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Economics of Environmental Policy

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Take Home Exam 1
Spring 2015

Due at 426 Eggers by 5:00 pm on Friday 3/6 if submitted on paper.
Due by 11:59 pm on Friday 3/6 if sent by email.

DO NOT OPEN THIS EXAM UNTIL YOU ARE READY TO BEGIN
(SEE POINT 6 BELOW)

Instructions

1. Write your **SUID** on your answer and **DO NOT** write your name.

2. Please write your answers on regular paper (not a blue book). You do not need to type them.

3. There's no hard time limit on the exam but try to do it in one sitting of no more than about 3 hours.

4. Show all your work. Answers without supporting work will receive little or no credit.

5. The exam is "open book/open notes": you are welcome to refer to your notes, to the exercises and their answer sheets, the class web site, or to readings listed on the syllabus.

6. It is NOT "open friend": you must do the exam yourself MAY NOT talk with anyone about it until after the due date. That's why you shouldn't open it until you are ready to begin.

7. Rule number 6 includes your friend Google: you can use materials that you already have on hand but please don't go hunting for more.

8. Using a spreadsheet is OK as long as you attach a printout showing the details of your calculations. However, you should have no problem doing the exam with a calculator as long as you take advantage of some of the compound PV formulas.

Question 1: Managing an Externality

Consider a good purchased by two types of buyers, A and B. There 10 type-A buyers and 20 type-B buyers. The WTP equations for an individual *i* of each type are shown below. The WTA curve for suppliers as a group (that is, the market supply) is also given. In addition, it is known that the good produces an air pollution externality according to the MCext curve shown below.

Type-A individual:	WTPai = 800 – 2*Qai
Type-B individual:	WTPbi = 400 – Qbi
Market WTA:	WTA = Qt/100
Externality:	MCext = Qt/300

(a) Please determine the market equilibrium and the efficient level of output given the externality.

(b) Suppose a policy maker wishes to use a tax to move the market to the efficient level of output. What should the tax rate be in dollars per unit?

(c) Please determine the amount of revenue raised by the tax, the gross value of the reduction in externality costs (that is, the externality gains), and overall welfare gain from the policy.

Now suppose the government wants to use the revenue for tax reform: it plans to lower an existing tax in the labor market. Suppose the demand for labor by employers and the supply of labor by employees are given by the WTPl and WTAl curves below, and that a $500 tax is initially in effect.

Employer WTP:	WTPl = 10,000 – 2*Ql
Employee WTA:	WTAl = 2*Ql

(d) Please determine the initial equilibrium in the labor market and report the following values: the price paid by employers; the price received by employees; the quantity of labor exchanged; and the total revenue raised by the tax.

(e) The government believes that it could cut the labor tax to $400 (that is, reduce it by $100) and it would still have at least as much revenue from the externality tax plus the new labor tax as it had with just the original labor tax. Please determine the new total tax revenue and indicate whether that assertion is true. If the government went ahead with the labor tax reduction, how much would Ql increase? How large would the gain in social surplus be in the labor market?

Question 2: Reducing Fertilizer Use

The use of fertilizers in agriculture contributes to water pollution through runoff of nitrogen, phosphorous and other nutrients into streams, and it also contributes to climate change through emissions of nitrous oxide (N2O), a greenhouse gas. However, farmers can have strong incentives to use large amounts of it. This question explores one possible policy to address the problem.

Suppose the annual output of a farm in a particular region depends on the weather that year and the amount of fertilizer the farm uses. To keep things simple, suppose there's a 70% chance the weather will be good (G) for the farm's crop and a 30% chance it will be bad (B), and that the farmer can choose either 12 units of fertilizer (H) or 2 units (L). The farmer must choose the amount of fertilizer before knowing the year's weather. The amount of revenue produced by the crop will depend on the combination of weather and fertilizer as shown below:

Table 2.1: Farm Revenue

		Fertilizer Use	
		H	L
Weather	G	$300,000	$250,000
	B	$200,000	$50,000

Again to keep things simple, you may assume that the only cost is fertilizer, which sells for $10,000 per unit (alternatively, you can assume that the revenue numbers are net of all other costs).

(a) Please compute the expected value of the two fertilizer options and indicate which one a risk-neutral farmer would choose.

(b) Suppose that the farmer is actually risk-averse and has a utility of consumption given by the function $u(c) = c^{0.1}$. What is the farmer's decision in this case? What is the certainty equivalent for each fertilizer option?

(c) Now suppose that an analyst has proposed the following policy: (1) each unit of fertilizer would be subject to a $2,000 tax, and (2) each farmer would receive a lump sum payment of $12,000. Please determine what fertilizer option a risk-averse farmer would choose under the policy. Compute the certainty equivalent of each option and compare those with the certainty equivalents under the business as usual case in part (b). Discuss how well off the farmer is under the policy compared to business as usual. You may assume that the supply of fertilizer is perfectly elastic.

(d) Finally, suppose that each unit of fertilizer creates $2,000 of external costs (i.e., the tax was set to MCext). Please compute the total gain from reduced externalities, the overall change in government revenue, and the overall change in surplus.

Question 3: Uncertain Technological Standards

Many electric utilities are considering replacing the traditional electric meters they use for measuring residential electricity consumption with new "smart meters" that have many advanced features. One key benefit of smart meters is that the utility can check a customer's monthly electricity use automatically over a network; traditional meters must be read by a person visiting each house, which is much more expensive. However, the technology is very new and there are competing devices and standards. This question explores some of the tradeoffs utilities face.

Suppose a smart meter using technology A can be installed for $600 in year 0, would last for 20 years, and would save $80 in labor costs every year (years 1-20) compared to a traditional meter. However, technology B is under development and will have more features. Meters using B will become available for installation in year 5, would operate in years 6-25, and would save $100 per year relative to a traditional meter. However, the purchase price of a type-B meter is uncertain: there is a 40% it would be $500 and a 60% chance it would be $900. Type-A meters will continue to be available in year 5 and would have the same cost and performance as in year 0.

(a) Please determine what the utility should do and briefly explain your reasoning (be sure to be quantitative). What is the expected NPV of the optimal plan? If option value is involved, please calculate it. The utility uses an interest rate of 10% in present value calculations.