ECON 110, Prof. Hogendorn

Problem Set 3

1. *Healthcare.* Recently in my e-mail, I received notice of a new ar-
   ticle published in an economics journal. The article is entitled "A
   theoretical rationale for an inelastic demand for health care."

   (a) OK, you've only taken a few days' worth of economics, but
       can you provide a theoretical rationale for inelastic demand
       for health care?

   (b) Draw a supply and demand diagram for health care making
       both functions linear. Draw the diagram so that at the equi-
       librium, demand is inelastic and supply is perfectly elastic.

   (c) If costs rose in the health care industry, show what would
       happen in your diagram, and discuss the relative size of the
       changes in the quantity and price of health care.

2. *Tokens3.* Suppose the demand for subway tokens is

   $$t(p_t) = 13.39 p_t^{-2/3}$$

   (a) Graph this demand function and show the price/quantity
       point where the price of a token is $1.50.

   (b) What is the elasticity of demand?

   (c) If the transit authority raises the price of subway tokens to
       $2.00, will revenue rise or fall in the short run? Can you jus-
       tify your answer without actually finding the new revenue?

3. *Juvenor.* You take a job at a pharmaceutical market research firm.
   On your first day, the woman in the cubicle next to you says, "You'd

better watch yourself – there was some guy from Amherst here before you, and he only lasted a week." On your desk you find some handwritten notes:

Assignment: find market equilibrium for Juvenor (drug that makes people feel younger) and find consumer surplus.

Data: demand from men: $p = 100 - .02q$, demand from women: $p = 4000q^{-1}$, supply: perfectly inelastic, $q = 1000$.

Solution:

(a) Find market demand: men+women $= 100 - .02q + 4000q^{-1}$.

(b) set equal to supply: $1000 = 100 - 0.02q + 4000q^{-1} \Rightarrow q = 4.44$

(c) Draw graph:
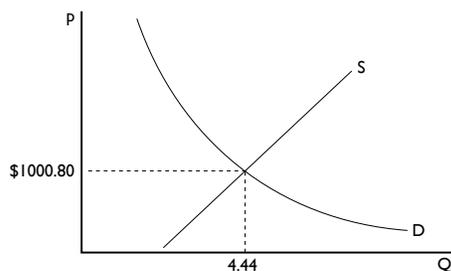
(d) Find consumer surplus: $CS = \int_0^{4.44} 100 - 0.02q + 4000q^{-1} dq$

At this point, there is some scratch work on the integral, and then a line trailing off to the lower right corner of the page. Your boss tells you that the data are correct, but you should redo each step of the solution, and explain what mistakes your predecessor made.

Review Problems only, not to turn in:

4. *Axolotls.* Suppose the market demand for axolotls, is given by the function $q = \frac{A}{p}$, where q denotes quantity demanded, p is the market price of axolotls, and A is a constant.

   (a) Graph this demand function.

   (b) Using calculus, derive an expression for the price elasticity of demand as a function of p. How does elasticity vary with the price?

   (c) For any given point on the demand function, determine the impact of changing price on consumers' total expenditure on this good.

   (d) Now suppose the demand function were instead given by $\frac{A}{p+z}$, where z is the price of zuzus, a different good. Are axolotls and zuzus substitutes or complements? Explain.

5. *Textbooks.* Suppose the market supply curve for economics textbooks is given by $s(p) = 10p$ and the market demand by $q(p) = 100 - 10p$. Derive and graph the competitive equilibrium price, quantity exchanged, and consumer and producer surplus.

6. *Five-Households.* Suppose there are 5 households, each with demand curve $q(p) = 10p^{-2}$. Derive and graph the market demand curve. What is the total consumer surplus when $p = 2$?

7. *London.* In February 2003, drivers entering central London began paying a toll of £5 to help mitigate congestion. Previously there was no toll, and about 250,000 cars entered central London each day. The toll cut traffic by 15% and the city uses the toll revenue to fund public transportation projects.

(a) Using the data above, find an approximate linear demand curve for automobile access to central London. (Hint: do not try to use elasticity to do this.)

(b) Using your demand curve, what is the approximate price elasticity of demand with the £5 toll in place?

(c) What was the price elasticity of demand without the toll? Do not use any math to answer this question.

(d) How much revenue does the toll generate? Do you know whether London could obtain more revenue by raising the toll?

Answers to Review Problems:

4. *Axolotls_a.*

(a) The graph is:

(b)
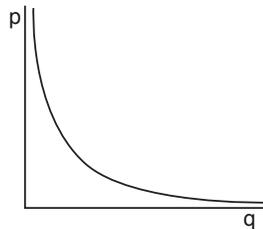
$$\varepsilon = \left| \frac{dq}{dp} \frac{p}{q} \right| = \frac{A}{p^2} \frac{p}{\frac{A}{p}} = 1$$

This is an example of a *constant elasticity demand function* along which elasticity does not vary with price. In this case, it's unit elastic along the entire curve.

(c) On this curve, total expenditure is $pq = p\frac{A}{p} = A$. Thus total expenditure on the good is A regardless of the price. This makes sense since the curve is unit elastic: total spending/revenue does not change as price changes.

(d) Suppose z increases. We find the effect on demand by taking the derivative with respect to z :

$$\frac{dq}{dz} = -\frac{A}{(p+z)^2} < 0$$

Since the derivative is negative, an increase in z reduces demand for axolotls which means the goods are complements.

5. *Textbooks_a*. Supply equals demand when $10p = 100 - 10p$, or $p = 5$. At this price, $q = 50$. The choke price is 10; thus consumer surplus is $\frac{1}{2}(10 - 5)50 = 125$. Producer surplus is $\frac{1}{2}(5 - 0)50 = 125$ as well.
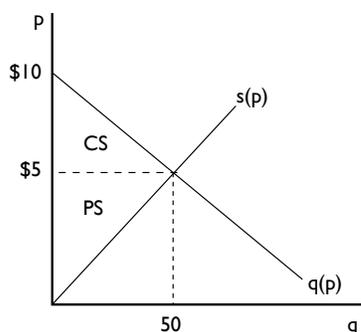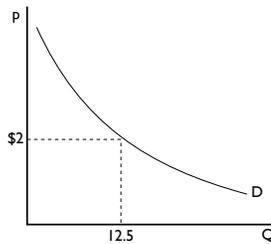

6. *Five-Households_a*. We can simply add quantities up (horizontal addition in the graph). Thus the market demand function is 5 times the individual demand function, or $q(p) = 50p^{-2}$.

To find the consumer surplus, note there is no choke price, and therefore the integral is improper. But the answer is:

$$\int_2^\infty 50p^{-2} = \lim_{t\to\infty} \int_2^t 50p^{-2} = \lim_{t\to\infty} -50t^{-1}+50{\cdot}2^{-1} = 0+25 = 25$$

The graph is:

5

7. *London_a.*

(a) The original point was $(p, q) = (0, 250000)$. Finding that 15% of 250,000 is 37,500, the new point is $(5, 212500)$. The equation for a linear demand curve that connects these points is:

$$q(p) = 250,000 - 7,500p$$

(b) $\epsilon = \left| \dfrac{dq}{dp} \dfrac{p}{q} \right| = 7,500 \dfrac{5}{212,500} = 0.16$

(c) Demand is linear, and without the toll we are at the bottom of a linear demand curve where elasticity is 0. Alternatively, if price is 0, any increase in price is an infinity percent increase, and any percent change in quantity divided by infinity is 0.

(d) The toll generates $5 \cdot 212,500 = £1,062,050$ in revenue. Since demand is inelastic at this point, increasing the toll will increase revenue.