

## Handout 3

### Externality Theory And Policy

(starting directly from Handout 1)

A. Introduce an unpriced good; call it  $z$ .

$z^j$  is net production of  $z$  by firm  $j$

$z^h$  is consumption of  $z$  by household  $h$ .

B. Supply/demand by the firm:

$$L^j = p \cdot y^j - \delta^j f^j(y^j, z^j)$$

2 FOCs (sort of)

$$p_i = \delta^j \frac{\partial f^j}{\partial y_i^j} \quad \forall i, j \quad [1]$$

$$0 = \delta^j \frac{\partial f^j}{\partial z^j}$$

Better to write second as (using Kuhn-Tucker conditions)

$$0 = z^j \left( \delta^j \frac{\partial f^j}{\partial z^j} \right) \quad \left[ \text{with } \delta^j \frac{\partial f^j}{\partial z^j} \geq 0 \right] \quad \forall j \quad [1a]$$

If  $z$  is an input? [like environmental quality]

If  $z$  is an output?

C. For consumers ( $z$  isn't a choice variable)

$$L^h = U^h(x^h, z^h) + \gamma^h (p\omega^h + \theta^h \pi - p x^h)$$

$$\frac{\partial U^h}{\partial x_i^h} = \gamma^h p_i \quad \forall i, h \quad [2]$$

D. Pareto Optimality Results for this setting

1. To investigate economic efficiency in the presence of this new good, we need to know the physical linkage between  $z$  emissions and their distribution among consumers.
2. We'll assume perfect mixing – all sources of  $z$  have the same effect on

environmental quality. So we can focus on  $\sum_j z^j$ . Let's further assume each household is exposed to a fixed share of this sum:

$$z^h = v^h \sum_j z^j \text{ and } \sum_h v^h = 1$$

3. The Pareto problem is then

$$L = \sum_h \lambda^h \left( U^h \left( x^h, v^h \sum_j z^j \right) - \bar{U}^h \right) - \sum_j \alpha^j f^j(y^j, z^j) + \sum_i \beta_i \left( \omega_i + \sum_j y_i^j - \sum_h x_i^h \right)$$

FOCs

$$y_i^j : \quad \beta_i = \alpha^j \frac{\partial f^j}{\partial y_i^j} \quad \forall i, j \quad [3]$$

$$z^j : \quad \sum_h \lambda^h \frac{\partial U^h}{\partial z^h} v^h = \alpha^j \frac{\partial f^j}{\partial z^j} \quad \forall j \quad [3a]$$

$$x_i^h : \quad \lambda^h \frac{\partial U^h}{\partial x_i^h} = \beta_i \quad \forall i, h \quad [4]$$

E. So, the CE isn't PO due to [1a] as compared to [3a].

F. Pigouvian policy:

Let's give each firm a pollution entitlement of  $Z^j$ . They can use more  $z^j$  than that, if they wish, but they must pay  $r$  per unit. Likewise, they may use less  $z^j$  than that, in which case they receive  $r$  per reduced unit.

$$L^j = p y^j + r(z^j - Z^j) - \delta^j f^j(y^j, z^j)$$

Revised [1a] is

$$r = \delta^j \frac{\partial f^j}{\partial z^j} \quad \forall j \quad \text{Pigouvian [1a]}$$

Which encourages economic efficiency iff

$$r = \sum_h \lambda^h \frac{\partial U^h}{\partial z^h} v^h$$

Sign of  $r$ ?

G. Pigouvian Conclusions (price-guided policy; economic instruments)

1. Correctly stated incentives can correct this externality.
2. The incentive is the same for all firms.
3. No policy instruments are needed for consumers (called the *asymmetry* result in formal literature such as Baumol and Oates).
4. PO happens regardless of our choice of the many  $Z^j$ .

