

**Economics 101**  
**Fall 2011**  
**Homework #5**  
**Due: 12/11/2012**

**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 eligibly and neatly**; otherwise you will not receive full credit. Good luck!

**1. Monopoly**

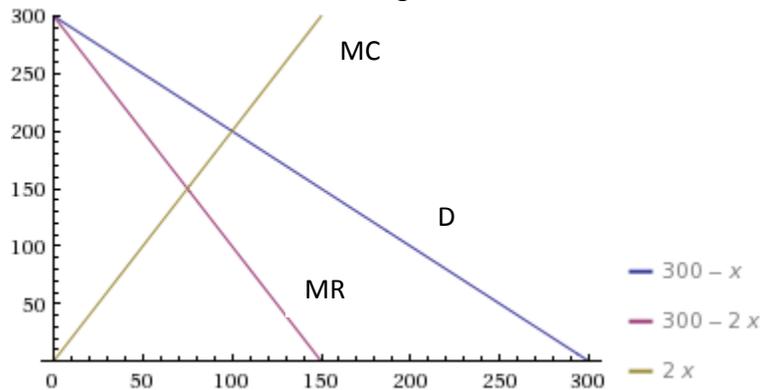
In Madison, the University owns the rights to sell Badger Soccer tickets. The costs of providing these tickets is represented by  $TC = Q^2 + 100$ . That is, each additional ticket costs  $2Q$  to the university ( $MC = 2Q$ ) and the University rents the stadium from the lease holder for \$100 per game.

The demand for Badger Soccer tickets is given by:  $P = 300 - Q$ .

- a) What is the equation for UW's Badger Soccer ticket Marginal Revenue curve?

$MR = 300 - 2Q$

- b) Draw the Demand Curve, Marginal Revenue Curve, and Marginal Cost Curve.



- c) What is the profit-maximizing production quantity of soccer tickets sold? What is the price of a Badger soccer ticket?

Profit maximizing quantity is found by setting  $MR=MC$ .  $Q = 75$ . The price charged is the maximum price consumers are willing to pay at  $Q$ .  $P = \$225$ .

- d) Compute the consumer surplus, producer surplus, DWL, and profits for the monopolist. Will the University continue to sell Badger Soccer tickets in the long run?

$CS = \$2,812.5$ ,  $PS = \$11,250$ ,  $DWL = \$937.5$ ,  $Profit = 11,250 - 100 = \$11,150$ . Yes the university will continue to sell Badger Soccer tickets in the long run.

Suppose the university is forced to behave as if there is perfect competition and charge  $P = MC$

- e) Repeat d) with this MC regulation.

$Q = 100$ ,  $P = \$200$

CS = \$5000, PS = \$10,000, DWL = \$0, Profit = \$9900. The University will continue to produce in the long run.

- f) Which regulation (No regulation, MC) do the consumers prefer? Which regulation does the University prefer? (Remember, if the university is forced to shut down or exit, surplus in the long run will be 0).

The consumers prefer MC regulation in this case because if there is MC regulation, the consumers have a higher surplus. They get more of the good at a cheaper price.

The university prefers No regulation because they make the most profits this way (assuming the university is more interested in making profits than having students attend the game which is not entirely true in the case of our own university).

## 2. Price Discrimination

MG&E is a Natural Monopoly in Madison. They supply electricity ( $Q$  = megawatts) for a price ( $P$ ) per megawatt. They have constant Marginal Costs and high fixed costs. In this case,  $TC = 10Q + 200$ .  $MC = 10$ .

There are 2 groups of consumers in the market. The first group of consumers is composed of College Students. The second group of consumers is composed of Professors.

The demand for Electricity for College students is:  $P = 110 - Q$

The demand for Electricity for Professors is:  $P = 150 - Q$

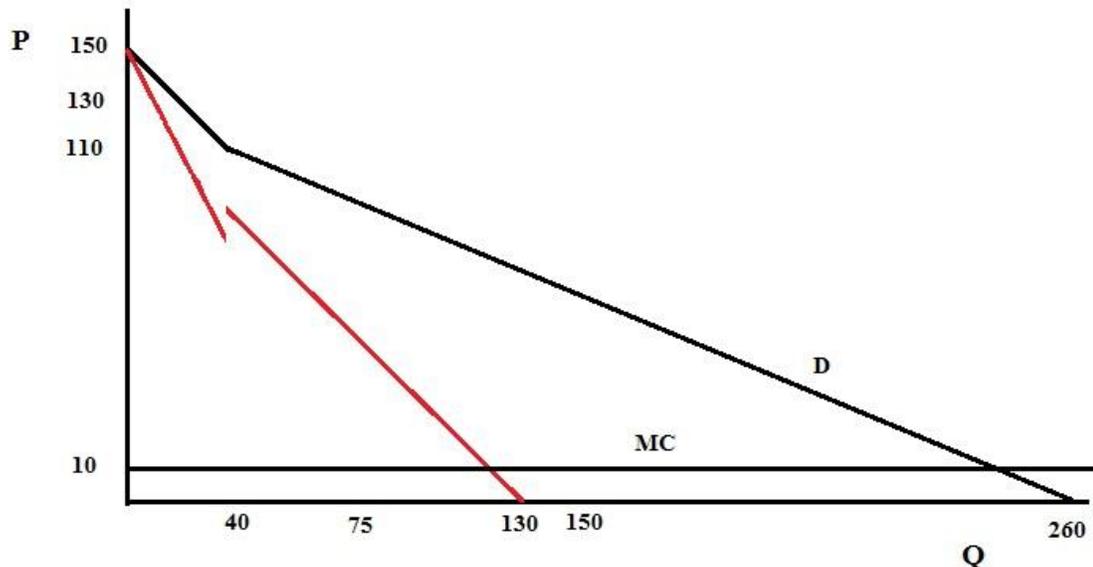
Suppose MG&E is allowed to price discriminate and charge a different price to College Students and Professors.

