

Economics 101
Fall 2011
Homework #6
Due: 12/13/2010 in lecture

Directions: The homework will be collected in a box **before** the lecture. Please place your name, TA name and section number on top of the homework (legibly). Make sure you write your name as it appears on your ID so that you can receive the correct grade. Please remember the section number for the section **you are registered**, because you will need that number when you submit exams and homework. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!

1. Monopoly

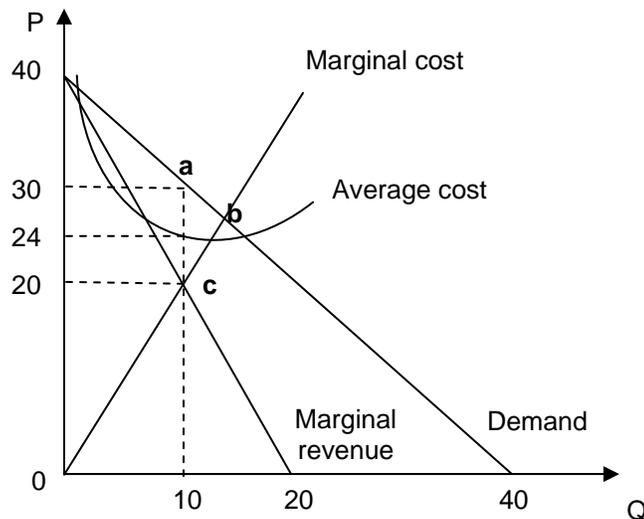
Suppose Exxon Mobile purchased every gas company in the world and set their prices. Then, it would have a control of the gas market with no other competition. Thus Exxon Mobile becomes a monopolist in providing gas. The market demand curve faced by Exxon Mobile is $P = -Q + 40$, and Exxon Mobile's cost is given by $TC=Q^2 + 14Q$, and the marginal cost is given by $MC=2Q$.

a) What is the equation for Exxon Mobile's Marginal Revenue curve?

$MR = -2Q + 40$

b) Draw the Demand Curve, Marginal Revenue Curve, Average Cost Curve and Marginal Cost Curve for this monopolist in a graph. Label your graph carefully and completely.

The graph is below



c) What is the monopolist's profit-maximizing production quantity Q_M ? What price will the monopolist charge P_M ?

Use $MR=MC$, we have $-2Q + 40 = 2Q$, and we can get $Q_M = 10$

Plug $Q_M = 10$ into demand equation, we have $P_M = -10 + 40 = \$30$

d) Compute the consumer surplus, producer surplus and profits for the monopolist.

$$CS_M = 10 \times 10 / 2 = \$50$$

$$PS_M = 10 \times 10 + 20 \times 10 / 2 = \$200$$

In order to get the profit,

First,

$$\text{Profits} = TR - TC$$

$$TR = P_M Q_M = 30 \times 10 = \$300$$

Second,

$$TC = Q^2 + 140 = 10^2 + 140 = \$240$$

Then,

$$\text{Profits} = TR - TC = \$300 - \$240 = \$60$$

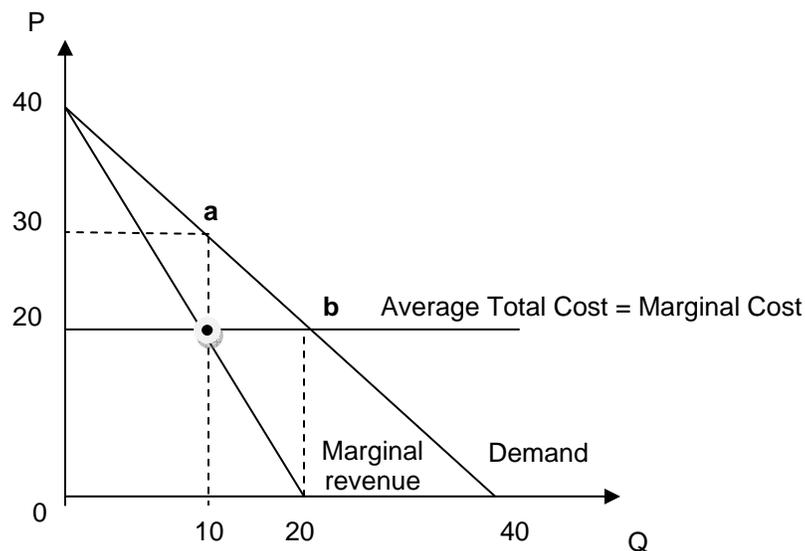
Now, suppose there is a technological change for the monopolist, and its total cost is now given by $TC = 20Q$ (no fixed cost), and its marginal cost is given by $MC = 20$.

e) What is the monopolist's profit-maximizing production quantity Q_M ? What price will the monopolist charge P_M ? Show these values in a graph.

