AEM 4510 / ECON 3865 Cornell University

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*Problem Set #2: Pigouvian Policies*

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(Sign Here)

**Instructions:**

This problem set consists of four questions. Each is worth 25 points. Please show your work in order to receive partial credit. In general, space has been provided to answer all questions (which is why this document is so long). Feel free to attach more sheets if you need more room.

You may work in groups of up to 3, use your notes, textbook, or other resources in answering these questions.

1. (Pigouvian Tax and Abatement): Two producers in a market producing widgets have different marginal abatement costs:

MAC1=2A1

MAC2=3A2

Where A is units of abatement, **NOT EMISSIONS,** in tons per year, and P is price in $/ton.

The demand/marginal benefit for abatement is as follows (hint: what is this equivalent to?):

MAB=22-A

1. What is the aggregate MAC function for the Widget market (at a given price, how much will be abated?)?
2. Draw and label a graph of the individual MAC curves, aggregate curve and MAB curve:

c. What is the optimal level of emissions abatement?

1. If the Widget producers have no current incentive to abate emissions (A=0 units), what would be the appropriate tax for the government to impose in order to reach the efficient level of abatement?
2. What are the individual firm levels of emissions abatement with regard to the tax?

f. What are the total costs of abatement?

2. Gasoline is generally considered a private market good. However, the combustion of gasoline can have various negative environmental effects on global warming, acid rain, particulate levels, etc. Suppose the private demand and private and social marginal costs of gasoline are given by the following equations:

Private demand: P = 50 - 0.001 Q

Private cost: P = 1 + 0.001 Q

Social cost: P = 1 + 0.0015 Q

The diagram below shows the curves (not to scale).

$/Gallon

Production of

gasoline (gallons)

MC (social)

MC (private)

1

MB (demand)

50

a. What is the private market (unregulated) equilibrium quantity of gasoline in the economy? Provide the value below and label this quantity QU on the diagram above.

b. What is the socially optimal level of gasoline production for this economy? Provide the value below and label this quantity Q\* on the diagram above.

c. If the government is going to apply a sales tax to control gasoline purchases, what is the optimal tax level, *T*? With this optimal tax, what is the consumer price of gasoline, PC? What is the after-tax price, PP, that producers will receive? Provide the values for PC, PP, and T below and label these items on the diagram.

d. How much revenue will the government raise from the gasoline tax? Indicate the area corresponding to revenue on the diagram with crosshatch shading and label it. Provide the value below.

e. Ignoring the effects on the public finance system, calculate the **net** benefit of the reduction in the amount of gasoline consumed. Indicate this area on the diagram with a bold outline and label it. Provide the value below.

3. (Uncertainty): Consider a market with MD and MAC curves labeled on the axes below where the MACe curve indicates the expected marginal benefits from emissions and the MACh and MACl curves indicate the upper and lower bounds of uncertainty about the emissions benefits.

Line chart

Description automatically generated with low confidence

a. Suppose the government wanted to reach an efficient level of emissions abatement, what would be the best approach, a price-based instrument, or a quantity-based instrument? Explain the intuition for why one is better than the other.

b. If the government went with a quantity-based approach using the MACe curve and the actual benefits turned out to be MACh, What would be the deadweight or efficiency loss of such an error? Outline and shade in on the graph above. What about the deadweight loss with a price-based approach?

4. (Permit Trading and Initial Allocation Rules): An industry is comprised of two firms, each of whom emit 20 tons of CO2. However, the marginal abatement (or control) costs of the firms differ as described by the following equations:

MAC1 = 4A1

MAC2 = 2.4A2

where MAC is in $/ton and A is in tons CO2 abated/year. The government is considering instituting an allowance (permit) system to achieve an *overall* abatement goal of 24 tons of CO2 (or equivalently, a reduction in overall emissions of 24 tons). The government is considering two options. The first is grandfathering the permits to the firms in proportion to their pre-regulation emission levels (i.e., allocating permits to the firms for free based on their historical emissions). The second is auctioning the permits to the firms and generating revenue for the government, the latter of which is not politically favored by the industry. Each permit is equivalent to one ton of CO2.

a. Consider the grandfathering option, but where trading between firms is **not** permitted. Based on historical emissions and the desired emissions goal, how many total permits will be allocated by the government? How many permits will be allocated to each firm? How many units of CO2 will each firm abate? What is the cost of achieving these reductions for each firm and for the industry as a whole? Is this economically efficient? Why or why not? (In an example where we’re only working with 2 firms, it is sometimes useful to construct consider this graphically)

b. Consider the grandfathering option, where now where trading between firms **is** **allowed**. That is, after the permits are grandfathered to each of the firms, they are allowed to trade them on the CO2 market. What is the price of permits in the market? How many units of CO2 will each firm abate? What will be the abatement costs to each firm? Which firm is selling, which is buying, and how many permits are transferred? After these market transfers are made between the firms, what are the net costs of abatement for each firm and for the industry as a whole? Is this economically efficient in that it maximizes total surplus? Explain why, why not, or why we may not be able to tell.

c. Consider the auction option, where trading between firms is allowed. Suppose that permits are auctioned to the firms by the government. What would be the theoretical market price of these permits at auction? How many permits would each firm buy? What would be the net costs (abatement cost + permit cost) for each firm and for the industry as a whole? What would be the government revenue generated by the auction? Is this economically efficient? Why or why not?

d. What is the efficiency loss between the grandfathering (without trading) and auctioning scenarios? (*Hint: it may be useful to construct a table illustrating the net costs in parts a – c*). How could the government make the auctioning system more politically favorable within the industry? In reality, why might the auctioning system not be as efficient as this theoretical example?