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Take Home Exam 1

Spring 2011

Due at the beginning of class on 3/9.
Do not open this exam until you are ready to begin.

Instructions

1. Please write your answers on regular paper and staple this sheet to the front. You do NOT need to type your answers.

2. Write your SUID in the upper right corner. Please do NOT write your name.

3. Please do the exam in one sitting of no more than 3 hours. The time limit is there to keep it from eating up more of your week than it warrants.

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, 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.

7. The item above 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.

Question 1: Externalities and Tax Reform

Suppose a household consumes two goods, "C" and "D". Its preferences are given by the Cobb-Douglas utility function shown below. The household's demand equations and expenditure function are also shown. Variable *M* is the household's income, which is equal to $1680 throughout the problem.

Utility:	$U = C^{0.5} * D^{0.5}$
Demand for C:	$C = 0.5 * M / P_c$
Demand for D:	$D = 0.5 * M / P_d$
Expenditure:	$M = 2 * U * P_c^{0.5} * P_d^{0.5}$

The marginal cost of producing each good is constant and equal to $10; that is, *MCc* = $10 and *MCd* = $10. Initially, the government raises revenue via a $5 tax on good C and the price of good C is $15. There is no tax initially on good D and its price is $10.

(1) Please calculate the household's initial consumption of each good, its utility, and the amount of revenue raised by the tax.

Now suppose that production of good D creates a $2 external cost per unit. The government wants to control the externality by levying a new $2 tax on production of good D. However, it also wants to keep its total tax revenue constant. Since it will be raising revenue from D, an analyst proposes lowering the tax on C to $2 (that is, reducing the tax by $3).

(2) Please calculate the household's consumption of each good under the proposed policy. What is its new utility? Is the household better or worse off than under part 1? How much will it pay in taxes? Will the new system will succeed in matching the revenue of the old system?

(3) Please determine how much better or worse off the policy would make the household in dollar terms by computing the equivalent variation for the policy.

(4) What is the dollar value of the reduction in the externality under the new policy?

(5) Finally, what is the overall net benefit of the policy considering both the change in the externality and the equivalent variation for the tax reform? Briefly explain what your findings show.

Question 2: Risk and Innovation

Suppose a researcher has developed a prototype lighting technology that is highly efficient. If the device could be manufactured at low cost, the idea would be worth $20 million. However, there are difficult manufacturing problems to overcome and the chance it could be made at low cost is only 1 percent. If the problems can't be overcome, the idea is worth $0. The researcher must choose between keeping her current job, which pays $100,000 and would prevent her from working on the technology, and quitting to work on the technology full time.

(1) What is the expected value of the project? If the researcher were risk-neutral, would she undertake it? What would be her expected gain or loss?

Now suppose the researcher is risk-averse and maximizes her expected utility. The utility she gets from any amount of income, c, is given by the square root of c: $u = c^{0.5}$.

(2) Please determine whether she would stay in her current job or quit to undertake the project.

Finally, suppose the researcher is approached by a venture capitalist (VC) who offers her the following contract. If she quits her job to work on the technology, the VC will pay her $90,000 whether or not the project succeeds. In exchange, the VC would be entitled to 60 percent of the project's payoff ($20 million or 0).

(3) Please determine whether the researcher would accept the contract. Please also compute the certainty equivalent of the contract to her, and the expected payoff to the VC.

Question 3: Clean Energy Standard

An investor is considering building a new onshore wind farm with a capacity of 100 MW. The construction cost of the turbines would be $2,400,000 per MW. The turbines would have annual fixed costs of $28,000 per MW and zero variable and fuel costs. To keep things simple, you should assume that the entire farm could be built in period 0, would begin producing power in period 1, and would last forever.

Suppose that a new "clean energy standard," or CES, policy has been passed by Congress and power companies are obligated to buy a specified amount of renewable energy. As a result, the price per MWh of wind power is likely to be high. However, the exact price is uncertain and will depend on the amount of wind power actually generated. The amount of wind power, in turn, is uncertain and depends on the capacity factor the turbines achieve. The investor knows that there are two possible outcomes, "LW" and "HW", and each has a 50 percent chance of occurring. In case LW ("low wind output"), the capacity factor turns out to be 0.2 and the price is $100/MWh. In case HW ("high wind output") the capacity factor is 0.3 and the price is $50/MWh. That is, the capacity factor and the price are negatively correlated in the two cases.

The investor uses a 5 percent interest rate in present value calculations.

(1) Please compute the net present value of the wind farm under each of the two cases (without taking the uncertainty into account yet).

(2) Now take the uncertainty into account: what is the expected net present value of the farm?

Just in case you're curious, the numbers above are consistent with a demand curve for renewable power that has an elasticity of -1.

Question 4: Investing in Improving Technology

A firm is considering renovating one of its buildings in order to reduce its energy consumption. The cost of carrying out the renovation in period 0 would be $1 million and starting in period 1, the firm would save $60,000 in energy costs every year forever. However, the technology it would use is cutting edge and the firm knows there is a good chance it will drop in price over time. In particular, the firm believes that if it waits until year 5 to act, there is a 50 percent chance the price of the renovation would fall to $800,000. The energy savings produced would be the same: $60,000 per year (although starting in year 6). The firm uses a 5% interest rate

(1) What is the expected net present value of the firm's best action? If option value is involved, please calculate it.