ECON1922 spring 2024

University of Oslo

POSTPONED EXAM – SOLUTION PROPOSAL

Problem 1. Optimal pollution and the measurement challenge (20 points)

Consider a simple static model with flow pollution. Emissions are given by E. Environmental damages (in $) are given by an increasing and convex function of emissions, $D(E)$. Without any pollution control, total emissions are given by $E = E_0$. Abatement is denoted by R. Abatement costs (in $) are given by an increasing and convex function of abatement $C(R)$. Total abatement is given by $R = E_0 - E$. Total welfare costs are given by the sum of environmental damages and abatement costs.

a) (10 points – words and figure)
Illustrate marginal environmental damages and marginal abatement costs in a diagram with emissions measured along the x-axis. Explain how the optimal level of pollution E^* is determined.

Solution key:

The optimal level of pollution is discussed in Smith, S. (2011), chapter 2.

The students are expected to explain what marginal abatement costs (MAC) and marginal environmental damages (MED) measure, and what it means that we assume that

(i) damages are given by an increasing and convex function of emissions
(ii) abatement costs are given by an increasing and convex function of abatement

The optimal level of pollution is determined by the emission level that equalizes MAC to MED. The students are expected to explain that MAC=MED maximizes the net benefit to society.

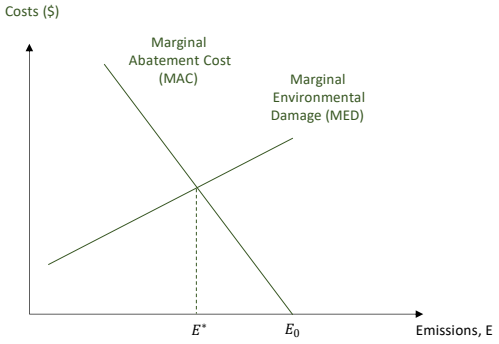
Relevant lecture slides:

The optimal level of pollution

The economist's answer: weighing up the costs and benefits of each additional $ spent on pollution control.

Marginal Abatement Cost (MAC) = Marginal Environmental Damage (MED)

MAC: Costs of each additional unit of abatement
MED: Benefits (reduction of damage) of each additional unit of abatement



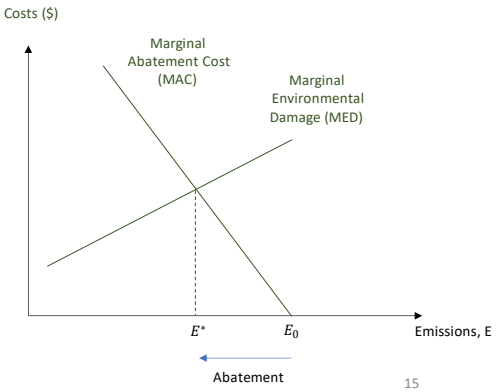
The optimal level of pollution

Assume, at the outset, that $E = E_0$.

The first tonne of pollution abatement is beneficial, because the benefit (reduced damage) exceeds the cost.

Abatement is beneficial until $E = E^*$, where (MAC=MED).

If $E < E^*$, MAC >MED, and increasing emissions by one unit saves abatement costs more than it causes damage

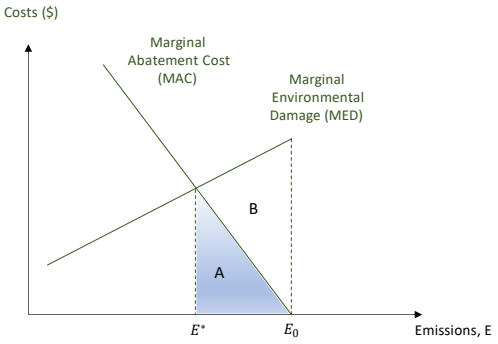


The optimal level of pollution

Total abatement costs incurred reducing emissions from E_0 to E^* is the triangular area marked by A.

The total environmental benefit from this abatement is the sum of areas A and B.

The net benefit to society is B.



b) (10 points - words)
Assume that an environmental regulatory authority wants to reduce the level of pollution to E^*. To implement appropriate environmental policies, we need to measure the value pollution control. Discuss two methods to measure the value of pollution control: hedonic pricing and contingent valuation.

