Public Economics

Spring 2024
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)

Are the following statements true or false? Explain why (*max. 10 lines for each*).

a. If two plants that cause pollution have different marginal reduction costs, price intervention is preferable to quantity intervention to correct the externality.

For efficiency, this is true unless quantity intervention is done through tradable permits. A tax would allow different firms to reduce efficiently (the firm with a lower marginal cost of reduction would reduce more), whereas quantity intervention would require information about those cost functions to be able to set different quantities for different firms; fixing a uniform quantity reduction for all firms would not minimize the costs of reduction for the whole economy and would generate a deadweight loss.

Grading: 0.5 for explaining the efficiency goal; 1 for the explanation; 0.5 for the conclusion if this is a uniform reduction.

b. If a Government official bases her decisions about investment in defense on the median voter choice, then she will achieve a Pareto improvement.

Street lighting is a public good and therefore we expect preferences to be single-peaked and we can apply the median voter theorem and achieve a consistent aggregation of individual preferences using majority comparisons. However, the median voter choice need not coincide with the efficient choice, due to concentration of costs and benefits. Moreover, even if the median voter choice led to efficiency, going from an inefficient situation to an efficient one does not necessarily mean an actual Pareto improvement, since it is possible that some people would become worse off.

Grading: 0.5 for explaining nature of good and single-peaked preferences; 0.5 for explaining connection between median voter choice and efficiency; 0.5 for explaining that the move towards efficiency does not necessarily mean an actual Pareto improvement; 0.5 for the conclusion.

c. In an economy with 2 agents and 2 goods, an egalitarian-equivalent allocation will satisfy the equal division lower bound.

False. If the utility function of agent A is u(x,y)=x.y and the utility function of agent B is u(x,y)=x+y, and there is a total of 4 units of x and 4 units of y, then the allocation that gives (1,1) to agent A and (3,3) to agent B will be egalitarian equivalent, since both will be indifferent with respect to the reference bundle (either $x=3+2\sqrt{2}$, $y=3-2\sqrt{2}$ or $x=3-2\sqrt{2}$, $y=3+2\sqrt{2}$) but agent 1 will clearly prefer equal division (2,2) to bundle (1,1), violating the equal division lower bound.

Grading: 0.5 for each definition; 0.5 for counterexample; 0.5 for conclusion.

II (3.75 points)

The two consumers that constitute an economy have utility functions $U_1=2\min\{x_1,y_1\}$ and $U_2=2x_2.y_2$ Assume there are exactly 2 units of each good to distribute among the agents.

a. (2 points) Find the set of Pareto efficient points and the utility possibility frontier.

Representing preferences in the Edgeworth box, we conclude that the set of Pareto efficient allocations is such that $x_1=y_1$.
Therefore, $U_1=2x_1$ and $U_2=2x_2^2=2(2-x_1)^2=2(2-U_1/2)^2$

Grading: 1 for set of efficient allocations (including 0.5 for justification with Edgeworth box or verbal), 1 for UPF

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

To maximize $\min\{U_1,U_2\}$ s.t. $U_2=2(2-U_1/2)^2$, we have $U_1=U_2$ and therefore $U_1=U_2=2$.
The resulting allocation is $x_2=y_2=1$ and $x_1=y_1=1$ and this will be envy-free.

Grading: 0.5 for setting up the maximization problem, 0.5 for the solution; 0.25 for the corresponding allocation, 0.5 for the analysis of no-envy.

III (4.5 points)

The UK and Sweden produce pollution that may have an effect not just on the residents of their country but also on the other country, through wind effects.
Let A represent 'tons of avoided pollution' (assume that if A = 0 then both countries will release 300 tons of pollution into the atmosphere). Avoiding pollution emissions has costs. In each country, the total cost of avoiding the emission of A tons is $C(A)=A^2/2$.

The cost caused by each ton of pollution is different between countries (note that the cost of one additional ton of pollution can be interpreted as the benefit of one additional unit of good A).
In the UK, one ton of pollution causes damages of 100 monetary units (m.u.), while the damages of one ton of pollution in Sweden are valued at 150 m.u.

Moreover, due to wind effects, one ton of pollution from the UK also causes a damage of 75 m.u. to Sweden. Swedish pollution does not pose any additional costs to the UK.

a) (1.5 points) If currently the value of A is at its optimal level for each country (but not taking into account possible effects on the other country), what quantity of A is each country using?

