SUID:

Peter J. Wilcoxen
Economics for Public Decisions

Department of Public Administration
The Maxwell School, Syracuse University

Exam 3
Fall 2021

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)

An important aspect of policy design is how rapidly the policy takes effect. To explore that, suppose the government of a large city is concerned about air pollution and other externalities created by old heating systems in large apartment buildings. Currently, the damages from the externalities are $2 billion per year. The city is considering two policies, S and G, that would require building owners to upgrade their heating systems. Policy S would be imposed suddenly: building owners would have to start replacing their systems with new equipment soon. It would cost $6 billion per year in years 1-5 and it would eliminate the externality damages starting in year 6. Policy G, on the other hand, would be more gradual. It would lower costs by allowing owners to replace old equipment as it wears out. It would not require any action in years 1-5 and would cost $2 billion per year in years 6-15. The externality would be eliminated starting in year 16.

Please: ☐ determine the net present value of each option, and ☐ indicate which the city should choose. The city uses an interest rate of 5% in PV calculations.

Question 2 (15 points)

Suppose a region like Texas usually has relatively mild weather (M) but once in a while gets severely cold (C). The chance of C in a given year is 5% and the chance of M is 95%. When C occurs, however, there is a 20% chance that critical parts of the natural gas pipeline system will freeze (F), causing $100 billion in damages by reducing the supply of natural gas to homes and power plants. When F does not occur, C does not cause any damage.

The region's government is concerned about the situation and is considering a policy that would require pipeline operators to winterize (W) their equipment. Winterizing wouldn't change the probability of C but it would reduce both the probability of F and the damages that would occur when F happens: the probability of F when C occurs would drop to 5% and the damages would drop to $80 billion.

Please determine: ☐ the expected annual net gain from adopting policy W before considering its cost. Now suppose that W would require a one-time investment of $10 billion in year 0 and would then produce the expected annual net gain forever starting in year 1. Please determine: ☐ the NPV of the policy using an interest rate of 5% and ☐ indicate whether the region should go ahead with it. You should assume that the government is risk-neutral and would like to pick the approach that has the best expected value.

Question 3 (15 points)

The US legal doctrine of sovereign immunity means that federal government decisions can't be challenged in court except where Congress has specifically waived that immunity. In recent decades, Congress has routinely waived sovereign immunity for decisions by executive branch agencies, such as the EPA, but not for decisions by Congress itself. This question explores the implications. It is loosely based on the regulation of toxic air pollutants in the US.

Suppose that a large group of chemicals needs to be regulated. Some chemicals create health hazard X (type X) and others create health hazard Y (type Y). It is known that 25% of the chemicals are likely to be type X and 75% are likely to be type Y but the type of any given chemical is not known without a detailed investigation by the EPA. In addition, there are two types of regulation: A and B. The net payoff, in millions of dollars, of regulating each type of chemical with each type of policy is given in the table below:

	Policy A	**Policy B**
Type X	\$10	−\$6
Type Y	−\$2	\$6

Congress would like to deal with the chemicals and is considering three options: CA, a one-size-fits all policy applying A to all chemicals ("CA" for "Congress mandates A"); CB, a similar one-size-fits-all mandate applying B to all chemicals; or a third policy, D, delegating decisions about individual chemicals to the EPA. Under D, EPA experts could infallibly determine each chemical's type at zero cost and then apply A or B as appropriate for that chemical.

(a) Please determine: ☐ the expected payoffs of applying each policy, CA, CB or D to a random chemical; and ☐ indicate which option is best.

Question 3, continued.

Now suppose that under D, EPA's decisions about the policy to apply for type-Y chemicals will always be challenged in court. Defending a decision will cost the government $6 million in legal fees (you can assume the government always wins in the end). For simplicity, type-X decisions are never challenged. In contrast, under CA or CB there's no litigation cost for either type of chemical because Congress is protected by sovereign immunity.

(b) Please determine: ☐ whether the best policy changes. If it does, ☐ indicate how much benefit is lost per chemical relative to your answer to part (a). Finally, ☐ briefly explain in words what goes wrong.

