depends on the state
- N non numeraire commodities

$S = (s_1, ..., s_k)$ price vector, depends on taxes and amount of goods available in period 2
W_0^h :Initial stock of good zero at the beginning of period 2

Application: Incomplete Markets

Maximum expected utility in period 2

$$V^h(W_0^h, s) = \sum_k b_k u_{2h}^k(x_k^{h*}, W_o^h, s_k)$$

where

$$x_k^{h*} = \arg\max u_{2h}^k(x_k^h)$$

$$s.t. s_k(x_{jk}^h - W_{jk}^h) \leq 0$$

b_k: probability of state k $\bar{W}$: initial endowment
Two period expected utility

$$u^h(W_0^h, s) = u_1^h(\bar{W}^h - W_0^h) + V^h(W_0^h, s)$$

Application: Incomplete Markets

Small changes in period 2 prices affect W_0^h and through it s.

$$\frac{dR}{dt} = \sum_h \sum_k b_k \frac{dE^h}{ds_k} \frac{ds_k}{dt} = \sum_k \left[\sum_h \bar{x}_k^h \frac{\lambda_k^h}{u_1^h} \right] \frac{ds_k}{dt} b_k$$

Changes in the distribution of prices limits the ability of risk sharing across states. Each individual takes the price distribution as given so he does not consider this effect.