ECON 110, Prof. Hogendorn

# Problem Set 5

1. *Lawns.* Grass lawns create a variety of negative externalities, including air and noise pollution from mowing, herbicide and pesticide pollution, water scarcity from irrigation, and destruction of woody plants and shrubs that provide better wildlife habitat and carbon sequestration. The average American household spends around $1200 per year on lawn care (obviously this varies enormously by household, but that's the average). Again using an average, there is about 1/3 acre of lawn per household (lawns are America's biggest and most polluting agricultural "crop").

   (a) Use the data point of price equals $1.2 thousands and quantity equals 0.33, and suppose that the (private) price elasticity of demand for lawn is $|\varepsilon| = 1.5$. What is a back-of-the-envelope linear demand curve for lawns? (Let $p = 1.2$, this problem is easier in thousands.)

   (b) Let the supply curve for lawns (really for lawn care products and services) be $s(p) = 0.25 + 0.067p$. What is the equilibrium price, quantity, consumer, and producer surplus from lawns?

   (c) Suppose that the negative externalities from lawn *consumption* add up to $400 per acre. What is the social demand curve $q_s(p)$?

   (d) What is the social equilibrium? How much deadweight loss is there? Calculate numerically and show on a graph.

   (e) If the government administered a Pigouvian tax by making each household pay $400 per acre of lawn, how much

tax revenue would be generated? Calculate numerically and show on a graph.

2. *Silicon Valley.* In Silicon Valley, there are many information technology (IT) firms clustered in one place. This is usually attributed to positive externalities in production: when firm produces a product, the skilled workers can exchange ideas with one another, with venture capitalists, and so on. Thus, firms in Silicon Valley are more productive than similar firms elsewhere.

   (a) Graph the supply and demand curves for one IT good (e.g. web servers) in Silicon Valley. Show the positive externality in production.

   (b) Label the graph to show the external benefits and the deadweight loss in both the free-market and the socially optimal situations.

   (c) If the California government were to intervene in this market, what should it do?

3. *Ford Toyota.* Let Ford and Toyota have two small factories, each with exactly the same production function for producing cars:

$$f(L) = 316L^{1/4}$$

Each company makes a single type of car that sells for a price of $p = \$25,000$. Each worker's annual salary is $\$62,500$. Each company makes 1000 cars per year at its factory.

   (a) What is the conditional factor demand for labor? What is the average variable cost and marginal cost of a car?

   (b) Toyota has a fixed cost of $15,000,000 at its factory. What is its operating profit and its net profit? Show the profits on a graph of price, average cost and average variable cost.

(c) Ford has the same $15,000,000 fixed cost, plus additional fixed costs of $6,000,000 due to pensions for retired employees. What is its operating profit and its net profit? Show the profits on a graph of price, average cost, and average variable cost.

(d) Assume production is fixed at 1000 cars and does not change from year to year. Toyota's factory will last for 5 years. Car prices and workers' salaries are both projected to grow at 5% per year. The production function will not change, and the same $15 million fixed cost occurs every year. The factory will have no value at all after 5 years. If the interest rate is 10%, how much is the factory worth today?

4. *Low.* Suppose a firm has cost curves $MC(q) = 0.0512q$ and $AC(q) = \frac{50}{q} + 0.0256q$. Use the first derivative of $AC$ to prove that $MC$ crosses $AC$ at the lowest point on the $AC$ curve.

# Review Problems only, not to turn in:

5. *Fatburgers.* There are 400 fatburger consumers and 100 fatburger producers. The price of a fatburger, $p$, is measured in cents. Each of the 400 consumers has demand curve

$$q_i(p) = 100 - \frac{p}{4}$$

Each producer has supply curve

$$s_i(p) = 4(p - 5)$$

(a) Determine the market supply and demand, find the equilibrium price, and draw on a graph.

(b) The government imposes a per-unit sales tax of $t$ cents per fatburger. Find the new equilibrium price and quantity as a function of $t$.

(c) Show that the government achieves the maximum possible tax revenue when it sets $t = 197.5$ cents. You will need to find and maximize the government's revenue as a function of $t$.

(d) How much does the tax in part (c) reduce consumer surplus and producer surplus, and how much deadweight loss does it cause? Show on a graph as well as giving numerical results.

(e) You have just learned that when people eat fatburgers, it causes significant long-term health problems. Much of the cost of these health problems is paid for by the government rather than the individuals. In fact, careful analysis suggests that the government ends up paying $1.975 in health costs for every fatburger eaten. Show how this information changes the graphical analysis of part (d). (Numerical results are not necessary.)

6. *GoogleStock.* Google stock recently closed at $338 per share. There are 315.29 million shares of Google stock outstanding. Net profit (or "earnings") were $4,226.86 million for 2008.

   (a) What is the market value of Google? What is the EPS (earnings per share)? What is the price/earnings ratio?

   (b) Suppose you know that all market analysts agree that the proper discount rate for Google's earnings is 10%. Which of the following is the most plausible estimate of the next three year's earnings for Google, given the information about the stock price? Explain.

      i. $6,000 million in 2009, $9,000 million in 2010, and $15,000 million in 2011

      ii. $4,800 million in 2009, $5,400 million in 2010, and $6,200 million in 2011

7. *NetAlone.* Suppose netalone.com is an Internet startup that specializes in e-business consulting. The following table summarizes the company's projected earnings in the next 5 years:

| Year | Earnings |
|------|----------|
| 2009 | 100,000 |
| 2010 | 300,000 |
| 2011 | 500,000 |
| 2012 | 700,000 |
| 2013 | 1,000,000 |

The CEO of netalone.com announced that the company was going to issue 10,000,000 shares of common stock and the IPO (initial public offering) price was set at $1 per share. (A share of stock entitles you to a share of ownership of the company, and the company's value is based on its earnings.) Suppose the market discount rate is 10%. Based on the above earnings forecast, will you buy the stock? What do you think is a more reasonable price?

