SUID:

Peter J. Wilcoxen
Economics for Public Decisions

Department of Public Administration
The Maxwell School, Syracuse University

Exam 3

Fall 2017

DO NOT OPEN THIS EXAM UNTIL YOU ARE TOLD TO DO SO.

Instructions

1. Write your SUID in the upper right corner of this exam. Do NOT write your name.
2. SHOW ALL YOUR WORK. Answers without supporting work will receive little or no credit.
3. There are 120 points on the exam and you'll have 180 minutes to complete it. Be sure to budget your time accordingly.
4. Some questions provide a blank table you can use to organize your calculations. Be sure to label the columns clearly. Where applicable, show the equation for the column in the bottom row of the table. The tables may have more rows or columns than you need.
5. Do all your work on the exam. If you need extra space, write on the backs of the pages. However, if you do write an answer on the back of a page, *be sure you've noted that near the question*.
6. Some potentially helpful formulas and equations:

$$\frac{1}{2}bh \qquad \frac{F_t}{(1+r)^t} \qquad \frac{F}{r}$$

Question 1 (15 points)

Suppose that children in two neighborhoods (A and B) near a major highway have unusually high rates of asthma, and the rates have been shown to be due to exposure to vehicle exhaust. Neighborhood A is nearest the highway and its cost of extra asthma cases is $200,000 per year. Neighborhood B is further from the highway but more heavily populated: its cost of extra asthma cases is $400,000 per year.

The city government would like to reduce the cost of asthma and is considering two policies: M and S. Policy M would move the highway to an unpopulated area. Construction would cost $1 million per year for years 1 to 8. Beginning in year 9, the asthma rate would drop to normal (no extra cases) in *both* areas. Policy S, in contrast, would focus on renovating the ventilation in buildings in neighborhood A to keep pollutants out of homes and schools. It would cost $600,000 per year for years 1 to 4. Beginning in year 5, the asthma rate *in A* would drop to normal; the asthma rate in B would not be affected. Under either plan, the government would pay for the construction cost using a tax with a deadweight loss of $0.20 per dollar of revenue.

Please calculate the net present value of each plan and then indicate which one is best. You may assume that the government uses an interest of 4% (four) in present value calculations.

Question 2 (15 points)

The government of small city is concerned that development along a nearby river has raised the risk that one of its buildings may be flooded. Historically, the risk has been 0.5% (half a percent) but the city believes there is a 20% chance that development has changed the city's floodplain and the risk of a flood may now be 5%. If a flood occurs, the building would suffer $5 million of damage. However, the city could spend $150,000 to renovate the building to make it flood resistant. To keep things simple, you may assume that if the building is renovated, it will not be damaged at all by a flood. Finally, the city could also hire an engineering firm to determine whether the floodplain has changed before making a decision on the renovation. The firm's determination would be infallible: the city would know for certain whether or not the building is in the floodplain (and thus whether or not the risk has increased).

Please determine the maximum the city would be willing to pay for the test. To keep things simple, you may assume that everything (decisions, renovation, possible flooding) happens in one period, and there is at most one flood.

Question 3 (15 points)

A city with an aging fleet of diesel buses is considering two options for replacing them. Option N would use buses powered by natural gas. It would cost $5 million in year 0, last for 20 years (years 1 to 20), and produce $750,000 of benefits every year in reduced fuel costs and lower pollution. Option E would use electric buses instead. It would cost $12 million in year 0, last for 20 years (1 to 20), and produce $1.25 million of benefits each year in lower fuel costs, lower pollution, and cheaper maintenance. However, the city is aware that the cost of electric buses may fall as the technology develops. It believes there is a 50% chance that in 5 years the cost of option E will drop to $8.25 million (otherwise it will remain $12 million). The city could continue using the diesel buses and wait to make the decision about new buses in year 5 after it is clear whether or not the price falls. If it does so, the cost would occur in year 5 and the benefits would arrive in years 6 to 25.

Assuming the city is risk-neutral and uses an interest rate of 5% in present value decisions, please determine what the city should do.

Question 4 (15 points)

Some states are now using artificial intelligence (AI) during the sentencing phase of trials to determine the risk that a defendant will commit additional crimes (reoffend). However, the algorithms are not infallible. This question explores one aspect of the issue.

