SUID:

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Exam 3
Fall 2015

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 growing city is struggling with traffic. Two policies, R and B, have been proposed to reduce congestion. Policy R would construct a light rail system (essentially an above-ground subway), and policy B would create special express bus lanes on major roads. R would take 20 years to construct (years 1-20) while B would take 5 (years 1-5). Both options would cost $20 million per year in each year of construction (20 for R, 5 for B). Benefits from B would begin in year 6 and be $10 million per year forever. Benefits from R, in contrast, would be small for the first years the system is running and only become large after households and businesses gradually move closer to the system's stations (a real issue with rail). To keep things simple, suppose the benefits of R are 0 in years 21-35 but rise to $90 million per year starting in year 36 and then go on forever at that level.

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 city is concerned about two brownfield sites, A and B, and is considering policies to address them. The degree of contamination at A is known. Cleaning it would cost of $20 million and produce $80 million in benefits. Site B is more complex: its degree of contamination is not known precisely and it would need to be cleaned up in two stages. Stage 1 would cost $40 million and would reveal whether the site was heavily (H, 40% chance) or lightly (L, 60% chance) contaminated. The city could then choose between two stage-2 policies: C and R. Policy C would install a cap over the contamination. It would cost $20 million (above and beyond the stage 1 cost) and produce $50 million in benefits in either H or L. R would remove the contamination and produce $200 million in benefits. It would cost $20 million in L but $200 million in H (both in addition to the stage 1 cost). The city can clean up either site but not both. However, if it begins cleaning up B it must finish the job with either C or R—it can't abandon the site after the first stage.

Please determine what the city should do. You may assume it 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 needed.

Question 3 (15 points)

A government would like to encourage firms to build more wind farms to generate renewable electricity. With no policy in place, a wind farm could be built in year 0 for $140 million and would earn $10 million in profits per year over a 20 year lifetime (years 1-20). The government has decided to offer two policies and allow firms to choose between them. Policy P would provide a production subsidy of $2 million per year, bringing the firm's profit to $12 million per year. It would be guaranteed for years 1-4 but there is a 60% chance that a future government would repeal the policy after year 4 and it would not be paid in years 5-20. Policy I would instead provide an investment subsidy in year 0 to offset $20 million of the wind farm's initial cost. Since the payment would occur immediately, there is no risk it would be repealed.

Please determine whether the firm would prefer P or I and indicate whether or not that policy would be sufficient to get the firm to build a wind farm. 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 small city is considering two possible upgrades to its highway system. Option H would build a high capacity system and would cost $100 million. Option L would build a low capacity system and would cost $25 million. The benefits of H depend on future growth of the city. There is a 40% chance the city's growth will be fast (F) and the benefits of H would be $200 million. However, there is a 60% chance growth will be slow (S) and benefits of H would only be $50 million. The benefits of L will be $30 million for either growth rate. Finally, the city could pay a consultant $5 million to determine the city's likely future growth rate.

Please determine the city's best course of action and give its expected value. To keep things simple you may assume that all the numbers given above are present values (so no additional PV calculations are needed) and that the consultant could carry out the study immediately and would be correct in its prediction.

Question 5 (15 points)

A non-profit organization provides advice about mortgages to first-time home buyers. It has total costs given by TC = 760 + 5*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 = 400 – 5*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 35 and 45, inclusive.

Question 6 (15 points)

Suppose a profit-maximizing firm is considering a research project to develop a controller chip for advanced robotic limbs for veterans and other people who have had severe injuries. If it succeeds, the annual demand for the chips would be given by $P = 13700 - 200*Q$ and production costs would be given by $TC = 100*Q$. Assuming the firm is able to develop the chip, 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 30 and 40.

Variable								
Equation							

Question 7 (15 points)

Now suppose that the research project to develop the chip in Question 6 would cost $2 million which would be paid in year 0. However, there is only a 30% chance the project would succeed. You may assume the project could be carried out in year 0 and, if it succeeds, 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 $100, 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 suppose that advocacy groups have lobbied the government to provide stronger incentives for the research project. As a first step in evaluating a possible policy, please compute the expected present value of the consumer surplus (during and after the patent period) that would be created if the firm undertook the project. You may assume that after the patent expires other firms enter the market and the price drops to $100. The government uses a 5% interest rate in present value calculations.

Question 8, continued.

Finally, suppose the advocates recommend a venture-capital-style partnership in which the government would cover part of the research costs in exchange for part of the profits if the project succeeds. In this case, the government would pay 75% ($1.5 million) of the research costs. If the project succeeds, the firm would make a one-time payment to the government of $700,000 in year 0. The firm would NOT make the payment if the project fails. (Please note that the $700,000 is not a typo: it's intentionally less than the government's contribution to the research cost.)

Would the partnership induce the firm to undertake the project? Assuming for simplicity that the government only cares about consumer surplus and its payments to or from the firm (that is, assuming it doesn't care about the firm's profits), what is its expected value from the partnership?

Have a great break!