Assignment 2 – Public Economics

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Exercise 1) Drawing on your own experience, give an example of a situation in which there is a positive externality and suggest two possible ways of internalizing it, discussing the limitations of either approach. (max. 250 words) **(6 points)**

The student should present 1 positive externality and explain 2 ways to internalize it (quantity regulation, Pigouvian subsidy, merger, Coase Theorem, etc.), discussing its limitations.

Exercise 2) A study by Karl-Goran Maler, from the Stockholm School of Economics, estimated that replacing *uniform* reductions in pollutant emissions (for example, reductions of 30% in all European countries) by an *efficient* reduction (defined by the author) would allow European states to obtain an additional benefit of 3.6 billion German Marks (1984). The first scheme (of uniform reduction, as required by European directives) would allow by itself a total benefit of 2.7 billion German Marks.
This study is based on the fact that due to weather phenomena, some countries are more prone to suffer the consequences of pollution from other countries. Based on a computer weather model known as EMEP, Karl-Goran Maler concluded that countries located in the east (Russia, Poland, Germany and Sweden) were the great importers of pollution due to the wind effects. Other countries, like the UK, were more protected and suffered very little from pollution created outside their borders.

a) One assumption of this study is that each European country had already reduced emissions to the point where the environmental damage to that country caused by an additional ton equals the cost that companies have to face in order to reduce their emissions by the same amount. In this context, how would it be possible for a uniform reduction of all countries to produce a net benefit? (max. 250 words) **(2.5 points)**

Each country is at their private optimum. By imposing a uniform reduction all countries will incur a loss due to the extra pollution reduction. But some countries will also benefit from the reduced negative externality imposed on them (the East countries, which suffers the most from the pollution from the West countries). If these benefits exceed the costs, the net result may be positive.

b) In the efficient reduction scheme proposed by the author, some countries would need to reduce their emissions by 81% (UK) or 86% (Germany), while others would have to reduce them only by 2% (Russia) or 4% (Sweden). Explain the difference between these numbers. (max. 250 words) **(3 points)**

Each country's socially optimal reduction level depends on the trade-off between the costs the country faces when reducing pollution, and the social benefits that Europe reaps as a result of that same reduction. Countries that face higher abatement costs should, all else equal, have a lower optimal reduction. This is consistent with the estimations by the authors, as the technology available in more industrialized countries, such as the UK and Germany should, in general, allow for a less costly transition to "greener" alternatives. Moreover, countries that inflict more damage on other countries should, all else equal, have a higher optimal reduction level. Once again, this is consistent with the numbers presented in the study, as the weather moves the pollution towards the East, meaning that countries in Western Europe (such as the UK and Germany) "export" pollution, which can justify a greater reduction.

c) Discuss the following statement: "The UK is almost not affected by the emissions of other states and will therefore never be better-off with the reductions imposed on emissions from those countries. On the other hand, an 81% reduction in its own emissions will certainly have a negative effect on the welfare of the country. Consequently, it is impossible to convince this country to participate in the efficient scheme proposed by the author." (max. 250 words) **(2.5 points)**

Moving from a socially inefficient outcome to a socially efficient outcome constitutes a positive-sum game. As a consequence, it is (in theory) always possible for the "winners" of the new reduction scheme to compensate the "losers" (such as the UK), in a way such that every country ends up in a better outcome, compared to the initial situation. Allowing for this compensation is, of course, easier said than done (diplomacy and institutional relations are usually not that straightforward). However, we can think of real-life examples of this. For example, when a relevant share of the EU budget is spent on subsidies for the adoption of "green" technologies. Such subsidies are funded by all countries but granted to the countries that actually reduce pollution.

Exercise 3) The current price of emissions allowance traded on the European Union's Emissions Trading Scheme (ETS) is 75 euros per metric ton of CO_2.
The EU ETS is a cap-and-trade system: the emissions cap is the limit set on the total amount of CO_2 that can be emitted by the installations and aircraft operators covered by the system. Emitters must hold one allowance for each ton of greenhouse gas they emit. Companies initially receive an equal share of allowances and may then buy and sell allowances, and this market establishes the emissions price.
Assume that there are only 10 emitters. For 5 of them, the individual marginal benefit from emissions (Q_i) is $150-15Q_i$. For the remaining 5, the individual marginal benefit from emissions is $75-15Q_i/2$.

a) What is the emissions cap? **(3 points)**

In order to know the total amount of CO2 that can be emitted, one needs to find the optimal level of emissions for each firm.