Suppose that defendants fall into two types: those that are likely to reoffend (type R), and those that are not (type N). The probability that any given defendant is type R is 25%. Further, suppose that each defendant receives one of two possible sentences: incarceration (I) or probation (P). Ideally, type-R defendants would be incarcerated (call that outcome RI) and type-N defendants would receive probation (outcome NP). In practice, two kinds of mistakes are possible: (1) giving an R defendant probation (so they are out in the community and can commit additional crimes; call that RP), or (2) incarcerating an N defendant (it's expensive and they may become more serious criminals; call that NI). To keep things simple, let the payoff from a correct outcome (RI or NP) be \$0 and the payoff from an incorrect outcome (RP or NI) be a *loss* of \$500,000. That is, the payoffs of bad outcomes will be measured as losses relative to good outcomes. Finally, suppose that the courts make sentencing decisions based on expected value.

(a) Suppose that initially no information is available about a given defendant's type. What is the expected payoff of each type of sentence? Which will be used? How many incorrect decisions of each type will there be, on average, for every 100 defendants?

Question 4, continued.

(b) Now suppose that an AI algorithm can be used to evaluate the defendant. However, the algorithm is not perfect. It has a 10% chance of reporting that a high-risk type-R defendant is a low risk type N, and a 20% chance of reporting that a low risk type-N defendant is a high risk type R. The company providing the algorithm charges $5,000 for an evaluation. Please determine whether the courts will use the test. How will the number of incorrect decisions of each type for every 100 defendants compare to the results from part (a)?

In practice, the use of these systems is controversial because there is evidence to suggest that some AI algorithms (which are often owned by private companies and not fully disclosed) may produce racially biased results. That would occur if the type-N-reported-as-type-R error occurred much more for one race than another. For this question, however, you can leave that complication out and assume that the system is not biased.

Question 5 (15 points)

A non-profit organization provides advice on environmental sustainability to small towns in New York. It has total costs given by the following equation: $TC = 500 + 20 * Q^2$, where Q is the number of towns it serves. It believes the demand for its advice is given by the equation $P = 900 - 30 * Q$, and there are no other organizations nearby providing a similar service. The organization wishes to serve as many towns as possible without running a deficit.

What price should the organization charge and how many towns will it be able to serve? How much profit will it earn? As a hint, the value of Q is between 12 and 22, inclusive.

Variable								
Equation								

Question 6 (15 points)

One way to address climate change would be to develop an inexpensive technology for "carbon capture and storage" (CCS) that would keep the carbon dioxide produced by power plants from being emitted into the atmosphere. Suppose a profit-maximizing firm is considering a research project to develop a CCS technology. If it succeeds, the annual demand for the technology would be given by P = 3800 – 100*Q and production costs would be given by TC = 200*Q. Assuming the firm is able to develop the technology, what price would it charge and what quantity would it produce in each year during the time it is a monopolist? What profits will it earn each year? As a hint, the quantity will be between 15 and 25.

Variable								
Equation								

Question 7 (15 points)

Now suppose the research project in Question 6 would cost $300,000 and there is only a 10% chance it would succeed. If the project succeeds, the firm would be a monopolist for 20 years (years 1-20). After that, other firms would enter the market, the price would fall to $200, and the firm's profits would drop to 0.

(a) Please calculate the expected net present value of the research project assuming that the firm uses an interest rate of 5% in present value calculations. Should the firm undertake it?

Question 7, continued

(b) The government is interested in the CCS project for two reasons. As usual, it values the consumer surplus the technology would produce if the project succeeds. In addition, however, it cares about the reduction in carbon dioxide emissions. To keep things simple, suppose that each unit of the technology would produce $5,000 of positive externalities in the year it was sold. For example, 3 units sold in year 4 would produce $15,000 of positive externalities in year 4. Using an interest rate of 5%, what is the total expected present value of the sum of the CS and the externality benefits during and after the patent period?

Question 8 (15 points)

Finally, suppose the government proposes the following policy. It will provide the firm with a $150,000 grant to undertake the project. In addition, the government promises that if the project succeeds, it will pay the full value of the externality to the firm during the patent period. (In the example above, 3 units sold in year 4 would cause the government to pay the firm $15,000 that year.) However, the firm believes there is a 40% change the policy will be repealed after the next election and it won't get the externality payments. To keep things simple, assume the repeal would happen in year 0 but after the firm had invested in the project: thus, there is a 60% chance the firm would get all of the externality payments and a 40% it would get none of them. The firm would get the initial $150,000 whether or not the policy was repealed. Also, you may assume the externality payment would be a lump sum and would not change the firm's decision on the quantity to produce.

Would this policy induce the firm to undertake the project?

This is an issue known as policy risk. The credibility of policies (the perceived likelihood that the government will carry out future promises) can have a big impact on policies intended to encourage long term investments.

Additional page for calculations

If you use this, please remember to indicate near the question that part of the answer is here.