14.03/14.003 Problem Set 5
Fall 2014

Professor David Autor

Due Tuesday, 11/25/2014 at 5pm EST via Class Website

1 Short Questions (25 points)

1. Consider 4 lotteries:

   (A) \$100 with certainty

   (B) \$1,000 with probability 0.1; \$100 with probability 0.89 and; \$0 with probability 0.01

   (C) \$100 with probability 0.11; \$0 with probability 0.89

   (D) \$1,000 with probability 0.1; \$0 with probability 0.9

   Suppose Alex picks lottery A over lottery B. If Alex is an expected utility maximizer, he will always pick lottery C over lottery D. *True/False/Uncertain and why?* [Hint: Express preference relations in lotteries in terms of expected utilities and then you can rearrange terms by adding and subtracting terms to transform one set of lotteries to another] **(6 points)**

Now consider the following lotteries

(A) \$100 with certainty

(B) \$200 with probability 0.7; \$0 with probability 0.3

(C) \$110 with certainty

(D) \$1200 with probability 0.1; \$0 with probability 0.9

(E) \$200 with probability 0.35; \$100 with probability 0.5; \$0 with probability 0.15

(F) \$1200 with probability 0.05; \$110 with probability 0.5; \$0 with probability 0.45

2. Suppose Bob is indifferent between lottery A and lottery B. He is also indifferent between lottery C and lottery D. Is Bob risk-averse, risk-loving, risk-neutral or is it impossible to say. Explain your answer. **(4 points)**

3. Cynthia has same choices as Bob. She is indifferent between lottery A and lottery B and between lotteries C and D. If Cynthia is an expected utility maximizer and her utility is increasing in money/wealth, which lottery will she pick when faced with a choice between lottery E and lottery F? **(5 points)**

4. Donna is a farmer who receives \$500 in good state (plentiful rain) which occurs with probability 0.8. With probability 0.2, there is drought and she receives \$50. If her utility function is given by $u(x) = \ln(x)$, how much is she willing to pay for insurance that pays \$450 in case of drought and nothing in the case of plentiful rain. (You can assume that she does not have any other wealth). **(5 points)**

5. Assuming that all consumers are risk averse and that health insurance can be purchased by any consumer who is willing to pay the going market price, why might not everyone choose to buy insurance? Offer at least two possible explanations. **(5 points)**

2 Data Mining (35 points)

You are interested in estimating the VSL by analyzing data on salaries and fatalities in coal mining.[1] You decide to compare mine workers to steel workers. Like mine workers, steel workers do physically demanding jobs under tough working conditions. But fatal injury rates in steel manufacturing are much lower.

For each worker i, imagine that they have two potential annual salary rates, one if employed in coal, one if employed in steel. Call these W_{1i} and W_{0i} respectively. Similarly, imagine that each worker has two potential annual fatality rates (annual probability of death), one if employed in coal, one if employed in steel. Call these M_{1i} and M_{0i}, and assume $M_{1i} > M_{0i}\ \forall i$.

1. Assume that all workers share the same $VSL = V$ and have full knowledge of W_{1i}, W_{0i}, M_{1i} and M_{0i}. Characterize their choice problem of which sector to work in. **(5 points)**

2. Suppose that we observe these four parameters for all i (though of course this is impossible), along with each worker's revealed (i.e., chosen) preference of which sector to work in. [Assume indifferent workers flip a coin to determine their choice of sector.] How would you use this information to bound V (that is, to place a minimum and maximum value on V)? Will we ever be able to pin down V exactly? Explain. **(5 points)**

3. Suppose for simplicity that all workers are indifferent between the two sectors, and maintain the assumption that all workers have the same VSL. For this question we only observe the *actual* earnings and fatality rates of workers in their chosen sector, and not counterfactual earnings and fatality rates. Write the simple ratio estimate of V. Is it likely to provide an unbiased estimate of V? Explain why or why not. [Hint: are steel workers similar in demographics or human capital to miners?] Offer one plausible scenario under which your proposed calculation would *underestimate* V. **(5 points)**

4. You discover that a coal mine suddenly introduced stringent safety regulations in 2000, bringing down fatality rates enormously. Data exists on fatality rates for this particular coal mine since 1990, as well as other coal mines in the area. Data also exists on mine-specific wages since 1990. How would you use this quasi-experiment to estimate the VSL? Is this estimate likely to be unbiased? **(5 points)**

5. Miners and steel workers are aware of $M_{1i} = M_1$ and $M_{0i} = M_0$ (you can assume common risk here) due to reporting by the Occupational Safety and Health Administration. But miners in Kentucky do not know that at the Upper Big Branch Mine, the mine operator has been covertly violating mine safety rules to increase profits. If you were to calculate the VSL (as in **(3)**) using wage and fatality data from the UBB Mine, would you tend to over or underestimate the VSL? **(5 points)**

6. A technological innovation in mining reduces average fatality rates by half. How would you expect this to affect $E[W_1 - W_0]$? How would you expect it to affect the VSL? **(5 points)**

7. Mine fatality rates vary greatly over time and across countries. According to Wikipedia, "In 2003, the death rate per million tons of coal mined in China was 130 times higher than in the United States, 250 times higher than in Australia (open cast mines) and 10 times higher than the Russian Federation (underground mines)...in 2007 China produced one-third of the world's coal but had four-fifths of coal fatalities."

   Provide an economic hypothesis for why mine fatality rates may be higher in China and Russia than in the U.S. and other high income countries. This explanation should assume that markets are operating efficiently in all countries. Provide a non-economic hypothesis for why mine fatality rates may be higher in China and Russia than in the U.S. and other high income countries. This explanation should not assume that markets are operating efficiently in all countries. **(5 points)**

[1] From the US Dept. of Labor: "From 1880 to 1910, mine explosions and other accidents claimed thousands of victims. The deadliest year in U.S. coal mining history was 1907, when an estimated 3,242 deaths occurred...While metal and nonmetal (non-coal) mining was less deadly than coal mining, available records for the era show that it, too, was highly hazardous...Total deaths in all types of U.S. mining, which had averaged 1,500 or more per year during earlier decades, decreased on average during the 1990s to under 100 per year, and reached historic lows of 35 total deaths in 2009 and 2012." Elsewhere, Wikipedia estimates that 1049 workers were killed in Chinese coal mines during 2013.

14.03/14.003 Microeconomic Theory and Public Policy
Fall 2025