Notice that the $ATC = MC$

Use $MR = MC$, we have $-2Q + 40 = 20$, and we can get $Q_M = 10$

Plug $Q_M = 10$ into demand equation, we have $P_M = -10 + 40 = \$30$



f) Suppose this market was a perfectly competitive market (i.e., the monopolist's demand curve is still the market demand curve, but now there are many firms providing gas for the market). Given the market is perfectly competitive, what would be the equilibrium price (P_{pc}) and quantity (Q_{pc}) in this competitive market?

The competitive market equilibrium price should satisfy $P = MC$, so $P_{pc} = \$20$

Plug $P_{pc} = 20$ into demand, we get $20 = -Q + 40$, $Q_{pc} = 20$.

g) Assume the technological change in the market is still true. What is the difference between the consumer surplus in the monopoly case and the consumer surplus in the perfect competition case?

$$CS(\text{monopoly}) = (1/2)(\$40 \text{ per unit} - \$30 \text{ per unit})(10 \text{ units}) = \$50$$

$$CS(\text{perfect competition}) = (1/2)(\$40 \text{ per unit} - \$20 \text{ per unit})(20 \text{ units}) = \$200$$

So the difference in consumer surplus is \$150 greater with perfect competition than with monopoly.

h) What is the difference between the producer surplus in the monopoly case and the producer surplus in the perfect competition case?

$$PS(\text{monopoly}) = 10 \times 10 = \$100$$

$$PS(\text{perfect competition}) = \$0$$

So the difference in producer surplus is \$100 greater with monopoly than with perfect competition.

i) What is the dead weight loss caused by the monopolist?

$$\begin{aligned} TS(\text{perfect comp.}) &= CS(\text{perfect competition}) + PS(\text{perfect competition}) \\ &= 200 + 0 = \$200 \end{aligned}$$

$$\begin{aligned} TS \text{ monopoly} &= CS(\text{monopoly}) + PS(\text{monopoly}) \\ &= 50 + 100 = \$150 \end{aligned}$$

$$DWL = [TS(\text{perfect competition})] - [TS(\text{monopoly})]$$

$$DWL = 200 - 150 = \$50$$

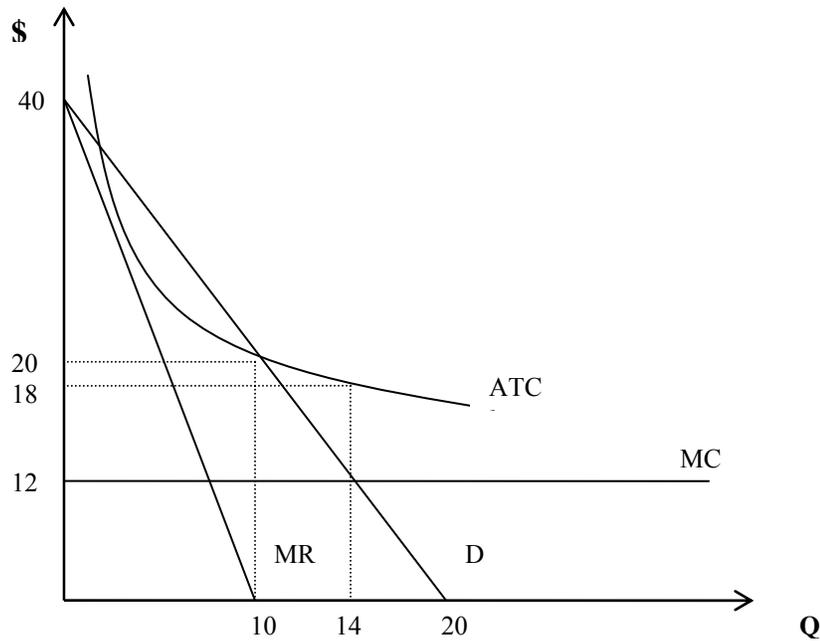
Alternatively,

$$DWL (\text{with monopoly}) = (1/2)(\$30 \text{ per unit} - \$20 \text{ per unit})(20 \text{ units} - 10 \text{ units}) = \$50$$

2. Natural monopoly

a) Suppose Madison Gas and Electric (MGE) is a natural monopoly in Madison for electricity. That is the case where one firm can produce the total quantity in a market more cheaply than multiple firms because there is a large fixed cost or economies of scale in this industry.

