ECON1922 spring 2024

University of Oslo

EXAM

Instructions:

(i) All problems should be solved. Weights are reported in brackets.
(ii) Each exercise indicates how the question should be answered, whether we expect you to explain in words, provide a graphical illustration, or use calculus.
(iii) Restrict your answer to what the exercise asks for. Non-relevant information is given no credit. Full credit is only given to figures and graphs that are fully explained, correctly illustrated and with notation on the axes.

This exam consists of 4 main questions.
The weight of each question is indicated, and the maximum is 100 points.

Problem 1. Flow pollution (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.

b) (10 points - words)
Assume that an environmental regulatory authority wants to reduce the level of pollution to E^*. Give examples of policy instruments to reduce the level of pollution and explain the difference between command-and-control policies and emissions pricing (incentive-based) policies. What are their relative advantages?

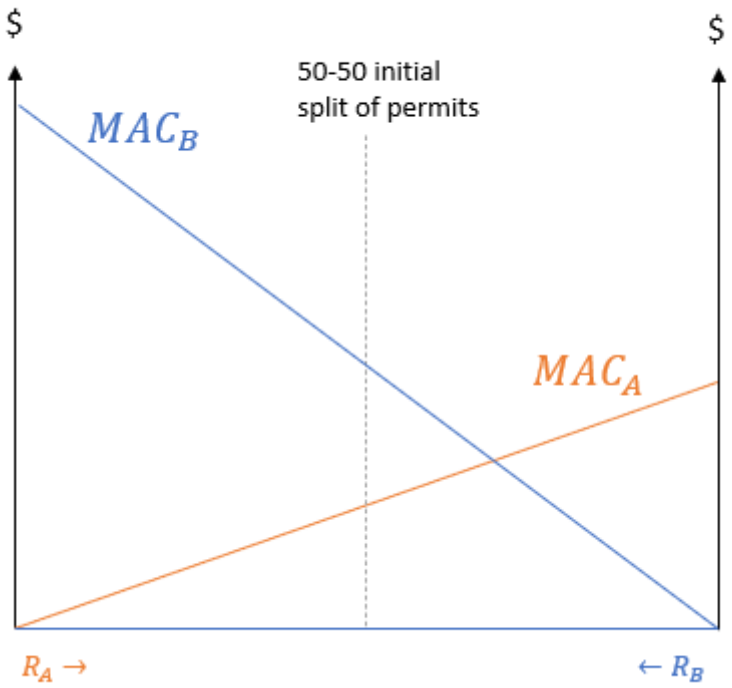
Problem 2. Cap-and-trade (20 points)

Consider an industry consisting of two polluting firms $i = A, B$ with different abatement technologies. In absence of any pollution control, the two firms emit $\bar{E}$ emission units in total.

The regulator wishes to reduce industry emissions down to a total of E^* emission units and implements a quota system with E^* permits. Each permit gives the right to emit 1 emission unit. The regulator grandfathers an equal number of permits to each firm.

Figure 1 illustrates the market for emission permits. R_A and R_B are the emission abatement of firm A and firm B, respectively. MAC_A and MAC_B are the marginal cost of abatement for firm A and firm B, respectively. The width of the diagram corresponds to the abatement required to limit emissions to E^*. The stippled line indicates the allocation of abatement corresponding to a 50-50 initial split of permits.

Figure 1: *The market for emission permits*



Assume that the two firms are allowed to trade permits.

a) (10 points – words and figure)
Reproduce Figure 1 and indicate the equilibrium allocation of permits as well as the equilibrium price. Explain the pattern of trade in permits from the initial split to equilibrium.

b) (10 points – words and figure)
Reproduce Figure 1 and illustrate the gains from trade created by the market for permits. Explain why a cap-and-trade system yields a cost-effective allocation of abatement across firms.

Problem 3. Climate change policy (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 what the "social cost of carbon" is and discuss why estimates of the social cost of carbon have a wide range.

b) (10 points - words)
Explain why we discount future costs and benefits, and the implications of the choice of discount rate when determining the social cost of carbon.

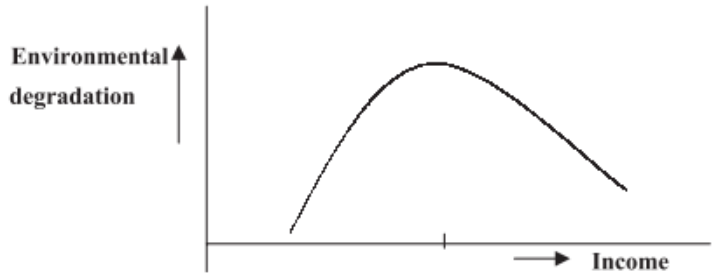
c) (10 points - words)
Explain what "carbon leakage" means and discuss potential measures to mitigate carbon leakage in industry markets.

d) (10 points - words)
Explain how supply-side climate policies can supplement demand-side climate policies in restricting carbon emissions caused by fossil fuel combustion.

Problem 4. The environmental Kuznets curve (20 points)

In this exercise you will be explaining concepts related to the so-called Environmental Kuznets Curve (EKC). The curve is a hypothesized relationship between various indicators of environmental degradation and per capita income. See Figure 2 for an illustration.

Figure 2: *The Environmental Kuznets Curve*



(a) (10 points - words)
Discuss different mechanisms that might explain why we may have this inverted-U-shaped relationship between environmental degradation and per capita income.

(b) (10 points - words)
On the y-axis in Figure 2 we measure the level of "environmental degradation". Discuss the empirical relationship between per capita income and different indicators of environmental degradation. For which indicators of environmental degradation is the Environmental Kuznets Curve hypothesis more likely to hold?