H. Optimal Regulation (quantity guides; command and control)

1. Optimal regulations are dualistically related to optimal incentives, so:
2. Correctly stated regulations (the  $z^j$ ) can correct this externality.
3. Optimal regulations vary across firms.
4. No regulation of consumers is necessary.

There are differing regulation "sets" ( $z^j$  for all  $j$ ) depending on which of the PO we are going to.

Social preference between price-guided and quantity-guided policy?

I. Market Policy (informed by theory on optimal price guides)

1. Market policy means to define property rights to the commodity in question and enforce them and allow transfers.
2. This establishes a market and solves certain types of externalities via the 1<sup>st</sup> Theorem.
3. Does it matter who gets the new property rights(s)?

Coase Theorem (CT)

Strong Version of CT: If there are (1) no aggregate income effects and (2) no transaction costs, market activity will result in a particular PO state regardless of the initial distribution of property rights.

income effects: when different people will spend an added \$100 on different things

transaction costs = information costs

Weak Version of CT: If there are no transaction costs, market activity will result in PO regardless of the initial distribution of property rights.

J. "Second Best" Considerations

1. Issue: Policy situations usually address a single market failure. Yet, the real world involves many distortions causing departures from PO conditions. If one externality is "internalized" by corrective policy that achieves first-best PO conditions, will we be any closer to a Pareto frontier? That is, the many remaining market failures constitute constraints that would idealistically be recognized in a Pareto problem for the market failure under consideration. But we don't do that. It's too difficult.

2. Solution: Thus far, the "solution" has been to "have faith" that society is addressing the worst of its market failure ills first and that each "correction" is truly an advance in economic efficiency.

### For Other Externality Types

There are externality scenarios other than depletable (rival) externalities with perfect mixing and fixed shares. There are other varieties of depletable externalities, and there are undepletable externalities.

1. For example: Undepletable (nonrival) with perfect mixing. Change our prior model by having each consumer affected by the entirety of  $z^j$ 's.

$$z^h = \sum_j z^j$$

This alters PO condition [3a], but not the CE conditions nor the Pigouvian-policy CE conditions.

Again, CE conditions are not PO.

Pigouvian policy is corrective if we choose the incentive correctly.

$$r = \sum_h \lambda^h \frac{\partial U^h}{\partial z^h}$$

The same Pigouvian Conclusions hold true again.

In terms of yet other externality situations, what happens when ... :

2. Firms are also affected by each others' decisions (production externalities)?
  - [3a] gets more complex
  - same policy conclusions apply
3. Externality is beneficial
  - signs of  $\frac{\partial U^h}{\partial z^h}$  are positive
  - sign of  $r$  flips
  - same policy conclusions apply
4. Mixing isn't perfect
  - source (emittor) matters
  - $r$  must vary by source

## Externality Definition

from Baumol and Oates, 2<sup>nd</sup> edition, *The Theory of Environmental Policy*:

"An externality is present whenever some individual's (say A's) utility or production relationships include real (that is, nonmonetary) variables, whose values are chosen by others (persons, corporations, governments) without particular attention to the effect's on A's welfare."

Baumol and Oates also identify a second condition which may need to be satisfied in addition to the above, but then they state a preference for the single requirement restated above.

## Externality Classifications

- Used to help understand externalities and to decide if policy is appropriate and what kind of policies might be attractive.
- Many taxonomies have been submitted over the years. [Some others are defunct now.] Three remaining ones are worth knowing.

### 1. Depletable/Undepletable

Undepletable: greater or lesser impact on one agent does not decrease or increase the impact on others. (nonrivalness)

Examples?

This is the area in which the distinctions between externalities and public goods/bads becomes clouded.

### 2. Pareto Relevant/Pareto Irrelevant

Pareto Relevant: an externality causing a market failure; CE  $\Rightarrow$  PO

Examples?

Most Pareto irrelevant externalities arise from policy transaction costs exceeding internalization benefits.

