Peter J. Wilcoxen
Economics of Environmental Policy

Department of Public Administration
The Maxwell School, Syracuse University

Take Home Exam 1

Spring 2014

Due at 426 Eggers by 5:00 pm on Friday 3/7 if submitted on paper.
Due by 11:59 pm on Friday 3/7 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, H (high income) and L (low income). There 10 type-H buyers and 20 type-L 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-H individual:	WTPhi = 1000 – 45*Qhi
Type-L individual:	WTPli = 400 – 10*Qli
Market WTA:	WTA = Q/8
Externality:	MCext = Q/4

(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 gross value of the reduction in externality costs (that is, the externality gains) and overall welfare gain from the policy.

Finally, now evaluate the distributional effects of the policy assuming that the income of type-H and L households are $100,000 and $40,000 respectively.

(d) Please compute the amount of tax paid by an individual household of each type and determine whether or not the tax is progressive, regressive, or neither. (It's OK to look up "regressive" if you've forgotten what that means.)

(e) The full distributional effects depend on the distribution of benefits as well. To keep things simple, suppose that H households live in clean areas and the externality *only* affects L households. Further, assume that the externality gains computed in part (c) are evenly distributed across the 20 L households: each household gains 1/20 of the total. Please compute the net effect of the policy on L households including both the externality gain and the tax and then discuss the overall progressivity or regressivity of the policy.

Question 2: Green Infrastructure

Many older cities in the United States, including Syracuse, have combined sewer systems that handle both sanitary wastewater (sewage) and stormwater. During heavy rains, the sharp surge in stormwater can push a combined system past its maximum capacity, causing overflows that release untreated sewage into rivers and lakes. A long-standing approach to reducing combined sewer overflows (CSOs) is to expand a system's treatment capacity and ability to store excess water temporarily, a technique known as "gray infrastructure". A newer approach known as "green infrastructure" uses landscaping, rain barrels, porous pavement and other techniques to reduce surges of stormwater. However, the performance of green infrastructure is less certain. This question explores some of the issues involved.

Suppose a city with a combined sewer system currently has a 10% chance of a significant overflow in any given year. When an overflow occurs, it causes $10 million in damages. The city is considering gray and green alternatives for addressing the problem.

- The gray approach would cost $10 million to construct and would raise maintenance costs by $300,000 per year. It would completely eliminate the overflows with certainty.

- The green approach would cost $7 million to construct and would raise maintenance costs by $140,000. There is a 50% chance it would be highly effective (outcome H) and eliminate overflows completely. If it is not highly effective, it would still be moderately effective (outcome M). In that case it would reduce the chance of an overflow to 8% and the damages when an overflow occurs to $6 million.

Both could be built in year 0 and begin operating and incurring maintenance costs in year 1. The city uses an interest rate of 5% in present value calculations. Please answer the following questions:

(a) Please calculate three NPVs: the NPV of the gray option, the NPV of the green option under outcome H, and the expected NPV of the green option under outcome M.

(b) What is overall expected net present value of the green alternative? If the city's leaders are risk-neutral, which option is best?

(c) Now suppose city's leaders are risk-averse and their utility from an NPV payoff is given by the function: U=NPV^0.25. What is the city's decision in this case? What is the certainty equivalent associated with the green option? Is the city's decision efficient? Please note that risk aversion applies to the NPVs calculated in part (a) and not to payoffs in individual years. In other words, you may assume the city uses expected value when calculating annual damages from overflows (to keep things simple).

(d) Finally, suppose the EPA offered the city a grant that would cover 10% of the construction cost. Would that be efficient? Would it change the city's decision?

This problem is motivated by the experience of Onondaga County, which has been a national leader in green infrastructure. In the County's case, there was a twist: it was state regulators who were risk averse and initially reluctant to approve a green approach.

Question 3: Regulating a New Technology

A central controversy in the debate over hydraulic fracturing has been the inherent risk the process poses to aquifers used for drinking water. The risk is not well understood at the moment and some observers argue it is very low while others argue that it's high. At the same time, ongoing research is likely to produce much better information in the next few years. This question is a stylized examination some of the issues related to regulating a new technology under these circumstances.

Suppose that current information suggests that, in general, the underlying vulnerability of aquifers to drilling is either low (L) or high (H). The regulator has three options: it can prohibit drilling (option N), it can allow drilling under existing drilling standards (option E), or it can allow drilling under new, tighter standards (option T). Together, the underlying aquifer vulnerability and regulatory standards determine the probability that an aquifer will be contaminated by drilling as shown in the table below:

Probability of Contamination

		Aquifer Vulnerability	
		L	H
Regulation	E	1.0%	15.0%
	T	0.2%	3.0%
	N	0.0%	0.0%

The regulator knows that a well produces $2 million of revenue every year forever (to keep things simple) no matter which regulation is imposed. However, costs vary: under E, drilling a well costs $10 million (year 0) and operating it costs $100,000 per year (starting in year 1); under T, drilling costs $13 million and operation costs $200,000 per year. If contamination occurs under either technology, the damage is $100 million and happens right away in year 0 (and only happens once – it's not an annual cost).

The regulator currently believes there is a 60% chance that L is true and a 40% chance that H is true. It also knows that decisions E and T are irreversible: once it gives the green light under either set of rules, drilling will begin and further rule changes will be politically impossible. Finally, the regulator uses a 10% interest rate for present value calculations

(a) Suppose the regulator must make a once-and-for-all decision in year 0. What is its best option: E, T or N? Please calculate and discuss the relevant expected NPVs.

(b) Now suppose the regulator knows that the science regarding the underlying vulnerability will be resolved soon and by year 3 it will be known whether L or H is correct. What is the NPV of choosing N in year 0 and then revising the rule in year 3 when the new information is available.

(c) Taking into account your results from part (b), what is the regulator's best decision at time 0? If your answer is different from part (a), please briefly explain why.