Name: ______________________________ Section: __________

Date assigned: Thursday, 9/24
Date due: Tuesday, 9/29

Instructions:

- This problem set has 7 questions, for a total of 35 points. The number of points for each question is indicated at the start of the question.
- Please solve the questions on separate pieces of paper that are to be turned in with your name written on top, **stapled**.

1: (4 points total)

Bill's demand for Swedish Fish (private good) is $Q = 20 - 2P$, and Ted's demand is $Q = 10 - P$.

(a) Write down an equation for the social marginal benefit of the consumption of Swedish Fish if Swedish Fish are private goods. (2 points)

(b) Write down an equation for the social marginal benefit of the consumption of Swedish Fish if Swedish Fish are public goods. (2 points)

Solutions:

(a) The social marginal benefit from the Qth Swedish Fish is the willingness of society to pay for the Swedish Fish . To compute it, we first find the social demand curve for Swedish Fish by summing individual demands horizontally:

$$Q = (20 - 2P) + (10 - 3P) = 30 - 3P$$

Inverting this gives $P = 10 - \frac{Q}{3}$. The willingness of society to pay for the Qth Swedish Fish is thus $10 - \frac{Q}{3}$.

(b) For public goods, we don't add quantities horizontally; we add prices vertically. For Bill, $Q = 20 - 2P$; solving for P yields $P = 10 - 0.5Q$. For Ted, $Q = 10 - P$, so $P = 10 - Q$. Summing vertically, total

$$P = (10 - 0.5Q) + (10 - Q) = 20 - 1.5Q$$

2: (5 points total)

The citizens of Balaland used to pave 120 miles of roadways per year. After the government of Balaland began paving 100 miles of roadways per year itself, the citizens cut back their paving to 30 miles per year, for a total number of roadway miles paved per year of only 130 miles. What might be happening here?

Solution: Private paving in Balaland is partially crowded out by the public paving. On their own, Balalanders chose to pave 120 miles of road, presumably their optimal number of miles when they were bearing the cost themselves. When the government began providing 100 miles of paved roadway, Balalanders chose a new optimal quantity. That new quantity is more than the original 120 because the cost borne by them is less, but the quantity is less than the original 120 plus the government's 100 because the marginal benefit of additional paved miles declines with each additional mile that is paved. If Balalanders strongly desire the first 120 miles of paving but get no additional utility from additional miles of paving, they would have paved only an additional 20 miles after the government paved 100. This would have been complete crowding out. However, by paving 100 miles for the citizens, the Balaland government made them richer. This income effect may have increased their demand for paved road miles to 130.

3: (8 points total)

Suppose 10 people each have the demand $Q = 20 - 4P$ for streetlights and 5 people have the demand $Q = 18 - 2P$ for streetlights. The cost of building each streetlight is 3. If it is impossible to purchase a fractional number of streetlights, how many streetlights are socially optimal?

Solution: Compute the social optimum by inverting the demand curves and summing to get the social demand:

$$P = 10(5 - \frac{Q}{4}) + 5(9 - \frac{Q}{2}) = 95 - 5Q$$

Setting the result equal to the marginal cost of 3 and solving for Q gives $3 = 95 - 5Q$, or $Q = 18.4$. This indicates that the social optimum is somewhere between 18 and 19. We need to figure out whether society is better off with 18 or 19 units. To do this, we must compare the social benefits versus the social costs (i.e. find the area below the social demand and above the social cost curves – Graph this to see!). To do so, first compute the total social benefit (ignoring costs) from 18 and 19 units, respectively. This is the area underneath the social demand curve to the left of 18 and 19 units. Noting that the height of the demand curve at 18 and 19 units is $95 - 5(18) = 5$ and $95 - 5(19) = 0$, respectively, we compute

$$\text{Area under social demand to the left of 18 units}: \frac{1}{2}(95 - 5)(18) + 5(18) = 900$$

$$\text{Area under social demand to the left of 19 units}: \frac{1}{2}(95 - 0)(19) = 902.5$$

The total social cost of 18 units is $18(3) = 54$. Similarly, the total social cost of 19 units is 57. Hence, the total social surplus from 18 units is $900 - 54 = 846$, and the total social surplus from 19 units is $902.5 - 57 = 845.5$. For social welfare, 18 units is slightly better than 19 units.

