ECN 275/375 Environmental and natural resource economics
Exercise set 5

Exercise 5.1 – Resource allocation mechanisms

Resource allocation mechanisms (RAMs) are the modern variant of principal-agent models.

(a) Write the three necessary criteria for a RAM to yield a predictable outcome, and explain what the three criteria are.

(b) Why is incentive compatibility (IC) and Pareto optimality (PO) necessarily not jointly achievable?

(c) Which is most important – incentive compatibility or Pareto optimality. Explain your answer.

Exercise 5.2 – Cost effectiveness and optimality in emissions space

Emissions space implies that the polluter's choice variable is emissions.

(a) Write down the mathematical definition for cost effectiveness emissions space. Explain the terms in the definition.

(b) Write down the mathematical definition for social optimality (efficiency). Explain the terms in the definition, and write the verbal definition for optimality.

(c) Why is cost effectiveness necessary for optimality?

Exercise 5.3 – Cost effectiveness and optimality in public goods space

Emissions space implies that the polluter's choice variable in public goods space, q.

(a) Write down the mathematical definition for cost effectiveness public goods space. Explain the terms in the definition.

(b) Write down the mathematical definition for social optimality (efficiency). Explain the terms in the definition, and write the verbal definition for optimality.

Exercise 5.4 – Graphical demonstration that fixed emission permits may not be cost effective while tradable permits are

(a) Draw a graph showing why non-tradable (fixed) emission permits in general are not cost effective.

(b) Under what conditions would fixed permits be cost effective? Why is this an unlikely situation?

Exercise 5.5 – Emission constraints and Lagrange

In the following sub-questions $0<m_i<\bar{m}_i$ is the emission level for agent i, $\bar{m}_i \leq m_o^0$ is agent i's maximum allowed emissions, and $\bar{M}$ is aggregate emissions. Note that there are $I \geq 2$ agents.

(a) Set up the equations needed for the fixed permits (non-tradable) case, i.e. $m_i \leq \bar{m}_i < m_i^0$, where formulate the Lagrangian, and comment on the cost effectiveness of the solution (you do not need to solve the problem).

(b) Set up the equation needed for the tradable permits problem and formulate the Lagrangian for the problem where aggregate emissions are less than or equal to the aggregate emission target.

Exercise 5.6 – Bath tub diagram where the resulting quota price is zero

Draw a bath tub diagram showing a situation where the tradable permit price is zero.

Exercise 5.7 – Bath tub diagram for two sectors – the optimal solution

The required total reduction in emissions equals $z_{A+B} = 100$ for two sectors such that $z_A + z_B = 100$.

Sector A's marginal cost function of supplying emissions reductions is $MC_A(z_A) = z_A$, while sector B's marginal cost function is $MC_B(z_B) = z_B/3$.

(a) Which of the two sectors do you expect needs to reduce emissions the most for a least cost (cost effective) distribution of emissions reductions? Briefly explain why.

(b) Find the least cost distribution of emissions reductions for the two sectors with a bath tub diagram.

(c) Solve mathematically for the optimal distribution of emissions reductions supplied for A and B. What is the marginal costs at the optimal distribution?