- a) What price and quantity of electricity will MG&E set for Students?  
Set  $MR = MC$  for the student market.  $110 - 2Q = 10$ , so  $Q = 50$ . Then plug  $Q$  into demand equation to find  $P = \$60$ .
- b) What price and quantity of electricity will MG&E set for Professors?  
Set  $MR = MC$  for the Professor market.  $150 - 2Q = 10$ , so  $Q = 70$ . Then plug  $Q$  into demand equation to find  $P = \$80$ .
- c) What are the total profits made by MG&E (remember, they only need to pay their Fixed Costs once)?  
Profits =  $TR - TC$ .  $Q_{total} = 120$ , so  $TC = 120 * 10 + 200 = \$1400$ .  $TR = 50 * 60 + 80 * 70 = \$8600$   
Profits =  $8600 - 1400 = \$6200$

The Mayor of Madison decides to step in and not allow MG&E to price discriminate. Now, MG&E can only set one price.

- d) What is the equation for the market demand that MG&E faces? (remember to write market demand with respect to quantities sold)  
We are going to horizontally sum the demand curves and so we need to write them in terms of  $Q$  first.  $Q = 110 - P$  and  $Q = 150 - P$ . Now Market demand is the sum of the  $Q$ 's so we have  $Q^{Market} = 260 - 2P$ . This gives us  $P = 130 - (1/2)Q$  for the market demand when  $Q > 40$ . We use only the professor demand curve for  $Q < 40$ .  
Thus, the market demand is:  $P = 150 - Q$  for  $Q < 40$  and  $P = 130 - (1/2)Q$  for  $Q > 40$ .

- e) Find the new marginal revenue curve for each part of the demand curve (with respect to quantity). Graph the Demand curve, Marginal Revenue curve, and Marginal Cost curve. MR for the first part of the demand curve is  $MR = 150 - Q$  for  $Q < 40$ .  $MR = 130 - Q$  for  $Q > 40$ .



- f) What price will MG&E set to maximize profits now that they can only set 1 price?  
They will set the price where  $MR = MC$  which is when  $10 = 130 - Q$ .  $Q = 120$  and then we plug that into the market demand to get  $P = \$70$ .

### 3. Public Goods

The city of Madison is looking to build some new parks in the city. The city is comprised of two types of people: college students and families. The families would really enjoy having some new parks and their demand for the new parks is given by  $P = 24 - Q$  where  $Q$  is the number of new parks and  $P$  is the price per park. The students have very little free time because their econ 101 class is so time consuming and so they are unwilling to pay very much for new parks. The students' demand for new parks is given by  $P = 12 - 3Q$ .

The total cost for a new park is given by the following:  $TC = 24Q$ . This implies that the MC of a new park is  $MC = 24$ .

- a) If the students try to free-ride off the families and not contribute to the new parks, how many new parks will be provided if only the families pay for the new parks?  
When only the families pay, we set  $MC = \text{Demand by families}$ . Thus,  $24 = 24 - Q$  or  $Q = 0$ . There will be no new parks if only the families pay for the new parks.

- b) What is the total demand for the park? To find the market demand for a park, we need to VERTICALLY sum the demand curves. You fix the size (Q) of a park and see how much in total people are willing to pay for that size.

The market demand curve for a public good is found by holding constant quantity and summing the prices that the consumers are willing to pay for this quantity of the good. Thus, if the quantity was zero, families would be willing to pay \$24 (this is a nonsense answer, but mathematically it is an easy answer to find) while students would be willing to pay \$12: together families and students would be willing to contribute \$36 for zero parks. Thus, the point (0, \$36) is on the market demand curve for the public good. Another point on the demand curve for the public good is (4, \$20): when 4 parks are provided, families are willing to contribute \$20 per park while students are willing to contribute \$0 per park for this level of parks. We can write the demand for parks as  $P = 36 - 4Q$  for quantities less than or equal to 4 parks. The market demand for parks for quantities greater than or equal to 4 parks is just the demand for parks from families: we can write this demand curve as  $P = 24 - Q$ .