Solution key:

Methods to measure the value of pollution control is discussed in Smith, S. (2011), chapter 4, and CORE Econ Unit 20.6.

The students are expected to discuss two methods: hedonic pricing and contingent valuation.

Hedonic pricing "tries to infer environmental values from observed behavior in certain non-environmental markets, especially the housing market, and to a certain extent, the labout market. In these markets, we can find situations where environmental goods, while not traded explicitly and separately, are 'bundled together' with traded commodities in observed transactions. Hedonic pricing is a technique for recovering implicit 'prices' for the various attributes of houses or other goods, including implicit prices for environmental attributes" (Smith, 2011, page 78-79).

Contingent valuation: "An alternative approach to valuing things which are not traded in real-world markets, and which therefore do not have market prices, is to ask people directly how much they would value having more or less of them" (Smith, 2011, page 85).

"Contingent evaluation is called a *stated* preference approach because it is survey-based and accepts the respondents' statements of their values as indicative of their true preferences. This is not the case for hedonic pricing" (20. Economics of the environment – The Economy 1.0 (core-econ.org)).

"Hedonic pricing is called a *revealed* preference approach because it uses people's economic behaviour (not their statements) to reveal what their preferences are" (20. Economics of the environment – The Economy 1.0 (core-econ.org)).

Problem 2. External effects (20 points)

Figure 1 illustrates the market for a private consumption good x. D denotes demand and S denotes supply. The production of x causes environmental degradation. The marginal external cost (measured in $) is constant.

a) (10 points – words and figure)
Reproduce Figure 1 and use the figure to discuss how the equilibrium quantity in an unregulated and perfectly competitive market x^{BaU} differs from the socially optimal quantity x^{SO}. Illustrate and explain how the introduction of a Pigouvian tax can reduce the production of x to the socially optimal quantity x^{SO}.

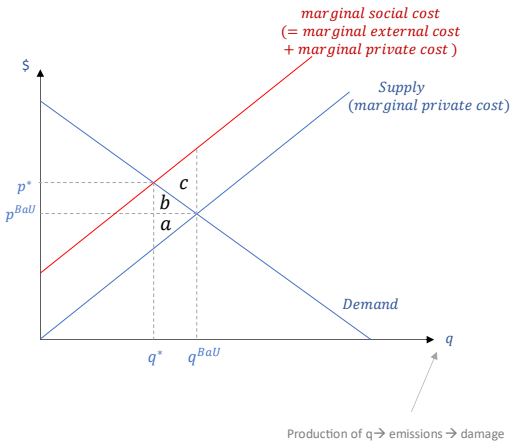
Solution key:
Relevant lecture slides:

A partial equilibrium model: negative externality

Pareto efficient production level: q^*, where demand = marginal social cost (MSC)

Net social gain relative to business as usual (BaU) =

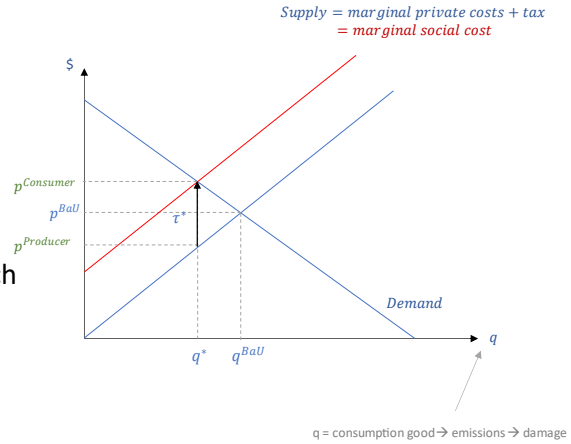
a+b+c (reduction in external cost)
- a (loss in producer surplus)
- b (loss in consumer surplus)
= c (net social gain relative to BAU)



Environmentaltaxes on products: partial equilibriummodel

Introduce a Pigouvian tax

- The Pigouvian tax equals the marginal external cost (MEC) at the Pareto-optimal level of production:
$$\tau^* = MEC(q^*)$$
- With the tax, the supply curve shifts up, such that supply=MSC
- New equilibrium is Pareto efficient



a) (10 points – words)
In the paper "The Problem of Social Cost", Ronald Coase argued that, in certain conditions, pollution problems and other externalities can be fully rectified through individual bargaining between the parties involved, without the need for any government policy intervention at all. Discuss Coase's argument, and the possible obstacles for successful 'Coasean' bargaining.

