SUID:

Peter J. Wilcoxen   Department of Public Administration
Economics for Public Decisions   The Maxwell School, Syracuse University

Exam 3
Fall 2022

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. Unless otherwise indicated, use an interest rate of 5% in PV calculations and assume the decision maker is risk neutral and cares only about maximizing EV in calculations involving uncertainty.

7. Some potentially helpful formulas and equations:

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

Question 1 (15 points)

A city is concerned about an aging highway that has become expensive to maintain. Currently maintenance costs $3 million a year. The city is considering two options: extensive repairs (ER) and complete replacement (CR). Extensive repairs (ER) would cost $2 million per year in years 1-5 and would lower the maintenance cost to $2 million a year forever starting in year 6. Complete replacement (CR) would be better in the long run but also more complex. Planning would delay the start of construction until year 6. Construction would then cost $4 million a year for five years (years 6-10). After that, maintenance costs would drop to $1 million a year forever starting in year 11. Under either policy, the original highway would continue to require maintenance until the project is complete (year 6 or year 11).

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)

A city is considering a redevelopment project in a low income neighborhood. The project would cost $100 million. However, its benefits are uncertain and depend on whether the area's residents like the outcome: if they like it (L), the project would provide $200 million in benefits, but if they dislike it (D) it would provide $80 million. Initially, the city believes there is a 75% chance the residents will like the project.

The city is considering hiring one of two consulting firms, F and E, to help with the project. Consulting firm F (for "forecast") charges $1 million and would be able to tell the city whether L or D will occur before the project is implemented, and is infallible. Consulting firm E (for "engage") wouldn't be able to tell the city in advance whether L or D will occur but instead would raise the chance of L to 80% by engaging with the public during the design phase. The city can hire E or F or neither but can't hire both.

What is the city's maximum willingness to pay for consulting firm E? You may assume that everything occurs in a single year (no need for present value).

Question 3 (15 points)

The recently-passed Inflation Reduction Act (IRA) includes a number of incentive policies for renewable energy. One of the policies, call it P, provides subsidies for the production of renewable electricity. Another policy, call it I, provides subsidies for investing in renewable generating equipment such as wind turbines or solar panels. An important and innovative feature of the IRA is that it allows firms to choose which incentive they want, P or I. This question explores that feature.

Suppose that before the IRA, a firm could build a renewable facility in year 0 for $400 million and would earn $30 million in profits per year over a 20 year lifetime (years 1-20). Under the IRA's policy P, it would receive a production subsidy of $5 million per year. The subsidy would be guaranteed for years 1-8 but there is a 60% chance that a future government would repeal the policy after year 8 and it would not be paid in years 9-20. Under the IRA's policy I, the firm would instead receive an investment subsidy in year 0 to offset $50 million of the facility's initial cost. Since the payment would occur immediately, there is no risk it would be repealed.

Please determine: □ whether the firm would build the facility without the IRA (under BAU); □ whether it would prefer P or I; and □ indicate whether or not that policy would be sufficient to get the firm to build the facility. Finally, to get at the heart of the issue, □ which policy, P or I, would the firm choose if there was no chance of P being repealed? You may assume that it uses a 5% interest rate in present value calculations and wants to pick the option with the highest expected net present value.

Question 4 (15 points)

A mid-sized community that is vulnerable to severe storms is about to upgrade its infrastructure for utilities (water, sewer, electricity, natural gas and internet service). It is considering two options: a conventional upgrade (C) and a more advanced system (R) that would increase the community's resilience to storms. Both options would be constructed in year 0 and be used for 40 years (years 1-40) during which the community would have to pay annual operating costs. Option C would cost $100 million in year 0 and would require $10 million in annual operating costs (years 1-40) while option R would be more expensive on both counts: it would cost $250 million in year 0 and require $20 million in annual operating costs.

Finally, the chance of a storm in any given year is 5%. Under option C, the damage from a storm is $500 million while under R, it is much smaller: only $100 million.

Please: □ determine the total present value cost (construction plus operation) of each option, C and R. Then □ determine the present value of the expected reduction in storm damage over the life of the project (years 1-40) if the city builds R instead of C. Finally, □ compute the net present value of R relative to C and indicate which the city should choose (you may assume that it has to build one or the other). The city uses an interest rate of 5% in PV calculations.

Question 5 (15 points)

A nonprofit organization provides basic cybersecurity audits for local businesses. It has total costs given by the following equation: $TC = 25Q^2$ where Q is the number of businesses it serves. It believes the demand for audits is given by $WTP = 2000 - 20Q$, 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 40 and 50, inclusive.

Question 6 (15 points)

Suppose a profit-maximizing firm is considering a research project to develop a gene therapy for a rare disease. If it succeeds, the annual demand for the therapy would be given by $WTP = 16200 - 100 * Q$ and production costs would be given by $TC = 200 * Q$. Assuming that the firm is able to develop the therapy, 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 76 and 86, inclusive.

Question 7 (15 points)

Now suppose the development process in question 6 costs $2 million (paid in year 0) and has a 20% chance of success. If it works, the firm would then need to test the therapy to ensure that it is safe. Testing would cost an additional $1 million (also in year 0) and there is a 25% chance the therapy would fail and could not be sold. However, if it passes, profits 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 price would fall to $200 and the firm's profits would drop to 0. If the project does not succeed or does not pass the safety test, the firm would earn no profits in any year.

(a)   Using an interest rate of 5%, please: ☐ calculate the PV of the monopoly profit if the project succeeds; ☐ 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 develops the therapy and it passes the safety test?

Question 8 (15 points)

Finally, now suppose the government is considering a partnership with the firm. Under the partnership, the government would pay $1.5 million of the development cost in year 0. In exchange, the government would receive 20% of the profits on the therapy during the monopoly period if the firm succeeds in developing it. If the project fails for any reason, the government does not receive any payment from the firm.

Please: □ determine whether the partnership 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.

Have a great break!

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