Question 4 (15 points)

Addressing climate change will require switching the vehicle fleet away from gasoline engines. Two alternative technologies are electric vehicles (EVs) and fuel cell vehicles (FCs) but both technologies are evolving rapidly. A federal policy emphasizing one or the other will bring about the transition sooner, but it also risks picking the wrong technology.

For example, EVs are the most promising technology now (year 0) but suppose it won't be known for sure what's best until year 10. At that point, there are two possible states: EVs are best (state E) or FCs are best (state F). The probability of E is 80% and the probability of F is 20%.

Suppose that the government could adopt a policy today (year 0) that would build infrastructure for one type of vehicle or the other; call the policies EV0 and FC0. Under EV0, the government would spend $200 billion per year in years 1-10 developing EV infrastructure. If state E occurs in year 10, that infrastructure would produce a benefit of $300 billion per year forever starting in year 11. However, if state F occurs, the EV infrastructure would only produce a benefit of $100 billion per year starting in year 11. Policy FC0 would be similar but would emphasize FC infrastructure. It would have the high $300 billion payoff in state F and the low $100 billion payoff in state E.

(a) Please: ☐ evaluate policies EV0 and FC0 and determine which one would be better. You may assume that the government uses an interest rate of 5% in present value calculations and makes decisions based on expected value.

Question 4, continued.

Now suppose the government could wait 10 years to see how the technologies evolve before adopting a policy. It could then choose EV10 or FC10, which would be similar to EV0 and FC0 but delayed 10 years. For example, under EV10, the government would spend $200 billion on EV infrastructure in years 11-20. It would create $300 billion benefits starting in year 21 under state E, or $100 billion per year under state F.

(b) Please determine: ☐ whether the option to wait would change the government's decision.

Question 5 (15 points)

A nonprofit organization helps small businesses set up their social media presence. It has total costs given by the following equation: $TC = 1000 + 5Q^2$ where Q is the number of businesses it serves. It believes the demand for its help is given by $WTP = 500 - 10Q$, and there are no other organizations nearby providing a similar service. The organization wishes to serve as many businesses as possible without running a deficit.

What price should the organization charge and how many businesses will it be able to serve? How much profit will it earn? As a hint, the value of Q is between 25 and 35, inclusive.

Question 6 (15 points)

Suppose a profit-maximizing firm is considering a research project to develop a compact medical-grade air purifier that would be highly effective at eliminating airborne viruses in restaurants and other small businesses. If it succeeds, the annual demand for the system would be given by $WTP = 6000 - 25 * Q$ and production costs would be given by $TC = 1000 * Q$. Assuming that the firm is able to develop the device, 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 96 and 106, inclusive.

Question 7 (15 points)

Now suppose that the research project in Question 6 would cost $1 million, which would be paid in year 0. The chance that the project succeeds in developing a purifier is 30%. However, for the device to qualify as medical-grade, the firm would then need to submit it to the Food and Drug Administration (FDA) for approval, which would require an additional $500,000 in costs. The chance of subsequent FDA approval is 80%.

To keep things simple, you may assume that the research project and the application for FDA approval could both be carried out in year 0, and if the FDA approves the device, the profits from Question 6 would begin to arrive in year 1. The firm would be a monopolist for 20 years (years 1-20) after which other firms would enter the market, the price would fall to $1000, and the firm's profits would drop to 0.

(a) Using an interest rate of 5%, please: ☐ calculate the PV of the monopoly profit if the project succeeds and the FDA approves the device; ☐ calculate the EV of the research project as a whole; and ☐ determine whether the firm would undertake the research.

Question 7, continued.

(b) Now consider the potential consumer surplus the device would produce. Using an interest rate of 5%, ☐ what is the PV of the CS that would be generated if the firm successfully developed the product and had it approved by the FDA?

Question 8 (15 points)

Finally, now suppose the government decided to offer a prize to encourage the firm to undertake the research project. It would pay the firm $2 million in year 0 if the device is approved by the FDA. However, it would pay nothing if the project fails or the firm abandons it for any reason.

Please ☐ determine whether the policy would change the firm's decision. Then, ☐ determine the government's expected payoff assuming it only cares about consumer surplus and its own payments under the policy. Please be sure to show your work.

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