Given that the price of an emission allowance is 75, we know that firms will want to buy allowances up until the point at which the MB of emitting one additional unit of pollution equals the price of emitting that same unit (75).

For the first type of firms: $P = MB_i \Leftrightarrow 75 = 150 - 15Q_i \Leftrightarrow Q_i = 5$
For the second type of firms: $P = MB_{ii} \Leftrightarrow 75 = 75 - 15\frac{Q_{ii}}{2} \Leftrightarrow Q_{ii} = 0.$
Aggregating: $Q^* = 5 * Q_i + 5 * Q_{ii} \Leftrightarrow \boldsymbol{Q^* = 25}$

Another way to see this would be by setting up the maximization problem of each firm.
Firms have an unknown allowed level of emissions, $\bar{Q}$ equal for all, and may have higher (or lower) emissions, Q_i, by paying (or receiving) a payment of p. There are two types of firms, those with $MB_i = 150 - 15Q_i$, and those with $MB_{ii} = 75 - 15\frac{Q_{ii}}{2}$.
Integrating the MB functions to obtain the Total Benefit functions, one can write the maximization problem of each firm, where they choose how many units of pollution to emit, given the constraints.

For the first type:
$$\max_{Q_i} f = 150Q_i - \frac{15}{2}Q_i^2 - p(Q_i - \bar{Q})$$

$$FOC = 0 \Leftrightarrow 150 - 15Q_i - p = 0 \Leftrightarrow p = 150 - 15Q_i\,(= MB_i)$$

For the second type:

$$\max_{Q_{ii}} f = 75Q_{ii} - \frac{15}{4}Q_{ii}^2 - p(Q_{ii} - \bar{Q})$$

$$FOC = 0 \Leftrightarrow 75 - \frac{15}{2}Q_{ii} - p = 0 \Leftrightarrow p = 75 - \frac{15}{2}Q_{ii}\,(= MB_{ii})$$

Therefore, we can discover the level of emissions of each firm since we know from the exercise that $p = 75$.

b) If authorities wanted to set a Pigouvian tax instead, what should it be? Would you recommend this possibility or the cap-and-trade system? **(3 points)**

For a socially optimal decision, the unit value of the tax must be equal to the size of the external damage, evaluated at the optimum.
$t_i = MD_i(Q^*)$

We know that at the optimum: $MB_i = MD_i$, thus:
$t_i = MB_i(Q^*)$

For the first type of firms:
$$\boldsymbol{t_i = MB_i(Q_i = 5) = 75}$$

For the second type of firms:
$$\boldsymbol{t_{ii} = MB_{ii}(Q_{ii} = 0) = 75}$$

Notice that the Pigouvian tax has the same value as the cap-and-trade permits price.

Regarding the choice of the policy options, it is important to bear in mind:

- If the government has perfect information, it can attain the optimal quantity with each policy. If there is uncertainty, simply defining the optimal quantity of permits and then letting firms trade (cap-and-trade) will lead to a lower DWL if the MD curve is steeper; taxation will lead to a lower DWL if the MD curve is flatter. In the case of global warming, we have a relatively flatter MD curve and so, in this case, a Pigouvian tax could work better under uncertainty.
- The Pigouvian tax requires the government to know a lot of information, namely the MB and MD curves, and while the cap-and-trade system requires the same level of information to set the optimal emissions cap, it is easier to adjust the cap over the years based on the information given by the equilibrium price of allowances.
- One disadvantage of the cap-and-trade system is that we need to have negligible transaction costs and bargaining power. The fact that we are talking about a reduced number of firms should imply lower costs, and the holdout problem is less likely to arise.
- Another disadvantage is that the cap-and-trade system has important redistribution implications – defining the initial allocation is crucial in terms of surplus redistribution.
- From a government perspective, the cap-and-trade system does not generate any revenue, unlike the tax.

Based on these (or other) arguments, students should present their recommended policy option.