Solution to midterm

Part I  Short definition

Question 1 (20 pts) Please write a SHORT explanation on the following terms

1. Hedonic pricing method of environmental valuation. (5 pts)

   The hedonic pricing method is the method used to estimate economic values for environmental services that directly affect market prices. Individuals’ WTP to consume a particular good is a function of the levels of the good’s characteristics. E.g. value of air quality could be reflected in the housing price.

2. Use benefits and Non-use benefits of the environment. (5 pts)

   Use benefits are defined as those benefits that derive from the actual use of the environment. Eg. people can derive a benefit from walking in the forest, using herbs for medicinal purposes.

   Non-use benefits is the benefits arises from knowledge that the environment exists and will continue to exist.

3. Point source pollution and Non-point source pollution. (5 pts)

   Point source pollution is the pollution coming from a single identifiable source such as discharge pipes from industry.

   Non-point source pollution is the pollution which does not come from a single, identifiable point but from a number of points that are spread out and difficult to identify and control.

4. Non-Rivalry and Non-excludability (5 pts)

   The good is non-excludable when it is not possible to prevent anyone from consuming a good or service once it has been made available to the public.

   The good is non-rivalry when one person’s consumption of a good or service does not reduce the quantity available for consumption by someone else.

Part II  Short essays (Please limit your answer within 1 page for each question)

Question 2 (15 pts) Suppose that the policy maker wants to reduce pollution to the socially optimal level. He has perfect information on the marginal social benefit curve of pollution; however, he is uncertain about the true marginal social cost of pollution. (Assume that the policy maker’s goal is to reduce pollution to the socially optimal level and he doesn’t care about welfare distribution) Which policy would you recommend: standard or tax? Does it depend on elasticity of marginal social cost curve? (Please support your arguments using Weitzman’s framework and.)

Answer: If the policy maker is uncertain about the marginal social cost and the only policy goal is the socially optimal level of pollution, standard and tax policy work equally well and elasticity of MSC would not affect the policy choices.

![Diagram](image-url)
From the figure above, without uncertainty, the socially optimal level of pollution would be at $X^*$. With uncertainty, suppose that the policy maker overestimates the MSC at $MSC_1$. The optimal taxes rate would be $\$OT$ and the pollution level would be at $X_{std}$, which is also equal to $X_{tax}$, the pollution level under standard policy. As you could see, tax and standard policies work equally well under uncertainty in MSC. The intuition is that the response of polluters to either type of policy is determined by the MSB curve, which is known with certainty. Consequently, both price (tax) and quantity (standard) instruments generate the same outcome.

**Question 3 (15 pts)**

In the first part of this semester, we have often considered the case of a negative externality such as pollution. Typically, we drew an output graph $(P,Q)$ with marginal benefits, marginal private cost and marginal social costs. We then discussed ways of moving from an unregulated market situation to the efficient outcome. In the simplest cases, we have seen that unit taxes, quotas (“standards”), or tradable permits can all get us to that social optimum. Discuss the situation in which tradable permits is preferred over the others. You can use, if you want, graphs and numbers to illustrate your arguments.

** Tradable permits policy is preferred over the other under pollution heterogeneity and when the knowledge about marginal benefit of pollution for each firm is limited.**

When firms are heterogeneous and differ in their ability to abate, or cut back their pollution which can be reflected by the difference in marginal benefit from pollution reduction, it doesn’t make sense to set the uniform standard, in which all firms are allowed to produce the same amount of pollution. The total social welfare of achieving the same level of pollution could be increased by redistributing the pollution rights through tradable permits policy. Eventually, the firm which benefits more from not having to reduce pollution will have more permits and the firm which benefits less from not having to reduce pollution will have less permits. The targeted level of pollution is reached without requiring the regulator to know the firm benefit functions. From the graph, suppose that there are 2 firms with different marginal benefit from pollution and the targeted level of pollution is at $X^*$. Under uniform standard policy, each firm is allowed to create pollution equal to $X^*/2$. If the policy maker uses the tradable permit policy, the optimal level of pollution to each firm would be $X^*1$ and $X^*2$. The social welfare would be increased as a result of gain from trade, $MNL + KNT$.