- c) How much of the park will be built if both students and families contribute to the park (that is, there is no free riding)?

To answer this question you must first decide which of the demand curves is the relevant demand curve for the problem: since  $MC = 24$  this means that you want to use the demand curve  $P = 36 - 4Q$  since that is the demand curve that the MC curve intersects with in the relevant range of production. So, Demand is  $P = 36 - 4Q$  and supply is given by  $P = MC = 24$ . So  $P = 24 = 36 - 4Q$ . Solving for Q gives us  $Q = 3$  new parks.

- d) In order to implement this socially optimal outcome, you should find what each group pays to fund the quantity of new parks. How much per park do students pay and how much per park do families pay? Hint: the total contribution by students and families must equal \$24 per new park. Do you think this is a fair way to fund a public good? How do you think the government finds the willingness to pay for a public good?

If the price of the park is \$24 per new park, we find that the students fund  $P_{\text{students}} = 12 - 3Q$  and since  $Q = 3$  new parks we find that the students contribute \$3 per new park. Families contribute  $P_{\text{families}} = 24 - Q$  and since  $Q = 3$  new parks we find that the families contribute \$21 per new park.

It is up to you to decide if this is a fair way to fund a public good or not. We have families who really would enjoy the new parks paying a larger share of the cost of providing the new parks, which seems fair. But this system can lead to people undervaluing the public good in order to get out of paying for it.

The government is comprised of representatives of the people who typically get their information from their constituents in order to determine what the socially optimal amount of a public good is.

#### 4. Game Theory

Currently Bucky's Candy Canes is the only producer of candy canes in Madison, with annual profits of 3 million dollars. A new producer, Golden Gopher Novelties, is contemplating entering the market in Madison. Bucky's and Golden Gopher must decide simultaneously

(i.e., without knowing what the other firm will do) if they will sell Candy Canes in Madison next year. If Golden Gopher enters the market and Bucky's remains in the market, Bucky's will earn 1 million dollars in profits and Golden Gopher will lose 2 million dollars next year. If Golden Gopher enters the market and Bucky's leaves, Golden Gopher will lose 1 million dollars next year.

If Bucky's leaves the market, it will make 0 profits, regardless of whether Golden Gopher enters. Similarly, if Golden Gopher does not enter the market, it will make 0 profits, regardless of whether Golden Gopher remains in the market.

a) Use the information above to complete the following payoff matrix:

		Golden Gopher	
		Enter Market	Do Not Enter Market
Bucky's	Remain in Market	(1, -2)	(3, 0)
	Leave Market	(0, -1)	(0, 0)

b) Does Bucky's have a strictly dominant strategy? Explain your answer.

If Bucky's thinks that Golden Gopher is going to enter the market, its best strategy is to remain in the market. If Bucky's thinks that Golden Gopher will not enter the market, its best strategy is still to remain in the market. Thus remaining in the market is Bucky's strictly dominant strategy.

c) Does Golden Gopher have a strictly dominant strategy? Explain your answer.

If Golden Gopher thinks that Bucky's is going to remain in the market, its best strategy is to not enter the market. If it thinks that Bucky's is going to leave the market, its best strategy is also to not enter the market. Thus not entering the market is Golden Gopher's dominant strategy.

d) What is the equilibrium outcome?

Since both companies will play its dominant strategy, the equilibrium outcome is (3, 0).

## 5. Externalities

Demand for education is characterized by the following equation:  $P = 120 - 2Q$ . The marginal private cost of education is  $P = 20 + 3Q$ . Production of education also creates a per unit positive externality equal to  $Q$ .

a) Suppose that the market is currently unregulated (i.e., the positive externality is not currently being corrected for in the market). What is output and price?

Use the marginal private cost function to find the unregulated market equilibrium. Therefore, solve  $120 - 2Q = 20 + 3Q$ , which gives  $Q = 20$  and  $P = \$80$ .

- b) The marginal social cost (MSC) accounts for the marginal private cost of production as well as for the additional benefits received by the society. What is the MSC equation for production of education?

MSC is the sum of marginal private cost and the per unit externality. Thus we have  $MSC = (20 + 3Q) - Q = 20 + 2Q$ .

- c) What is the socially optimal level of output and price?

The socially optimal level of production is determined by the MSC. Therefore, we can find the socially optimal level of output by solving  $120 - 2Q = 20 + 2Q$ , which gives  $Q = 25$  and  $P = \$70$ .

- d) Suppose that the government wants to achieve the socially optimal outcome. One way to do that is for the government to subsidize producers so that the firm's marginal cost decreases by the amount of the positive externality. What subsidy per unit of output should the government impose? What is the marginal cost of production after the subsidy?

The per unit subsidy should be equal to the per unit positive externality, so it should equal  $Q$ . The marginal cost after the subsidy will be equal to the MSC, so it will be  $20 + 2Q$ .