MIT 14.41 – Problem Set 5

Due November 18, 2022
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QUESTION 1: Health economics [55 points]

Assume that each person has a probability of being hospitalized in the next year, η, and being hospitalized has medical costs of $L = 300$. For simplicity, assume that the risk types are uniformly distributed in the interval $(0,1)$, with a total mass of 1. This technical assumption implies the following:

- Individual risk types lie in the interval $[0,1]$
- The fraction of people with risk type $\eta \leq x$ is given by x, with $x \in [0,1]$
- The probability that an individual with risk type η is hospitalized is $Pr = \eta$

For example, 25% of people have less than a 25% chance of being hospitalized in the next year, 50% have less than a 50% chance of being hospitalized, etc. This is just the definition of a uniform distribution.

Each individual has a fixed income $W = 400$ and gets utility from consumption y (the price of consumption is 1), given by

$$U = \sqrt{y}$$

Finally, we will assume that an individual's risk type can be determined by a medical exam, so individuals know their own risk type.

1. (a) (1 point) Plot individual utility on a graph with utility on the vertical axis and consumption y on the horizontal axis
   (b) (5 points) What is the level of consumption and resulting utility in the case that someone is hospitalized, and the case when they are not? Label these on your plot of utility against consumption.
   (c) (3 points) What is the expected utility of an individual with risk type η? Plot this on your graph.
2. Suppose there is an insurance company that offers a policy that fully covers the cost of hospitalization. Assume the company can obtain each person's medical exam (i.e. the company knows each person's risk type).
   (a) (2 points) What is the actuarially fair premium π_η for this insurance policy, for an individual of type η?
   (b) (4 points) Calculate the utility each individual would get from purchasing insurance at the actuarially fair price. Which individuals will choose to purchase insurance?
   (c) (1 point) How much does it cost the insurance company, on average, to cover an individual of type η?
   (d) (3 points) Is it socially efficient for an individual of type η to have insurance in this case? Why or why not? Who is it socially efficient to cover? Show this visually on your graph.

Now, suppose the insurance company can no longer obtain medical exams and it can't distinguish people's types. We want to know how much an insurer will charge for a full insurance policy, and how many people will buy the policy at that price. We also want to compare this to the socially efficient outcome. To do this, we need three things, which we will collect in the following questions:

- Consumer demand for insurance
- Marginal cost of providing insurance to a fraction Q of individuals
- The average cost of providing insurance to a fraction Q of individuals

3. We begin by deriving consumer demand for insurance, as follows:
   (a) (4 points) First, what is the maximum price (aka premium) c_η that a person of type η is willing to pay for full insurance? (Hint: c_η will be a quadratic expression in terms of η).
   (b) Using willingness to pay, derive the consumer demand curve using the following:
      i. (1 point) At a price of p, who will buy insurance? Write an expression in terms of c_η and p. Label the "marginal person" (the "last" person to buy insurance at price p) to have risk equal to $\bar{\eta}$. In terms of $\bar{\eta}$, what is the price that the marginal person is willing to pay?
      ii. (1 point) What is Q, the fraction of people who buy insurance, in terms of $\bar{\eta}$?
      iii. (2 points) Use your solutions to (i) and (ii) to solve for the consumer demand curve: In other words, find $P = D(Q)$, where Q is the fraction of individuals that will purchase at price P insurance. (Again, this will be a quadratic equation).
   (c) (2 points) Plot $D(Q)$ on a new graph with P and Q on the vertical and horizontal axes, respectively.
   (d) (1 point) Which way does demand $D(Q)$ slope, and why?

4. Next, we derive the marginal cost of providing insurance as follows:
   (a) (0 points) Remind yourself of the expected cost of providing insurance to an individual of type η.
   (b) (2 points) Suppose a fraction Q of individuals purchase insurance at a given price. Label the marginal risk type η_Q and write an expression for η_Q in terms of Q.
   (c) (2 points) Use this to derive the marginal cost MC(Q) of insuring a fraction Q of individuals.
   (d) (2 points) Plot the marginal cost curve on the same graph as you plotted the demand curve above.
   (e) (1 point) What is the slope of the marginal cost curve? Why does it slope up or down?

5. Finally, we derive the average cost of providing insurance as follows:
   (a) (2 points) What is the average cost of insuring all individuals in the range $[\eta_Q, 1]$?
   (b) (2 points) Use this to derive the average cost curve $AC(Q)$ of insuring a fraction Q of individuals.
   (c) (1 point) Plot the average cost curve on the same graph as you plotted demand and marginal cost above.
   (d) (2 points) What is the slope of the average cost curve? Why does it slope up or down? How does the slope of the average cost curve relate to the marginal cost curve?

