Public Economics

Fall 2022

Midterm Exam

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1. You have a total of 80 minutes (1 hour and 20 minutes) to solve the exam.
2. The use of calculators is not allowed.
3. If you need additional space to answer a question, you can use the back *of the same page*.

Read each question carefully. Good luck!

I (6 points)

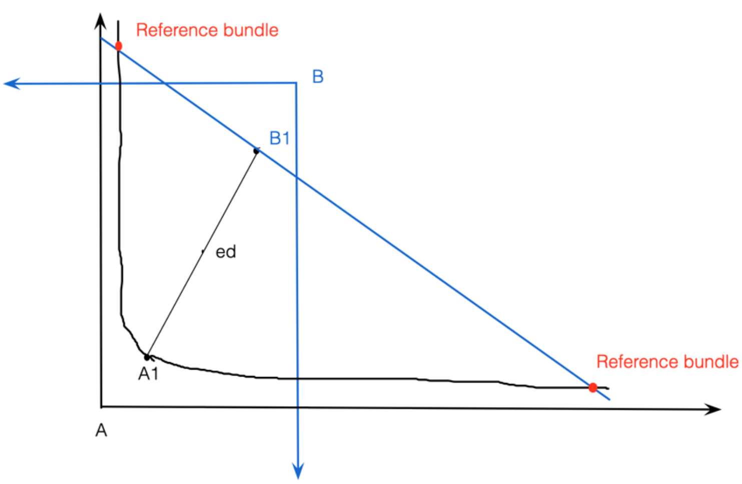
Discuss the following statements (*max. 10 lines for each*).

a. Switching the level of provision of street lighting to the level desired by the median voter will generate a Pareto improvement.

Street lighting is a public good and, since individual preferences will be single-peaked, the median voter theorem allows us to achieve a consistent aggregation of individual preferences into a social preference. However, the median voter choice is not necessarily efficient, because it does not take into consideration intensity of preference. Even if the distribution of costs and benefits is such that the median voter choice approaches efficiency, moving from an inefficient choice to an efficient one does not imply a Pareto improvement.

Grading: 0.5 for the identification of the good and single-peaked preferences, 0.5 for the median voter theorem, 0.5 for the consideration on the median voter choice and efficiency, 0.5 for the conclusion about Pareto improvement.

b. In an economy with two agents and two goods, an egalitarian-equivalent allocation may violate no-domination.



True: in the example we see that allocation A1 is such that A's indifference curve through A1 and B's indifference curve through B1 cross at two reference bundles. The allocation is therefore egalitarian-equivalent. However, the allocation violates no-domination: A receives less of both goods than B.

Grading: 0.5 for the conclusion, 0.5 for the definition of egalitarian-equivalence, 0.5 for the definition of no-domination, 0.5 for an example.

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c. A uniform reduction could be a good policy response to an externality that has a very steep marginal damage curve.

If there was no uncertainty about marginal costs of reduction, both price and quantity intervention would achieve efficiency. If, however, uncertainty is present about the costs of reduction, price intervention involves a greater deadweight loss than quantity intervention. If, however, this involves several plants with possibly different costs of reduction, a uniform reduction would be worse (in terms of efficiency) than quantity regulation that allows for different levels of reduction for each plant (with, for example, tradeable permits).

Grading: 0.5 for the case of no uncertainty; 0.75 for the comparison of price and quantity intervention with uncertainty; 0.75 for the conclusion regarding the possibility of several plants with different costs of reduction.

II (4 points)

Consider an economy with two consumers with utility functions $U_1 = min\{2x_1, y_1\}$ and $U_2 = \sqrt{8x_2 . y_2}$. Assume there is 1 unit of x and 2 units of y to distribute among the agents.

a. (2.25 points) Using an Edgeworth box, find the set of Pareto efficient points and find the utility possibility frontier.

Efficient allocations will be such that $2x_1=y_1$ and $2x_2=y_2$
Then, for all efficient allocations, $U_1=2x_1$ and $U_2 = 4x_2$. Therefore, $U_2=4(1- U_1/2)$ and $U_2 = 4-2U_1$.