The same amount of pollution can also be achieved with a pollution tax equal to $\lambda$ or with quotas at $X^*1$ and $X^*2$. However, these policies require knowledge of the true social cost of pollution and marginal benefit function of each firm.
Part III  Numerical questions

Question 4 (25 pts)
Assume that the marginal cost (MC) of producing a good is given by \( MC = 20 + 3Q \). The marginal benefits (MB) are given by \( MB = 120 - 2Q \), and the marginal externality benefits (MEB) are given by Q.

a) Calculate the socially optimal level of output \( Q^* \). (2 pts)

b) Calculate the competitive equilibrium output \( Q_c \) and the competitive equilibrium price \( P_c \). (2 pts)

c) Determine the consumer surplus (CS) (2 pts) and the producer surplus (PS) (2 pts) under the competitive case. Determine the deadweight loss (DWL) (4 pts)

d) Assume that the government wants to subsidize production in order to fix the externality problem. Determine the optimal unit subsidy (8 pts)

e) If the government imposes the subsidy found by you in part (d), by how much does the total external benefit change? (3 pts)

Answer

a) \( MSB = MB + MEB = 120 - Q \)
\[ MSB(Q^*) = MC(Q^*) \]
\[ 120 - Q = 20 + 3Q \]
\[ Q^* = 25 \]

b) \( MB(Q_c) = MC(Q_c) \)
\[ 120 - 2Q = 20 + 3Q \]
\[ Q_c = 20, P_c = 80 \]

c) \[ CS = \int_0^{20} (120 - 2Q)dQ = 2,000 - 1,600 = 400 \]
\[ PS = 80(20) - \int_0^{20} (20 - 3Q)dQ = 1,600 - 1,000 = 600 \]
\[ DWL = \int_0^{20} (MSB(Q) - MSC(Q))dQ = 50 \]

d) \[ MC(Q^*) - s^* = MB(Q^*) \]
\[ MC(Q^*) - MB(Q^*) = s^* \]
\[ s^* = [20 + 3(25)] - [120 - 2(25)] = 25 \]

e) \[ \int_0^{20} MEB(Q)dQ = \int_0^{25} QdQ = 112.5 \]
**Question 5 (25 pts)** Please put a box around your answer [25 minutes]

Assume that you have the following information about the individual demands for a public good:

High income: \( P_h = 40 - Q \)

Low income: \( P_L = 20 - Q \)

Assume further that there is a total of 3 people in the “high income” group and a total of 2 individuals in the “low income” group. Finally, assume that the marginal cost of producing the good is given by: \( MC = 5Q \).

a) What would be the demand function for the public good? (6 pts)

b) What is the efficient output level, \( Q^* \), of this public good? (4 pts)

c) Calculate the total cost of providing \( Q^* \). (3 pts)

d) What is the uniform fee that the government would charge each person just to cover its costs? (2 pts) Calculate the consumer surplus of a typical “low income” individual and a typical “high income” under this fee. (6 pts)

e) What is the maximum uniform fee that an unregulated concessionaire could charge each person without excluding any individual from consuming the good? (2 pts) Determine the concessionaire’s profits under this fee. (2 pts)

**Answer**

a) \( D = \begin{cases} 
160 - 5Q & \text{if } Q < 20 \\
120 - 3Q & \text{if } Q \geq 20
\end{cases} \)

b) \( D = MC(Q^*) \Rightarrow 160 - 5Q = 5Q \Rightarrow Q^* = 16 \)

c) \( \int MC(Q) dQ = \int_0^{16} 5Q dQ = 640 \)

d) \( \frac{\text{Total cost}}{\text{no. of people}} = \frac{640}{5} = 128 \)

\( WTP_L = \int_0^{16} (20 - Q) dQ = 192 \quad \Rightarrow \text{CS}_L = 192 - 128 = 64 \)

\( WTP_h = \int_0^{16} (40 - q) dq = 512 \quad \Rightarrow \text{CS}_h = 512 - 128 = 384 \)

e) The maximum uniform fee the government could charge without excluding anybody is equal to the willingness to pay of a typical person in the "low income" group. = 192

Concessionaire’s profits under the uniform fee = \( 5(192) - 640 = 320 \)