6. Now, put those pieces together to answer the following:
   (a) (4 points) Assume that there are many firms competing to offer health insurance. Therefore, the price a firm charges must equal its average cost at that price (the "zero-profit condition"). Using the demand and cost curves you derived above, compute the competitive equilibrium insurance premium $c^\star$ and quantity $q^\star$. How is this equilibrium reflected in your graph from the previous parts?

(b) (2 points) How does the competitive equilibrium differ from the socially efficient outcome? Discuss the source of the difference.

(c) (4 points) Suppose the government could give a subsidy to insurance companies for each person they insure (the same subsidy for all individuals, since the government can't identify risk types either). What is the new AC curve? How big does the subsidy need to be to move the market to the socially optimal outcome? Plot the new AC curve on your supply-demand graph.

(d) (1 point) Suggest one other policy that might help the market move towards the socially optimal outcome

QUESTION 2: Health care potpourri (T/F/U) [20 points]

For each question, indicate whether the statement is true, false, or uncertain, and explain why, using evidence we discussed in class and in the textbook where relevant.

1. (5 points) In the past 30 years, many employers have started to offer HMO insurance plans (high deductible, low premium) rather than just PPO insurance plans (low deductible, high premium). HMOs also often contract with doctors directly, paying them a fixed salary.
   Claim 1: HMOs reduce moral hazard
   Claim 2: HMOs reduce the effects of adverse selection in the health insurance market

   Please respond separately for Claim 1 and Claim 2.

2. (5 points) Linking health insurance to employment is inefficient.

3. (5 points) Optimal provision of health insurance would require that all insurance plans have first-dollar coverage, so that people are fully insured against their health costs.

4. (5 points) The individual mandate in the ACA had no effect on people who would have bought health insurance even without an individual mandate.

QUESTION 3: Government-provided healthcare [25 points]

There are two individuals in a society, a healthy person A and a sick person B. Healthcare is provided in this society not by insurance, but by a public healthcare system. Both people can use whatever quantity of healthcare services h_A, h_B they want free at the point of use, meaning that they don't pay any costs upfront for their healthcare. However, the healthcare services are funded by an equal tax on both individuals: $t = \frac{h_A+h_B}{2}$. It costs \$1 for the government to provide 1 unit of healthcare.

A's utility is given by

$$u_A = \ln(h_A) - t = \ln(h_A) - \frac{h_A + h_B}{2}$$

B gets more utility from healthcare, and his utility is given by

$$u_B = 3\ln(h_B) - t = 3\ln(h_B) - \frac{h_A + h_B}{2}$$

1. (3 points) How much healthcare will people choose to consume?

2. (3 points) What quantities of healthcare for each person maximise a utilitarian social welfare function?

3. (4 points) Are the socially optimal healthcare choices higher or lower than the individually chosen levels? Explain intuitively why this is the case.

Now suppose the government announces that people have to wait w hours per unit of healthcare they receive. Both people get disutility from waiting: the utilities of each type are now

$$u_A = \ln(h_A) - wh_A - \frac{h_A + h_B}{2}$$
$$u_B = 3\ln(h_B) - \alpha wh_B - \frac{h_A + h_B}{2}$$

Note that the two people have different disutility from waiting; if $\alpha > 1$ then B dislikes waiting more than A does, if $\alpha < 1$ then B dislikes waiting less, and if $\alpha = 1$ their disutility from waiting is equal.

4. (4 points) Find the privately optimal choices of h_A and h_B as functions of α and w.

5. (3 points) Suppose $\alpha = 1$. Can the government can set a $w > 0$ so that the individually optimal choices of healthcare will be socially optimal? If so, what is the w that achieves this? If not, explain intuitively why not.

6. (3 points) Suppose $\alpha = \frac{1}{2}$. Can the government can set a $w > 0$ so that the individually optimal choices of healthcare will be socially optimal? If so, what is the w that achieves this? If not, explain intuitively why not.

7. (5 points) When governments are providing centralized healthcare to people in this way, they can either make people wait for access to healthcare as you analysed above, or they can charge people a fee for the healthcare they use. Without doing any more math, suggest one justification for the government making people wait for healthcare, and one justification for instead charging people a fee.

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