### 3. Pecuniary/Technological

Pecuniary: when the externality interdependence is transmitted via nominal (price) variables

These do not qualify as externalities in contemporary definitions. [Baumol and Oates say "real" in their definitions.]

Thought of another way, pecuniary externalities are Pareto irrelevant.

### **Alternative Externality Correction Mechanisms**

The following list and abbreviated discussion is intended to identify some of the major alternatives which are available for the correction of externalities. Some of these alternatives may be regarded as potential policies while some may not. It is doubtful that this listing is exhaustive, but it is certainly demonstrative.

#### **A. Market Emergence**

1. In economic models the existence of an externality implies inefficiency. This suggests that there are gains to be made by "internalizing" an externality. Why, then, should we not expect markets to emerge whenever a Pareto-relevant externality arises? There are at least three possible answers to this question – each potentially valid.
  - Undepletable externality: the externality may be of the undepletable variety. In this case, markets are also inefficient.
  - Private property formation: market operation requires private property. Otherwise, the externality "good" cannot be traded. There may be some barriers to the formation of private property in this good:
    - Interested parties may contest the initial assignment of property rights (who gets what), and they may be unable to resolve this conflict. Resolution of this conflict by third parties (e.g. courts, legislatures) may take a long time to accomplish.
    - Other, perhaps noneconomic, social goals such as equity, liberty, health, or security may recommend that the public sector should not assign property rights.
  - Transaction costs: private property is more expensive to support than common property. In order for markets to be effective, property rights must be policed and enforced. In addition, there are search and information costs and bargaining and decision costs incurred by every agent that participates in trade. Perhaps the sum of costs are larger than the transaction benefits (= gains from trade) enabled by a new market, in which case market creation would not appear to be desirable.

#### **B. Merger**

1. This solution is most applicable when the externality occurs among very few firms.
2. When merger is hypothetical, as in the maximization of summed profit or summed surpluses, a potential Pareto criterion is being employed by the economic analyst, but actual merger endogenizes actual compensation and therefore embodies the Pareto criterion.

#### **C. Economic Incentives**

1. Taxes or subsidies attached to per unit production and/or consumption of the externality interdependence.

2. Cost-sharing of certain inputs (e.g. pollution control equipment): may be useful in the case where capital expenditures are needed to bring about efficient levels of externality production.

D. Regulation

1. Instead of specifying economic incentives and allowing economic agents to choose corresponding production and consumption levels, the government can specify these quantities directly. Such quantity controls are termed regulations.
2. If regulations are appropriately chosen, they can also induce Pareto optimality. Optimal regulations and optimal economic incentives are related as duals. In most instances, optimal regulations will differ among firms and differ among consumers.
3. As indicated by Baumol and Oates (Chapter 13) and others, regulation can be advantageous relative to incentives when the issue contains stochastic elements (such as weather patterns or river flows).

E. Prohibition

1. An extreme form of regulation
2. Rarely optimal because of its extremism

F. Pseudo-Markets

1. This refers to a market-like device such as transferable discharge/emission permits or transferable development rights (TDRs) in which an agency of government defines a fixed number of licenses to generate a set amount of an interdependence (externality). The agency allocates these rights and then "keeps the books" on subsequent transactions in which these permits are exchanged among individuals who hold these rights and individuals who want to obtain them. The agency is also in charge of monitoring externality generation and making sure that no one exceeds their permit holdings.
2. Within some of these proposals consumers are envisioned as active participants in the market. Others do not include a role for consumers.

G. Moral Suasion

1. An important mode of externality correction that is often overlooked in the theoretical literature.
2. This alternative relies on our social consciences to properly account for the effects of our decisions on others.

References

Baumol, William J., and Wallace E. Oates. *The Theory of Environmental Policy*. 2nd ed. Cambridge: Cambridge University Press, 1988.

Pezzy, John C.V. "Emission Taxes and Tradeable Permits." *Environmental and Resource Economics* 26 (2003): 329-42.