SUID:

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Exam 3
Fall 2014

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 helpful PV formulas:

$$PV = \frac{B_t}{(1+r)^t} \qquad\qquad PV = \frac{B}{r}$$

Question 1 (15 points)

A city on a major river experiences periodic floods and is considering two options to address the problem. Policy L would build levees along the river. Constructing the levees would take 5 years and cost $20 million in each year (years 1-5). When complete, the levees would provide protection worth $10 million per year forever (years 6+). Policy P would buy up land along the river, remove the buildings on it, and create a park that could absorb flood waters without damage. Creating the park would take 15 years and cost $10 million in each year (years 1-15). However, once complete it would provide better protection than the levees and produce $20 million of benefits per year forever (16+). You may assume that neither policy produces any benefits before it is complete.

Please calculate the net present value of each plan and indicate which one is best. The city uses an interest of 5% in present value calculations.

Question 2 (15 points)

A community is evaluating a new approach for managing patients on Medicaid (health insurance for people with low incomes). Its current approach (policy C) costs $20 million and produces $100 million of gross benefits. The alternative approach (policy A) integrates health care with other social services to help patients manage chronic health problems better. It is more expensive to operate and costs $40 million. It is also uncertain how the client population will respond. There is a 40% chance that the integrated system will work well and produce $200 million in gross benefits. However, if the population dislikes the integrated approach it would be less effective than the conventional method and would only produce $60 million in benefits. Once the community commits to either policy, it can't change its mind. However, it has the option to pay $25 million to run a test of policy A *before* making a final decision. You may assume that the trial can be conducted immediately, has no other costs or benefits, and will determine for certain whether or not policy A would succeed.

Please determine what the government should do. You may assume the government is risk-neutral and wants to choose the policy with the highest expected value. Also, please note that this problem only involves one time period and no present value calculations are involved (alternatively, you can consider all the numbers to be present values already).

Question 3 (15 points)

A city is considering a substantial renovation to its water supply system and is evaluating two options: a conventional upgrade (policy C) that would cost $50 million, and a high-efficiency upgrade (policy H) that would cost $90 million but would perform better in years with low rainfall. Policy C provides $5 million in benefits per year no matter how much rain the city receives. Policy H provides $5 million in benefits per year if rainfall is normal (same as C) but provides $15 million per year if rainfall is low. The city currently has normal rainfall every year but there is a 30% chance that climate change will cause the city to have low rainfall forever starting in year 11. The city will find out in year 10 whether or not its rainfall is going to drop.

The city could build either system in year 0 and begin receiving benefits in year 1. However, it could also wait until it finds out about climate change in year 10 and then build either system in year 10. If it waits, it will begin receiving benefits in year 11. Please determine the city's best plan of action. The city 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 large organization is considering whether to upgrade its system of computer servers and software. The existing system has been built up over many years, is expensive to maintain, and lacks some capabilities that the organization would like. The organization is considering an upgrade plan that would cost $20 million. If the upgrade succeeds, it will produce $40 million of benefits. However, due to the complexities of the organization's current system there is a 20% chance the upgrade will fail and produce no benefits at all.

A consulting firm has offered to carry out a study that would determine whether or not the upgrade would succeed before the firm undertakes it. Please determine the organization's maximum willingness to pay for the study. You may assume that the consulting firm is infallible and that everything occurs in a single year (no need for present value).

Question 5 (15 points)

A non-profit organization provides advice to low-income individuals about health insurance plans available under the Affordable Care Act. It has total costs given by TC = 2000 + 1*Q^2 where Q is the number of clients it serves and Q^2 indicates Q squared. The demand for its services is given by the equation P = 200 - Q, and there are no other organizations nearby providing a similar service. The organization wishes to serve as many people as possible without running a deficit.

What price should the organization charge and how many people will it be able to serve? How much profit will it earn? As a hint, the value of Q is between 80 and 90, inclusive.

Variable

Equation

Question 6 (15 points)

Suppose a US firm believes it may be able to develop a new vaccine for a dangerous tropical disease. If it succeeds, it believes that annual private-sector demand for the vaccine in the US would be given by the equation $P = 2600 - 50*Q$, and it would be able to produce the vaccine for a total cost given by $TC = 200*Q$. Assuming the firm is able to develop the vaccine and sells only in the US, 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 20 and 30.

Variable

Equation

Question 7 (15 points)

Now suppose that a research project to develop the vaccine in Question 6 would cost $400,000, which would be paid in year 0. However, there is only a 40% chance the project would succeed. You may assume the research project could be carried out in year 0 and, if it succeeds, the profits found in 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 $200, and the firm's profits would drop to 0.

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 8 (15 points)

Now let's consider the research project from a global perspective. Suppose that there is a second market for the vaccine outside the US. Call this the "rest of the world" market and suppose it has a demand curve given by $P = 300 - 0.01*Qr$, where Qr is sales in the rest of the world. During the patent period, the firm only sells in the US and $Qr=0$. After the patent expires and the price drops to \$200, sales to the rest of the world occur.

If the firm undertook the research and succeeded in developing the vaccine, how large would Qr be after the patent expires? Using a 5% interest rate, what is the present value of the consumer surplus in each market (US and rest of the world)? Now step back one step further and calculate the expected PV of the total consumer surplus (both markets together) given that the research project might not succeed.

Question 8, continued.

Finally, suppose that a philanthropic foundation (such as the Gates Foundation) is concerned about the disease because of its prevalence in the rest of the world. It wants to encourage research on the problem by offering a cash prize of $X to the firm if it successfully develops the vaccine. The prize would be a single payment delivered in year 0. The firm would earn the monopoly profit in the US as usual in years 1-20 and sales in the rest of the world would begin in year 21. If the firm does not undertake the research project or undertakes it and fails, it gets nothing.

What is the minimum value of X that would induce the firm to undertake the project? Assuming that the foundation *only cares about consumer surplus outside the US*, what is the expected net present value of the prize policy at that X? Would the foundation want to go ahead with the policy? You may assume that the foundation uses a 5% interest rate in present value calculations.

Have a great break!