

**Civil Systems Investment Planning and Pricing (12-706) /
Quantitative Methods for Policy Analysis (19-702) /**

(Individual) Homework 3 (Due October 10th - 10% penalty per day late)

Question 1 (5 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) If the market price for albums is \$10, how many will be demanded?
- b) At a price of \$10, what is the price elasticity for albums?
- c) At a price of \$10, what is the consumer surplus?
- d) If price rises to \$12, how much consumer surplus is lost?
- e) If income were \$60,000, what would be the consumer surplus loss from a price rise from \$10 to \$12?

Question 2 (5 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 (10 pts): On the website (link "PS 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 for the year of that consumption. There is also a column for building size in square feet.

- a) Given this data, estimate **one linear and one non-linear** demand function for campus building electricity. How good are your demand functions? (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) 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 (8 pts): Consider the market for highway use where there are costs of operating and maintaining the highways, and demand for using the highway (i.e., driving). In addition to the costs above, there are also social costs that happen in the market (e.g., vehicle emissions, safety, etc.). Assume the demand function is $q = 12 - 0.5p$. The marginal private cost is $p = q$.

- a) What is the initial equilibrium and social surplus?
- b) If the marginal social costs are double the private costs at all quantities, what is society's total willingness to pay to remove the social costs at the initial equilibrium?
- c) What is the socially optimal equilibrium? At the socially optimal equilibrium, what tax would be needed to remove the social costs?
- d) If a tax of \$6 is implemented, what would be the net social benefit?

Question 5 (12 pts): The Western Pennsylvania Maglev Development Corporation (WPMDC) – a public agency - proposes the construction of several parking garages in the downtown area. These garages will be linked by a low-speed magnetic levitation (Maglev) transit system. In such a system, the transit vehicle actually "floats" 2 inches above the track surface, supported by a superconductive process. The actual "track" will be built 20 feet above the ground.

Part A of the plan calls for the construction of a 5,000 space parking garage near Mellon Arena with a Maglev train connecting the garage to highly-used Grant Street. WPMDC plans to charge no fare for riding the Maglev vehicle, regardless of whether or not you park in their garage. Of course, daily and/or monthly fees will be charged for parking. They note a need for additional convenient parking for weekday commuters and the approximately 137 evening events per year at the Civic Arena (mostly hockey games and music concerts). WPMDC believes that the revenues from parking will be able to cover the costs of building both the parking garage and the Maglev over time.

a) Using the following "Base Case" information for the proposed project, calculate the NPV for the first 10 years of operating the garage. Assume that the garage will be completed and used in three phases, with the first completed portion of the garage available for parking starting January 1 of year 1, and remaining portions at the starts of subsequent years. Assume the money is in hand and does not need to be borrowed, and that the capacity utilization is equal for daily and event parking, and that the garage is otherwise closed on weekends.

Hint: I suggest you use Excel, especially the add-ins demonstrated in class, to solve this problem. If you do this, make sure you submit printouts of your results as well as your cell formulas (you can display/print cell formulas in Excel by typing "CTRL- ~" (tilde). Please do not forget that a printout of a graph is not an answer – you need to do analysis.

Base Case Assumptions	
Cost Items	Amount
Labor - Annual (security, toll collectors, etc.)	\$473,500
Operating & Maintenance (O&M) - Year 1 (1/3 complete, no Maglev)	\$790,000
O&M - Year 2 (2/3 garage completed, Maglev completed)	\$1,580,000
O&M - Years 3 onward (garage and Maglev complete)	\$2,370,000
Construction Cost (each year 1 through 3, at beginning of year)	\$50,000,000
Revenue Items	Amount
Daily Fees	\$10
Event Fees	\$7.50
Other	Amount
Percent of Spaces Occupied	80%
Discount Rate	7%
Time Horizon	10 years

b) How sensitive is your model to the inputs above? Justify relevant sensitivity analysis ranges of AT MOST $\pm 50\%$. Which is the most sensitive input?

c) Would you recommend that this project be done given your findings?

d) Does increasing the time horizon change your answer for part (a)? If so, how many years?

Question 6 (10 pts): Read the *Pittsburgh Post-Gazette* article below about the flawed property tax assessment system in Allegheny County. Please also note the link to the graphic that accompanied it in the printed edition.

Article: <http://www.post-gazette.com/pg/06288/729864-109.stm>

Graphic: <http://www.post-gazette.com/images4/20061015assessments.gif>

Based on our lecture on information design:

- describe the various flaws you perceive in the original
- discuss ways to overcome the flaws
- improve the graphic so that it is more accessible and more clearly conveys the message in the article.

The graphic file if printed is “Actual size” – you need to make a graphic that “fits” in the same size (roughly half a sheet of paper).

You might find it worthwhile to show visuals you chose not to use as well as your final result (such as shown in class). You may or may not find MS Excel useful to help. Be creative!