The Demand curve, Average Total Cost curve, Marginal Cost Curve, and Marginal Revenue Curve for this firm are shown in the picture below.



The government decides to regulate this market using marginal cost pricing. That is, the firm is told to produce that level of output where MC is equal to P for the last unit produced.

a) Identify in the graph the quantity (Q_{MC}) and price (P_{MC}) outcomes under this scheme; label it with the letter “A”. Is this regulatory scheme allocatively efficient? Why or why not?

Under this regulatory scheme the equilibrium is when $P=MC$.

$Q_{MC} = 14$ and $P_{MC} = \$12$;

The equilibrium is allocatively efficient since it maximizes the total surplus or, alternatively, because $P = MC$ for the last unit produced. Notice also that when $P = MC$ there is no deadweight loss which is another sign that the market is allocatively efficient.

b) Compute the profit of the firm. What is the minimum amount of subsidy that will be necessary in order to keep this monopolist in business?

$$TR = P_{MC} \times Q_{MC} = 12 \times 14 = \$168$$

$$TC = ATC(\text{at } Q=14) \times Q_{MC} = 18 \times 14 = \$252$$

$$\text{Profit} = TR - TC = -\$84$$

Hence, the minimum amount of subsidy that will be necessary in order to keep this monopolist in business is \$84; that is when the monopolist earns zero economic profits.

Suppose the government decides to use average cost pricing regulation. That is, the government tells the monopoly to produce that level of output where the firm earns zero economic profit.

c) Identify in the graph the equilibrium price and quantity that corresponds to this type of regulation label it with the letter “B”.

Under this regulatory scheme the equilibrium is when the monopolist gets zero profits. In the picture, the equilibrium is when Demand=ATC. Hence at this point;
 $Q_{AC} = 10$ and $P_{AC} = \$20$;

d) Is this price and output combination allocatively efficient? Why or why not?

The equilibrium is NOT allocatively efficient since it does not maximize the total surplus. Alternatively, the outcome is not allocatively efficient since P is not equal to MC for the last unit produced. In this example P is greater than MC which tells us that consumers place a higher value on the last unit produced than do suppliers: it tells us that the market is not producing enough of the output. Finally, when $P \neq MC$ we should expect there to be a deadweight loss: when the market is not allocatively efficient there will be a deadweight loss.

3. Third Degree Price discrimination

The University Book Store is the only store (hence, it is a monopoly) that sells the Krugman's book (Microeconomics) for the Econ 101 class. The staff (maybe some TAs) can only identify customers as morning class or afternoon class, but other than that they all look the same.

This monopolist faces demand from two groups of consumers.

Demand from morning class is given by: $Q_1 = 8 - P$

Demand from afternoon class is given by: $Q_2 = 12 - 2P$

The bookstore faces the following cost curves with respect to the market for selling the Krugman text (remember that the bookstore is a monopolist in this scenario):

$$TC = (1/2)Q^2 + 4$$

$$MC = Q$$

Notice that $Q = Q_1 + Q_2$

Finally, for this problem assume that the book store is able to price discriminate between the two markets.

a) Which group of customers has the more elastic demand curve?

The absolute value of the slope of the morning class, 1, is greater than the absolute value of the slope of the afternoon class, $1/2$; in other words the demand for afternoon class is flatter. Hence the demand from the afternoon class is more elastic in the sense that it is more sensitive to changes in price.

b) What is the equation for Marginal Revenue for each class of consumers?

Rewrite the demand from morning class: $P = 8 - Q_1$

MR from morning class: $MR_1 = 8 - 2Q_1$

Rewrite the demand from afternoon class: $P = 6 - (1/2)Q_2$

MR from afternoon class: $MR_2 = 6 - Q_2$

c) Assume the bookstore price discriminates between the two classes. What quantities will the monopolist sell in the two markets (the morning class market and the afternoon class market)?