Grading: 1.25 points for the identification, justification and description of efficient allocations; 1 point for the calculation of the UPF.

b. (1.75 points) Find the Rawlsian choice for this economy. Will the resulting allocation be envy-free?

We want to maximize min $\{U_1,U_2\}$ s.t. $U_2 = 4-2U_1$
We have $U_1=U_2$ and therefore $U_1=U_2=4/3$.
The resulting allocation is $x_1=2/3$, $y_1=4/3$, $x_2=1/3$, $y_2=2/3$ and this is not envy-free: agent 2 will envy agent 1 (and in fact the allocation violates no-domination - and preferences are monotonic).

Grading: 0.5 for the formulation, 0.5 for the solution, 0.5 for the analysis of no-envy and 0.25 for the conclusion.

III (5 points)

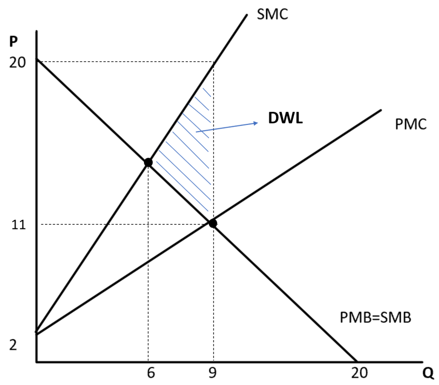
A competitive refining industry releases one unit of waste into the atmosphere for each unit of refined product. The inverse demand function for the refined product is $p = 20 - q$, which represents the marginal benefit curve. The inverse supply curve for refining is $MPC = 2 + q$, which represents the marginal private cost curve when the industry produces q units. The marginal external cost curve is $MEC = q$, where MEC is the additional marginal cost caused to society when the industry releases q units of waste.

a. (1.5 points) How much of the chemical should the market supply in the social optimum? How much would be chosen without government intervention?

   At the social optimum, we solve SMC=SMB, yielding 2+Q+Q=20-Q ⇔ $Q^* = 6$
   Without government intervention, we solve PMC=PMB, yielding 2+Q=20-Q ⇔ $Q^{Priv} = 9$
   Note that SMC = PMC + MEC = 2+Q+Q

   Grading: 0.75 for the social optimum, 0.75 for the no government intervention outcome.

b. (1 point) Identify in a graph – and calculate – the deadweight loss associated with the externality.



   PMC(Q=9) = 2+9 = 11
   SMC(Q=9) = 2+9*2 = 20

   DWL = [(9-6)*(20-11)]/2 = 27/2 = 13.5

   Grading: 0.25 for the appropriate drawing of the curves, 0.25 for the identification of the correct triangle of the DWL, 0.5 for the calculation.

c. (1.25 points) Suppose that the government imposes an emission fee of T per unit of emission. What should be the value of T if the market is to produce the efficient amount of the refined product?

   The fee per unit of emission should be a Pigouvian Tax, that is, a unitarian tax equal to the marginal external cost of the externality at the social optimum quantity. That way, private agents will internalize the cost of the externality, bringing the equilibrium in the market to the social optimum quantity. T=MEC(Q*=6)=6

   Grading: 0.5 for acknowledging and defining Pigouvian Taxes, 0.75 for the calculation.

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d. (1.25 points) The Prime-Minister is considering the possibility of introducing tradeable emission licenses instead of the emission fee. As her advisor, what would you recommend? (without additional calculations, max 10 lines)

Firstly, it is necessary to understand who are the ones suffering from the externality, as those would be the ones selling the pollution licenses to the firm. This may be challenging as we may have several agents in society facing the MEC. Secondly, we must make sure that the market of tradable permits will achieve an equilibrium. If we have many agents involved, this again may not be feasible. We are thus faced with an assignment problem (the first case) and the absence of costless bargaining because there are many agents involved (the second case). These are the same problems we face with the Coase Theorem.

Therefore, if these problems are verified and the market information given above is available, it may be wiser to stick with the emission fee.

Grading: 0.75 for mentioning the two problems that arise, 0.25 for mentioning the Coase Theorem, 0.25 for concluding on the best policy.