Solution key:

'Coasean' bargaining is discussed in Smith (2011), chapter 2, and CORE Econ Unit 12.2.

Problem 3. Public goods (20 points)

a) (10 points - words)
Define and give examples of (non-excludable) public goods.

Solution key:

Public goods are discussed in Smith (2011, page 11) and CORE Econ Unit 12.5.

CORE Econ definition of a public good: "A good for which use by one person does not reduce its availability to others."

"A good is termed public if once available to one person, it can be available to everyone at no additional cost and its use by one person does not reduce its availability to others. This character of a public good is called non-rival because potential users are not in competition (rivals) with each other for the good. Note that some economists add that others cannot be excluded from the goods' use. These goods are called **non-excludable public goods**" (CORE Econ Unit 12.5)

Examples of (non-excludable) public goods: public street lighting, clean air and a stable climate. The students are expected to explain how these goods are non-excludable and non-rival.

b) (10 points - words)
Explain why (non-excludable) public goods are underprovided in the market.

Solution key:

Non-excludable public goods are underprovided in the market for two reasons:

- *When goods are non-rival, the marginal cost is zero:* Setting a price equal to marginal cost (as is necessary for a Pareto-efficient market transaction) will not be possible unless the provider is subsidized.
- *When goods are not excludable there is no way to charge a price for them:* The provider cannot exclude people who haven't paid.

Problem 4. Climate change (40 points)

Consider a country with a new green government that is eager to implement policies to mitigate climate change. However, before they make any policy decisions, they have asked for expert advice from an environmental economist.

a) (10 points - words)
Explain to the policy makers how we can understand climate change as a result of market failure.

Solution key:

Definition market failure: A situation where market forces do not lead to a Pareto efficient resource allocation in the economy.

- *Missing market*: No one owns the atmosphere, and there is no market for buying and selling a stable climate.
- Greenhouse gas emissions are a *negative externality* of society's production and consumption, which diminishes the quality of a *public good:* a stable climate.
- There is significant *uncertainty* regarding the consequences of climate change and the Earth's capacity to withstand it.
- *Incomplete contracts*: There is no contract between the current generation (causing the problem) and future generations (who will bear the costs)

b) (10 points – words)
Explain to the policy makers how they can reduce carbon emissions by implementing a carbon tax and/or carbon emissions trading (cap-and-trade).

Solution key:

Carbon tax is discussed in Smith (2011, page 116-118).

Carbon emissions trading is discussed in Smith (2011, page 118-120) and CORE Econ Unit 20.5.

c) (10 points – words)
Explain to the policy makers why the carbon price should be equal across countries.

Solution key:

Carbon emissions are **uniformly mixing,** meaning that an extra tonne of carbon emitted to the atmosphere does the same harm regardless of emission location. Therefore, economic efficiency requires an equal carbon price across the globe.

d) (10 points – words)
Global warming is associated with a great deal of uncertainty regarding climate outcomes. Explain to the policy makers how they should take account of such uncertainties when developing climate policies.

Solution key:

Uncertainty regarding climate outcomes is discussed in Smith (2011, page 106-110). The role of multiple equilibria and tipping points in environmental processes is also discussed in CORE Econ 20.8. "When it is likely that a system displays multiple equilibria and a tipping point, environmental policy must go beyond balancing the costs and benefits of the abatement of environmental damage in the neighborhood of some sustainable equilibrium. Instead, policymakers must devise measures to ensure that a tipping point – especially if it is uncertain – for a critical resource is not passed. In this context, a **prudential policy** would seek to avoid the risk that the given situation may itself be radically and irreversibly degraded." (20. Economics of the environment – The Economy 1.0 (core-econ.org)).