Problem Set #1—Externalities and Pigouvian Instruments

Names (e.g., John Doe):_____

Cornell IDs (e.g., jsd12):_____

Instructions:

This problem set consists of five questions. Each is worth 20 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, use your notes, textbook, or other resources in answering these questions. Turn in one problem set for your entire group.

1. (Key Concepts): Social cost is a measure of the opportunity cost of all resources used in producing a good or a service. Private cost is a measure of the opportunity cost incurred by the individual or firm when make a decision. One resource use where there is a large gap between the public and private cost is the use of public motorways. (For example, one additional driver on the road imposes a cost, in terms of increased congestion, on all the other drivers on the road. It is likely that the sum of the costs imposed by one additional driver on all of the commuters using the road exceeds the benefits that the additional driver receives from using the road as opposed to a alternative method of commuting).

a. Give all the private costs of commuting by car to work/school/etc. Remember that private costs are all the opportunity costs that a driver incurs when operating a car.

b. One private cost of commuting via car is the costs of fuel. How much of the retail cost of a gallon of fuel is comprised of state and local taxes (check the EIA website)? When the price of a good includes a large tax component, only the non-tax part of the price represents real opportunity costs. In New York, what part of the price of fuel includes real opportunity costs?

c. Read the article "Is Gasoline Undertaxed in the United States?" by Ian Parry, which can be found at http://www.rff.org/rff/Documents/RFF-Resources-148-gasoline.pdf (or just google). Report four sources of external costs associated with gasoline consumption described by Parry, and describe the size of those external costs (in $/gallon)?

c. What kinds of policies are in place at the Federal and state level that reduce the number of individuals who choose to commute by car?

2. Buchanan Industries receives total benefit/profit from polluting according to the formula:

$$p = 10Q - Q^2$$

where Q = pollution emitted (in tons), and profits are measured in dollars. The total costs/damages associated with pollution from this facility are estimated to be:

$$D = Q^2 + 2Q$$

(a)   Draw a graph of both the marginal benefits and marginal damages from pollution curves, labeling all axes, intercepts, and slopes.

(b)   If Buchanan Industries does not have to pay for the damage its emissions cause:
- How much Q would it produce?
- How much profit would it earn at this level of production?
- How much would its total damages be?
- What would be the net benefits (i.e., difference between profits and damages)?

(c)   What is the socially efficient level of Q for this firm? How much profit would Buchanan Industries earn at this level of production? How much would total damages be? What would be the net benefits?

(d)   What is the deadweight loss associated with Buchanan Industries ignoring the damages that its production causes? Show the deadweight loss on your diagram.

(e)   Those who live near Buchanan Industries propose that it produce no more than Q = 1. What is the deadweight loss associated with this level of production? Show this DWL on your graph.

(f)   Who benefits from reducing Q from the initial level in (b) to the efficient level in (c)? Who bears the costs? Is this change Pareto improving or could it be a potential Pareto improvement (say after transfer/compensation)?

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

$$MAC_1 = 2A_1$$

$$MAC_2 = 3A_2$$

Where A is units of abatement in tons per year, and P is price in $/ton.

The marginal benefits from abatement is as follows:

$$MAB = 22 - A$$

a. What is the aggregate MAC function for the Widget market?

b. Draw and label a graph of the individual MAC curves, aggregate MAC curve, and MAB curve:

c. What is the optimal level of emissions abatement?

d. 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?

e. What are the individual firm levels of emissions abatement with regard to the tax?

f. What are the total costs of abatement?

