AEM 4510 / ECON 3865 Cornell University

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*Problem Set #2: Pigouvian Policies*

**Name (e.g., John Doe):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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**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. (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?

2. (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?

3. (Coase’s Theorem) In a remote valley, two businesses share a waterway. Tom’s Tomato Farm pumps water from a river and uses it to irrigate its fields. The used water eventually flows back into the river, carrying some of the fertilizer that Tom applies to his crops. Up to a point, more fertilizer helps increase Tom’s harvest. Downstream, Jay’s Riverview Campground offers campsites to interested vacationers. Fertilizer contamination of the river creates algae blooms that adversely affect Jay’s business.

The functions describing the profits of each establishment are:



where the subscripts “T” and “J” refer to Tom’s and Jay’s places of business, respectively. “F” represents the amount of fertilizer in the river generated by Tom.

(a) Derive the functions representing (i) the marginal benefit of fertilizer to Tom and (ii) the marginal cost of fertilizer to Jay. Plot them on the graph on the following page.



(b) Suppose that the existing law defines property rights that favor recreational users of waterways (e.g., campsites) at the expense of farmers. A campsite can sue a polluting farmer for prohibitive damages if any pollution takes place, unless the affected parties consent to an alternative agreement. Indicate (i) the amount of pollution that takes place in this scenario, and (ii) the profits of Tom and Jay. Assume that Jay has all the bargaining power (i.e., he captures the entire Coasean bargaining surplus).

(c) There exists a containment process for recapturing irrigation water in underground troughs and cleansing it of any leached fertilizer contaminants. This technology, which can be purchased for a cost of $X, would prevent Tom’s operations from polluting the river at all (regardless of his choice of F). Suppose property rights and bargaining power are defined as in (b). What is the most Tom would be willing to pay to obtain this new process?

5. (Pigouvian tax and uncertainty) **AEM 5510 ONLY**: You’re a policy analyst for the Pie-in-the-Sky Think Tank in Washington, DC. A prominent politician has asked you to determine what the efficient level of emissions would be for the electricity industry in the United States to cease its negative impact on climate change. Through some brilliant analysis, you’ve determined that the Marginal Damages from electricity CO2 emissions are:

MD = 10+0.0075E

and the marginal abatement cost for the industry are estimated to be:

MAC = 125 – 0.05E

where E = Million tons of CO2 emissions per year, and MD/MAC are dollars per ton.

a. What is the efficient level of emissions, and the MD at that level?

b. Suppose the government wanted to regulate this market using a price-based instrument. What is the efficient level of a tax on emissions?

c. What if the government wanted to regulate this market using a quantity-based instrument? What is the appropriate level of an emission cap?

d. What is the efficiency difference between a price-based and quantity-based approach? (ignore any government revenue issues you may be tempted to include here.)

Now suppose that after the regulation was implemented, we discover, through further market analysis that the true MAC to the industry is given by:

MAC = 110 – 0.05E

e. Given this new estimate of MAC, what is the true efficient level of emissions in this market?

f. Relative to the ideal (given in (e)), what is the social loss associated with the price-based approach you calculated in part (b)? Provide a quantitative answer and draw a graph showing this loss.

g. Relative to the ideal, what is the social loss associated with the quantity-based approach you calculated in part (c)? Provide a quantitative answer and draw a graph that shows this (you can use the same graph as part f, just make sure you use coloring or hash marks to differentiate.)