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IV (5 points)

Consider an economy with three agents and two goods, where X is a pure private good (money, with a unit price of 1) and G is a pure public good. Let the marginal cost of the public good be 9 monetary units.
Let x_i denote the amount of the private good consumed by agent i. Agent 1's preferences can be represented by utility function $U_1(x_1, G) = x_1 G^2$. Agent 2's preferences can be represented by utility function $U_2(x_2, G) = x_2 G$. Agent 3's preferences can be represented by utility function $U_3(x_3, G) = x_3$. The incomes of the agents before the provision of the public good are $m_1=6$, $m_2=10$ and $m_3=5$.

a. (1.25 points) Show that agent 1's demand for the public good is $p_1 = 4/G$ and that agent 2's demand for the public good is $p_2 = 5/G$.

For agent 1 we solve: $\max U_1 = x_1 G^2 \quad st.\ 6 = x_1 + P_1 G \Leftrightarrow x_1 = 6 - P_1 G$
The solution is: $MRS_1 = P_1 \Leftrightarrow \frac{2x_1 G}{G^2} = P_1 \Leftrightarrow 2(6 - P_1 G) = P_1 G \ \Leftrightarrow P_1 = \frac{4}{G}$
For agent 2 we solve: $\max U_2 = x_2 G \quad st.\ 10 = x_1 + P_2 G \Leftrightarrow x_1 = 10 - P_2 G$
The solution is: $MRS_2 = P_2 \Leftrightarrow \frac{x_2}{G} = P_2 \Leftrightarrow 10 - P_2 G = P_2 G \ \Leftrightarrow P_1 = \frac{5}{G}$

Grading: 0.25 for setting up the utility maximization problems, 0.5 for solving the problem for each agent.

b. (1.25 points) Find the socially optimal quantity of the public good.

Samuelson Condition (when private good is money): $\sum MB_i = MC$
We have the MB for agent 1 and 2 from above. It is straightforward to conclude that the MB for agent 3 is zero.
Solving: $\frac{4}{G} + \frac{5}{G} + 0 = 9 \Leftrightarrow G^* = 1$

Grading: 0.5 for stating the Samuelson Condition, 0.75 for the solution.

c. (1.25 points) Suppose that unanimity is required to decide on the amount of the public good and that the taxes must still cover the cost of the public good. What unit taxes should the government charge?

If unanimity is required, the government should set Lindahl Taxes. Lindahl taxes consist in taxing each agent the marginal benefit they derive from the consumption of the public good, at the social optimum level.
Therefore:

$$t_1 = MB_1(G^* = 1) = \frac{4}{1} = 4$$
$$t_2 = MB_2(G^* = 1) = \frac{5}{1} = 5$$
$$t_3 = MB_3(G^* = 1) = 0$$

If we sum $t_1 + t_2 + t_3 = 9 = MC$ and thus we see that the public good is fully-funded.

Grading: 0.25 for acknowledging and defining Lindahl Taxes, 0.25 for computing each agent's tax, 0.25 for checking that the taxes cover the cost of the public good.

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d. (1.25 points) Discuss the following statement: “If the government tried to implement a tax system like the one in c) but had to ask agents about their preferences, non-rivalry in consumption would lead agents to understate the benefits they derive from the public good”. (max. 10 lines)

The statement is incorrect. Non-rivalry in consumption means that the use of the good by one agent does not decrease its availability to others, implying that that aggregate demand is made through a vertical sum instead of the usual horizontal sum. This is one of the characteristics of public goods, along with non-excludability. Non-excludability means that agents cannot be excluded from consuming the good, which implies free riding issues.
A Lindahl Tax system based on reported valuations by the agents gives them an incentive to lie about their willingness to pay because the amount of money they pay to finance the public good is tied to their stated willingness to pay. Individuals may behave strategically and pretend that their willingness to pay is low so that others will bear a larger share of the cost of the public good. The incentive to lie with Lindahl pricing arises because of the free rider problem; that is, if an individual reports a lower valuation of the public good, she pays a lower amount of tax but she does not get much less of the public good.

Grading: 0.25 for defining each of the properties of public goods, 0.5 for explaining the free-rider problem and how it leads to underreporting, 0.25 for concluding on the accuracy of the statement.

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