4. Gasoline is generally considered a private market good. However, as we all know, 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).
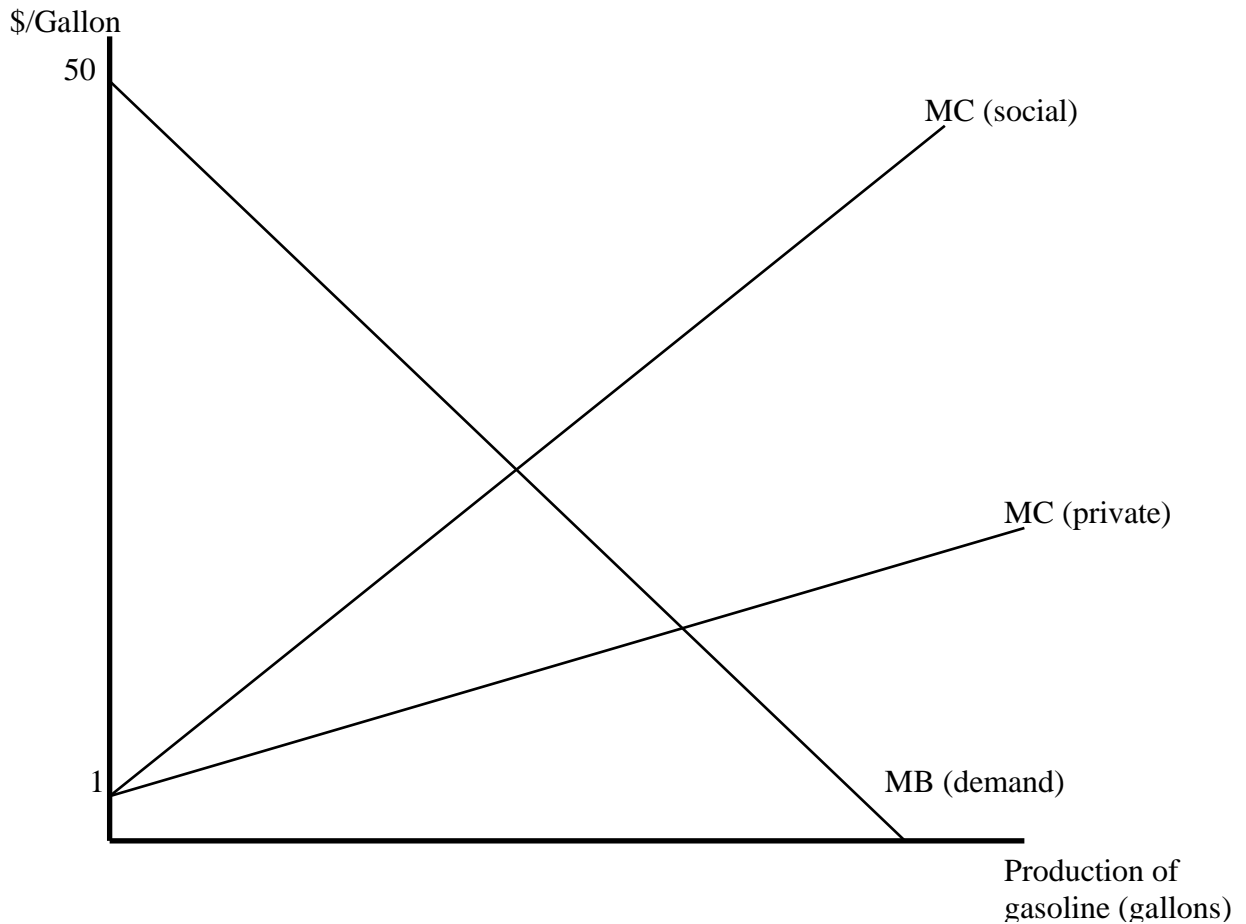
a. What is the private market (unregulated) equilibrium quantity of gasoline in the economy? Provide the value below and label this quantity Q_U on the diagram above.

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, P_C? What is the after-tax price, P_P, that producers will receive? Provide the values for P_C, P_P, 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.

5. 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 CO_2 emissions are:

$MD = 10+0.0075E$

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

$MAC = 125 - 0.05E$

where E = Million tons of CO_2 emissions per year, and MAC/MD 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 MEB 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.)

h. Given these results, and the estimated MAC that we began with, is a quantity-based or price-based instrument more economically advisable in this market?