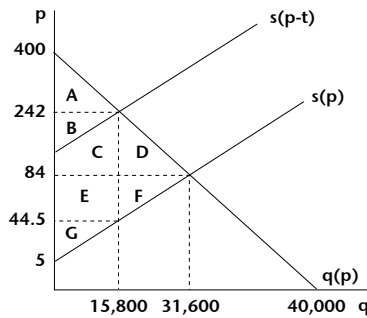## Answers to Review Problems:

6. *Fatburgers_a.*

   (a) Market demand: $q(p) = 400q_i(p) = 40,000 - 100p.$ Market supply: $s(p) = 100s_i(p) = 400(p - 5).$

$$
\begin{aligned}
40,000 - 100p &= 400(p - 5) \\
42,000 &= 500p \\
p &= 84 \\
q(84) &= 31,600
\end{aligned}
$$

P
400
242 A
B
C D
84
E F
44.5
G
5
s(p-t)
s(p)
q(p)
15,800  31,600        40,000  q

(b) This is a sales tax, so it is paid by producers and thus shifts the supply curve to $s(p-t)$ in the diagram. The new equilibrium price and quantity is found as follows:

$$
\begin{aligned}
40,000 - 100p &= 400(p - t - 5) \\
42,000 &= 500p - 400t \\
p(t) &= 84 + \frac{4}{5}t \\
q(p(t)) &= 31,600 - 80t
\end{aligned}
$$

(c) The government's revenue function is $R(t) = tq(p(t)) = 31,600t - 80t^2$. We can maximize this function by taking the derivative and setting equal to 0:

$$
\frac{dR(t)}{dt} = 31,600 - 160t = 0 \Rightarrow t^* = 197.5
$$

(d) First, using the formulas from (b) we can find that $p(197.5) = 242$ and $q(p(197.5)) = 15,800$. Then in the graph, we have the following:

$\Delta CS = -B - C - D$
$= -(242 - 84)15,800 - \frac{1}{2}(242 - 84)(31,600 - 15,800) = -3,744,600.$
$\Delta PS = -E - F$
$= -(84 - 44.5)15,800 - \frac{1}{2}(84 - 44.5)(31,600 - 15,800) = -936,150$
$DWL = D + F = \frac{1}{2}(242 - 44.5)(31,600 - 15,800) = 1,560,250$

(e) This is a very tricky question! There is actually a negative externality in *consumption* of fatburgers. That means that the

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social benefit is less than the demand curve. But we don't actually know anything about the shape of the $q_{soc}$ curve, perhaps it is some nonlinear curve like in the diagram below. All that we know is that at the $q = 15,800$ point, the negative externality is exactly equal to the sales tax.
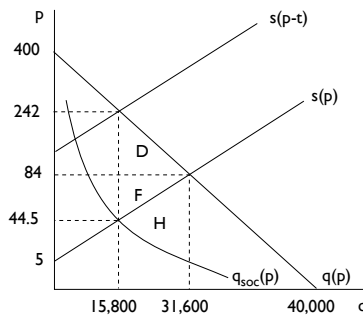


Without the tax, there would be a deadweight loss of area $H$. There would be too much consumption, and the costs $s(p)$ would exceed the benefits $q_{soc}$.

The sales tax corrects for the externality perfectly at the $q = 15,800$ point. It is not a true Pigouvian tax in the sense that if there were any shifts in the supply curve, it would no longer be optimal. But the supposed deadweight loss of $D + F$ that we found in part (d) turns out not to be a deadweight loss at all. Instead, it turns out that it was private consumer and and producer surplus that was exactly offset by the negative health externality.

7. *GoogleStock_a.*

(a) The market value is the number of shares times the price per share, or $338 \times 315.29$ million = 106,568 million, i.e. $106.6 billion.

Earnings per share are total earnings divided by the number of shares, or $4,226.86$ million $\div 315.29$ million = $13.40.

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The price/earnings ratio is then 338/13.40 = 25.2, which is very high by historical standards.

(b) The discounted present value of the two earnings streams is

    i. $\frac{6000}{1.10} + \frac{9000}{1.10^2} + \frac{15000}{1.10^3} = 24,162.28$

    ii. $\frac{4800}{1.10} + \frac{5400}{1.10^2} + \frac{6200}{1.10^3} = 13,484.60$

Dividing by the number of shares gives the 3-year DPV per share, $76.63 for (i) and $42.77 for (ii). Obviously both of these are much lower than the current share price of $338, but that price includes the additional DPV of earnings beyond the 3-year time horizon.

It seems unlikely that (ii) could be consistent with the current price unless analysts expect Google earnings to "hockey-stick" after the 3-year mark. But earnings stream (i) is about on track to add up to the current share price, so it is the most likely.

8. *NetAlone_a.*

    (a)

$$PV = \frac{100000}{1.10} + \frac{300000}{1.10^2} + \frac{500000}{1.10^3} + \frac{700000}{1.10^4} + \frac{1000000}{1.10^5} = 1813531$$

The present value of the earnings per share is thus $0.18. Paying $1 per share is too much unless there will be extremely spectacular growth after 2013. A price of $0.18 per share would be the fair value assuming that earnings beyond 2013 are not counted.