4: (4 points total)

You are trying to decide where to go on vacation. In country A, your risk of death is 1 in $10,000$, and you'd pay $\$6,000$ to go on that vacation. In country B, your risk of death is 1 in $20,000$, and you'd pay $\$9,000$ to go on that vacation. Supposing that you're indifferent between these two destinations, save for the differential risk of death, what does your willingness to pay for these vacations tell you about how much you value your life?

Solution: You are willing to pay $\$3,000$ to change your risk from 0.01% to 0.005%, a change of 0.005% (or 0.00005). In this situation, you are placing a value of $\$60$million$(= \frac{3,000}{0.00005})$ on your life. But people's perceptions and valuations of risk tend to be nonlinear and dependent on other considerations than that of the risk itself. These other considerations include remoteness of the risk, familiarity or experience with the source of risk, degree of control over the risk, and salience of the dangers, so this \$60 million figure is only an approximation.

5: (4 points total)

The city of Charlotte added a new subway station in a neighborhood between two existing stations. After the station was built, the average house price increased by $\$10,000$ and the average commute time fell by 15 minutes per day. Suppose that there is one commuter per household, that the average commuter works 5 days a week, 50 weeks a year, and that the benefits of reduced commuting time apply to current and future residents forever. Assume an interest rate of 5%. Produce an estimate of the average value of time for commuters based on this information.

Solution: Letting V denote the value of an hour, the annual value of the time savings from the change can be written as (5 days/week $\times$ 50 weeks/year $\times$ 0.25 hours/day) $\times$ V, or $62.5V$ per year. The present value of $62.5V$ per year, forever, at a 5% discount rate, is $\frac{62.5V}{0.05}$. The implication of the change in house prices is that households were willing to pay $\$10,000$ to gain 15 minutes per commuting day, i.e., that the present value of the time savings is $\$10,000$. Setting $\frac{62.5V}{0.05} = 10,000$ and solving gives $V = \$8$.

6: (4 points total)

Suppose you prefer working 40 hours per week to 20 hours, and prefer working 32 hours per week to either 20 or 40 hours. However, you are forced to work either 20 hours or 40 hours per week. Is your hourly wage rate an accurate reflection of the value of your time? Explain.

Solution: Given the choice between 40 hours and 20 hours of work per week, you will choose to work 40 hours. However, because you cannot freely trade an hour of your time for the wage rate, the hourly rate does not reflect the value of your time very accurately. You would have preferred a 32-hour work week, so it must be that for the last 8 hours you work (in a 40-hour work week), your wage is less than the value of your time.

6: (6 points total)

A new public works project requires $200,000$ hours of labor to complete.

(a) Suppose the labor market is perfectly competitive and the market wage is $\$15$. What is the opportunity cost of the labor employed for the project? (2 points)

(b) Suppose that there is currently unemployment among workers, and that there are some workers who would willingly work for $\$10$ per hour. What is the opportunity cost of the labor employed? Does this vary depending on the fraction of would-be unemployed workers hired for the project? (2 points)

(c) If your answers to (a) and (b) differ, explain why. (2 points)

Solution:

(a) The workers could have earned $\$15(200,000) = \$3,000,000$ elsewhere. Since labor markets are competitive, this represents a reduction in the value the workers would have produced by working elsewhere. Hence, $\$3,000,000$ is the opportunity cost of the labor employed here.

(b) The opportunity cost for the unemployed workers is only $\$10$ per hour; for those who are employed at $\$15$, it is $\$15$ per hour. The higher the fraction of unemployed workers hired for this project, the lower the opportunity cost of labor. If half the workers are otherwise unemployed, labor costs are $\$15(100,000) + \$10(100,000) = \$2,500,000$. If 90% of the workers are otherwise unemployed, labor costs are $\$15(20,000) + \$10(180,000) = \$2,100,000$.

(c) When employed workers are shifted into the public works project, they produce \$15 less elsewhere. When unemployed workers are shifted into the public works project, there is no loss in production elsewhere. However, these workers lose the value of their leisure time, which we infer is equal to \$10 per hour from the fact that they would be willing to work for this level of wages.