The monopolist will set marginal revenue in each class equal to the (common) marginal cost. Hence, in equilibrium

$$MR_1 = 8 - 2Q_1 \text{ and } MC = Q_1 + Q_2 = Q \text{ and thus, } 8 - 2Q_1 = Q_1 + Q_2$$

$$MR_2 = 6 - Q_2 \text{ and } MC = Q_1 + Q_2 = Q \text{ and thus, } 6 - Q_2 = Q_1 + Q_2$$

This is an equation system with two equations and two unknowns. From the first equation we obtain

$$(1) \quad Q_2 = 8 - 3Q_1$$

The second equation can be written as

$$(2) \quad 6 - 2Q_2 = Q_1$$

Replacing the expression of Q_2 of equation (1) into the equation (2), we get

$$6 - 2(8 - 3Q_1) = Q_1$$

$$5Q_1 = 10$$

$$Q_1 = 2$$

Replacing $Q_1 = 2$ in equation (1), we get

$$Q_2 = 8 - 3Q_1 = 2$$

d) What price will the price discriminating monopolist charge in each market?

The equilibrium prices are found simply by plugging the equilibrium quantities into the demand functions.

For demand from morning class

$$P = 8 - Q_1 = 8 - 2 = \$6$$

For demand from afternoon class

$$P = 6 - (1/2)Q_2 = \$5$$

e) Review your answers from parts (a) and (d). Compare the prices that the two classes pay for the textbook: which class pays the higher price and is this the class with the more elastic or more inelastic demand curve?

The demand from the morning class is steeper and is therefore more inelastic than the demand curve for the afternoon class: the morning class will pay a higher price for the textbook.

f) Which class gives the monopolist the greater revenue?

$$\text{TR from morning class: } TR_1 = P_1Q_1 = 6 \times 2 = \$12$$

$$\text{TR from afternoon class: } TR_2 = P_2Q_2 = 5 \times 2 = \$10$$

g) What is the profit of the firm?

$$\text{Total Revenue: } TR = TR_1 + TR_2 = \$22$$

$$\text{Total Cost: } TC = (1/2)Q^2 + 4$$

$$Q = Q_1 + Q_2 = 2 + 2 = 4$$

$$\text{Then } TC = (1/2)4^2 + 4 = \$12$$

Note: for the total cost we replace the total production $Q (=Q_1+ Q_2)$ on the equation of TC, if we replace Q_1 at the TC_1 and Q_2 at the TC_2 , and then we add both, we will get not the same TC. (For example prove with $Q_1=2$ and $Q_2=4$).

Hence,
 Profit = TR – TC = \$10

4. Game Theory

Amy and Bill live next door and work in the same office building downtown. In the morning each of them can get to the job either by car or by bike. The only road they can use is of very poor quality, and parking is scarce. Amy and Bill are the only potential users of this road. If both go by car it would take each 15 minutes to get to their workplace. Yet, if there is just one car traveling the time goes down to 5 minutes. Traveling by bike is generally quite fast: it only takes 10 minutes if there are no cars. However the local law gives priority to the cars on the road. As a result, it takes 17 minutes to reach the destination by bike if another person decides to drive at the same time. Amy and Bill love to sleep long hours (each minute matters in the morning!), so fast commuting time is their topmost priority. Even if they agree about the mode of transportation at night, there is no way they can guarantee that the neighbor sticks to their promise in the morning.

a) Use the information above to fill in the following payoff matrix:

		Bill	
		Bike	Car
Amy	Bike	(10, 10)	(17, 5)
	Car	(5, 17)	(15, 15)

b) Is there any strictly dominant strategy for Amy? Explain your answer.

If Amy assumes Bill is going to use bike, her best option would be to get a car. If Amy assumes Bill is going to drive, she is going to drive as well. Therefore, choosing a car is her dominant strategy.

c) Is there any strictly dominant strategy for Bill? Explain your answer.

Bill's dominant strategy is to use car as well (use the same argument as above).

d) What is the equilibrium outcome in this game? Do you think this is a socially optimal outcome?

In equilibrium each player will play a dominant strategy and drive to the downtown, the equilibrium payoffs are (15,15). This is not socially optimal since both players would travel faster if both could commit to riding a bike.

5. Externality

Demand in the market for refrigerators is given by $P=100-Q$. The marginal private cost of producing refrigerators is $10+Q$. However, the use of chloroflourocarbon (CFC) in the production process creates a per unit external harm (i.e. negative externality) equal to $0.5Q$ (i.e. the level of the externality increases with the quantity produced).

a) Assume that the negative externality is currently not being corrected for in this market. What will be the unregulated market output and market price given the above information?

Use $P =$ marginal private cost (or MC) to find the unregulated market outcome. Thus, $100 - Q = 10 + Q$, solve for Q to get unregulated equilibrium quantity $Q = 45$. Plug this quantity back into either MC or demand equation to find the market equilibrium price $P = \$55$.

b) The marginal social cost (MSC) accounts for the marginal private cost of production as well as for the additional costs borne by the society. What is the MSC equation for production of refrigerators?