PMCi=PMBi
UK: A=100
SE: A=150

Grading: 0.5 for the formula; 0.5 for each private optimal level.

b) (1.5 points) What is the efficient quantity for each of the two countries?

The optimum for SE does not change;
The optimum for UK must take into account the externality: UK: A=100+75 (=) A=175
Total reduction is 150+175=325.

Grading: 0.5 for each efficient level; 0.5 for total reduction.

c) (1.5 points) Suggest and defend a policy to try to achieve the outcome in b). (max 10 lines)

To ensure that the UK reduces pollution above its private optimum, SE must pay to the UK (given that there is the right to pollute). Computing the loss for the UK for the extra 75 units and the benefit for SE from those same units, one sees that there is indeed scope for a payment from SE to the UK.

Other policies could be considered: for example, a tax to the UK in the value of the constant Marginal. External Damage of 75 m.u. However, this policy would have to be set by an international organization or legislation.

Grading: 0.5 for policy suggestion (price or quantity regulation or trading permits); 0.5 for policy implementation (correct value of price/quantity imposed or permits); 0.5 for justification

IV (5.75 points)

Consider an economy with three agents and two goods, where X is a pure private good and G is a pure public good. Let the marginal cost of the public good be 1 monetary unit.
Let x_i denote the amount of the private good consumed by agent i.
Agent 1's preferences can be represented by utility function $u_1(x_1,G)= 2x_1+4\ln(G)$.
Agent 2's preferences can be represented by utility function $u_2(x_2,G)=2x_2+2\ln(G)$.
Agent 3's preferences can be represented by utility function $u_3(x_3,G)= x_3$

a. (1 point) Discuss the following statement: «Agent 3 derives no utility from the public good. Therefore, the good is not a pure public good». (max. 6 lines)

A pure public good is defined by respecting two characteristics: non-rivalry and non-excludability.
The fact that agent 3 derives no utility from the good is not relevant for classifying it as a public good.

Grading: 0.5 for definition of public good; 0.5 for conclusion.

b. (1.5 points) Show that the socially optimal quantity of the public good is 3.

$$MRS_1 = \frac{\frac{4}{G}}{2} = \frac{2}{G}$$

$$MRS_2 = \frac{\frac{2}{G}}{2} = \frac{1}{G}$$

$MRS_3 = 0$

Samuelson condition: $MRS_1 + MRS_2 + MRS_3 = MC \Leftrightarrow \frac{2}{G} + \frac{1}{G} = 1 \Leftrightarrow \frac{3}{G} = 1 \Leftrightarrow G^* = 3$

Grading: 0.5 for Samuelson condition; 0.25 for each MRS; 0.25 for optimal quantity.

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?

Lindahl taxes: equal to the MB of each agent evaluated at Socially Optimal Level of the Public Good, G*

For agent 1: $t_1 = MB_1(G^*) = \frac{2}{3}$
For agent 2: $t_2 = MB_2(G^*) = \frac{1}{3}$
Agent 3 pays zero as she does not value the public good.

(Notice that these taxes cover the MC of the PG: 1/3 + 2/3 + 0 = 1)

Grading: 0.5 for indicating Lindahl taxes and its correct definition; 0.25 each correct tax value.

d. (1 point) Discuss the following statement: "Free riding will also prevent the taxes found in c. from being charged." (max. 6 lines)

The preference revelation problem: the free rider problem can occur even in the Lindahl mechanism when agents do not reveal their true preferences. Agents may have an **incentive not to reveal their true preferences** because by underreporting their preferences, they can avoid the burden of public goods and still enjoy the benefit of public goods. By reducing their demand for public goods intentionally so that it is less than true demand, such agents can reduce their burden. This type of free riding behaviour can occur in the Lindahl equilibrium.

Grading: 0.5 for preference revelation problem; 0.5 for justification.

e. (1 point) Do you think that a government official will want to set the taxes found in c.? (max. 6 lines)

A government official may be reluctant to set Lindahl taxes to fund public goods if doing so conflicts with their own self-interest or if they perceive significant risks or challenges (**government failure**), such as opposition from interest groups, bureaucratic resistance, or electoral consequences. Instead, officials may prioritize policies that enhance their own political survival or serve the interests of influential stakeholders, potentially leading to suboptimal outcomes in public goods provision.

Grading: 0.5 for relating with notion of government failure and possible sources; 0.5 for justification.