

**Civil Systems Investment Planning and Pricing (12-706) /  
Quantitative Methods for Policy Analysis (19-702) /  
Economic Analysis of Private and Public Projects (73-359)**

**(Individual) Homework 3 (Due Monday Oct. 3 - 10% penalty per day late)**

Question 1 (10 pts): A persons' demand for music albums is given by:

$$q = 6 - 0.5p + 0.0001*I$$

where  $q$  is the quantity demanded at price  $p$  when their income is  $I$ . Assume initially that their income is \$40,000.

- a) At what price will demand fall to zero?
- b) If the market price for albums is \$10, how many will be demanded?
- c) At a price of \$10, what is the price elasticity for albums?
- d) At a price of \$10, what is the consumer surplus?
- e) If price rises to \$12, how much consumer surplus is lost?
- f) If income were \$60,000, what would be the consumer surplus loss from a price rise from \$10 to \$12?

Question 2 (10 pts): At the current market equilibrium, the price of a good equals \$30 and the quantity equals 10 units. At this equilibrium, the price elasticity of supply is 1.5. Assume that the supply schedule is linear.

- a) Use the price elasticity and equilibrium to find the supply schedule. [Hint: the supply schedule has the form:  $q=a+(\Delta q/\Delta p)p$ ]
- b) Calculate the producer surplus in the market.
- c) Imagine a policy that causes the price to fall to \$20. What is the change in producer surplus?

Question 3 (15 pts): On the website (link "HW 3 data") is a summary of data pertaining to the electricity costs and use of buildings at CMU for 2001. There are columns for the annual amount of electricity consumed (in kilowatt-hours) as well as the cost per year of that consumption. There is also a column for building size in square feet. This data is also on the course website.

- a) Given this data, estimate **one linear and one non-linear** demand function for campus electricity. (Note: the form of the function is your decision, as well as the estimation method. Please describe your assumptions and methods, and submit evidence of the work and model. **Make sure your demand function is like those we have done in class, i.e. price on y-axis**).
- b) Using these new demand functions, assume they are relevant for colleges in Pittsburgh. Assuming a price of 6 cents per kilowatt-hour, forecast the quantity of electricity demanded with both of your demand functions.
- c) If the price increases to 6.5 cents per kilowatt-hour, forecast the change in revenue and user benefit from your linear model only.
- d) How confident are you in the results above to use them for planning purposes? What additional data would be helpful to make a better model?

Question 4 (15 pts):

The US Army Corps of Engineers seems to be getting a lot of questions after Hurricane Katrina about why they did not spend more for flood control and the levee system in New Orleans. One representative was quoted as saying “we did a benefit-cost analysis and it did not justify upgrading the system for a Category 5 hurricane.”

I searched very hard in the last few weeks for a copy of this analysis, but could not find it (I think I know why). So let's think about what the benefit-cost analysis might have looked like. Assume that it estimated construction costs of upgrading the levee system around New Orleans at about \$10 billion. It estimated benefits at \$400 million per year and used a 5% social discount rate.

- a) Assuming the construction costs are paid in year 0, how many years would it be until the levee investment became worthwhile?
- b) A more likely scenario for the report would have been an estimate of catastrophic damage from a Category 5 hurricane of \$20 billion, happening once in 50 years. Reconsider your model from part (a) with this new information. How does your answer change?
- c) Do a sensitivity analysis on parts (a) and (b). Make sure that you at least answer the following:
  - a. What would the values of the three key variables have to change to in order for your answer to change?
  - b. Which of the three variables is most sensitive for your model?
- d) Assuming that their benefit-cost analysis was structured as we discussed above which of the assumptions was probably most in error that led to the catastrophic results?