The marginal social cost is a sum of private cost and externality created by production, $MSC = 10 + Q + 0.5Q = 10 + 1.5Q$.

c) To achieve the socially optimal level of production the producers should make their production decisions based on the marginal social cost rather than the marginal private cost. How many refrigerators should be produced to achieve social optimum? What would be the market price?

The socially optimal output is determined by condition $MSC = P$, or $100 - Q = 10 + 1.5Q$. From this equation we find that $Q_{\text{optimal}} = 36$; $P = \$64$.

d) Suppose that the government wants to achieve the socially optimal outcome. One way to do that is for the government to impose a tax on the producers so that the firm's marginal cost increases by the amount of the negative externality. What would be the size of the tax per one unit of output? What would be the marginal cost of production after the tax?

A tax $= 0.5Q$ (equal to the externality per unit of production) should be added to the firm's marginal cost. The new marginal cost is: $MC = 10 + 1.5Q$

5. Public Good

There are two groups of consumers in the economy that have a demand for national defense which is a public good. Because the two groups have different perceptions of the actual threat to the national security, their individual demands for national defense are different. Group 1 has demand $P = 10 - Q$, and group 2 has demand $P = 8 - 2Q$. The marginal cost of providing national defense is constant and can be expressed as $MC = 9$.

a) Which two properties must be satisfied for national defense to qualify as a public good?

Public goods must be non-rival and non-excludable, both are satisfied in the case of national defense. National defense is non-rival because if one person uses it, other people's use of this good is not affected. National defense is non-excludable because once this good is provided everyone can use it even if they have not paid for the good.

b) Is there a potential for a free-rider problem in the provision of national defense?

Yes, because the good is non-excludable, there might be people who didn't pay for it but will still be able to benefit from its provision (free-riders).

c) Derive the market demand curve for national defense (HINT: The market demand for public good is a VERTICAL summation (not horizontal as is the case with private goods) of the individual demand curves. At each quantity level, we see the willingness to pay of each individual and then estimate society's total willingness to pay by adding the willingness to pay of the various individuals.).

If there is no national defense provided ($Q=0$), Group 1 is willing to pay 10 dollars, and Group 2 is willing to pay 8 dollars. Together, they are willing to pay 18 dollars. At quantity of 4, Group 2 does not want any more public good provided (it is willing to pay 0 dollars), and Group 1 is willing to pay 6 dollars. To see this, just plug $Q=4$ into demand curve of Group 1: $P=10-Q=10-4=6$. At quantity of 10, both groups are not willing to pay anything ($P=0$).

Use the information calculated above to draw market demand curve. First draw the three points (10,0), (4,6), (18,0), and then connect these points with two straight lines. You'll see that the market demand curve has a kink at point (4,6). Therefore, the **market demand curve has two parts: $P=18-3Q$ if $P \geq 6$, and $P=10-Q$ if $P < 6$** . Note: you can derive the first part from the points (0,18) and (4,6) on the graph – you see that the y-intercept is 18, and you can calculate the slope from the two points. The second part is the same as demand curve of Group 1.

d) How much public good will be provided in the market if the socially optimal amount of the public good is provided? What price will each group pay: that is, what price will the first group pay per unit of national defense and what price will the second group pay per unit of national defense? (HINT: to find the socially optimal quantity, you need to identify the point where MC intersects the market demand curve. The market price is a sum of the individual prices paid by the two groups).

Draw the MC on the graph with market demand curve ($MC=9$). You can see that MC intersects the demand curve in the upper part. $MC = \text{demand} \Rightarrow 9=18-3Q \Rightarrow 9=3Q \Rightarrow Q=3$, there will be 3 units of good provided in the market if the socially optimal amount of output is provided.

Plugging $Q=3$ into the individual demand curves, you get that Group 1 is willing to pay \$7 and Group 2 is willing to pay \$2. Therefore, the total price per unit of national defense in this market will be \$9.

e) Is the result you found in part (d) a realistic outcome? In your answer, discuss how government funds public goods.

No, the result is not realistic. This example describes an idealized situation in which we are given demand curves of both groups. However, we usually don't know individual demand curves. If people refuse to reveal how much they are willing to pay for public service, there may be free-riders claiming that they don't actually need it. The government estimates the needs for these public goods and then passes tax legislation in order to fund public goods since the government recognizes that without government intervention public goods will either not be provided by the market or too little of the good will be provided by the market due to the free rider problem.