

Economics 101
Summer 2010
Answers to Homework #5
Due Tuesday, July 13, 2010

This homework is due at the beginning of the class lecture. Make sure that your homework includes your name, section number, and is stapled. There will be no stapler at the class lecture. Submitted homework should be legible, neat, and of professional quality. Please show all necessary work and please be sure that your answer is easy to identify and find.

Monopoly

1. Suppose there is an industry that is served by a single firm: this is a monopoly. Furthermore, suppose that this firm's total cost is given by the equation $TC = 100 + Q^2 + Q$ where Q is the quantity of output produced by the firm. The firm's MC equation based upon its TC equation is $MC = 2Q + 1$. You also know that the market demand for this product is given by the equation $P = 1000 - 2Q$ where Q is the market quantity.
 - a. This monopolist is a single price monopolist. What is the monopolist's profit maximizing quantity and price in this market given this information? In your answer make sure you identify what the firm's marginal revenue (MR) curve is.

To find the monopolist's quantity and price you need to first find MR for the firm. Recall that the MR has the same y-intercept as the demand curve and its slope is twice the slope of the demand curve: hence, $MR = 1000 - 4Q$. Setting $MR = MC$ yields $1000 - 4Q = 2Q + 1$ or $Q = 166.5$ units. Plugging $Q = 166.5$ into the demand curve you find the price: $P = 1000 - 2Q = 1000 - 2(166.5) = \667 per unit.

- b. Given your answer in part (a) calculate the firm's total revenue, total cost and profit at this profit maximizing price and quantity. Is this a short-run or long-run equilibrium? Explain your answer.

From part (a) you know the monopolist's price is \$667 and its quantity is 166.5. To find the monopolist's total revenue recall that $TR = P \cdot Q$. In this example, $TR = (\$667 \text{ per unit})(166.5 \text{ units}) = \$111,055.50$. The monopolist's $TC = 100 + (166.5)^2 + (166.5) = \$27,988.75$. The monopolist's profit is equal to $TR - TC$. So, $\text{Profit} = 111,055.50 - 27,988.75 = \$83,066.75$. This could be both a short-run and a long-run equilibrium in this market since the monopolist does not face competitors and there is no assumption of free entry into the market to help eliminate that positive economic profit.

- c. Given your answer in part (b), what do you anticipate will happen in this market in the long-run?

In the long-run it is quite possible for a monopolist to continue to make positive economic profits: monopolies are characterized as markets with a

single producer and where there is no easy entry of firms. The positive economic profits will persist into the long run or until there is some type of reduction in barriers to entry or some kind of technological advancement that allows competition to affect the monopolist's position in this industry.

Strategic interactions of Duopolists

2. Ford and Lexus are competing in the market for SUV's. For simplicity assume that there are no other rivals in the SUV market. The companies are planning to introduce a new model in this fall. They need to decide whether to invest lots of money in advertisements or not. The profits of the two firms are *interdependent*. The following table describes the situation. Each row represents an action taken by Ford, and each column an action taken by Lexus. The first (second) number in parenthesis means profits for Ford (profits for Lexus respectively).

		Lexus	
		Aggressive Advertisement	Normal Advertisement
Ford	Aggressive Advertisement	(7, 7)	(12,5)
	Normal Advertisement	(5,12)	(10,10)

- a. Find the dominant strategy of each firm if the two firms do not cooperate with one another.

Dominant strategy for each firm is to run aggressive advertisement

- b. Does this dominant strategy represent a Prisoner's Dilemma? Will the firms be able to achieve the outcome (10,10)? Explain your answer.

From a, we know that (Aggressive Advertisement, Aggressive Advertisement) is the equilibrium with the equilibrium payoff of (7, 7). There is a prisoner's dilemma, as both companies could be better off by cooperating and running normal advertisement – each company would get a payoff of 10 rather than 7. However, they cannot achieve the outcome (10,10) without a binding commitment, as each player is strictly better off advertising aggressively given that the opponent advertises normally.

- c. Suppose that both firms make an agreement in advance to use normal advertisement so that both firms get 10 in profits. Why might the agreement not work?

Since both firms have dominant strategies to aggressively advertise, they don't have incentives to follow the agreement. Each has an incentive to cheat on the agreement and advertise aggressively. For example, if Lexus sticks with the agreement and advertises normally, but Ford advertises aggressively, Ford is better off by cheating (they get 12 in profits) than by following the agreement (and getting 10 in profits).

Oligopoly

3. There are only two companies producing baseball caps in Milwaukee, Mycap and Yourcap. The demand function for baseball caps in this market is $P=10-Q$. The marginal cost is constant and can be expressed as $MC(=ATC)$ is 2.

- a. The companies try to coordinate their actions and set quantity and price like a single monopolist. Once they set this profit maximizing price and quantity, the plan is to split the resulting profit equally. What is the profit of each company if they both adhere to the plan?

MR=10-2Q; setting MR=MC we get Q=4 and P=6, so total profit is $(6-2)*4= \$16$. Thus, each company's profit is $16/2= \$8$.

- b. One of the companies, Yourcap, deviates from the plan, and sets its price equal to \$4. What is the profit of Yourcap? What is the profit of Mycap? (Hint: No one wants to buy overpriced goods!)

Mycap's profit is zero since nobody wants to buy its more expensive product. Yourcap's price is \$4, so from the demand function Q=6. Thus, Yourcap's profit is $(4-2)*6= \$12$.

- c. Both companies set price equal to \$4, and then split profit equally. What is each company's profit?

Now the firms split profits from selling 6 units, so each firm's profit is $12/2= \$6$.

- d. Now the firms have two options: to charge the joint monopoly price as found in part (a), or to set their price equal to \$4. Fill in a payoff matrix that represents these choices (use the template provided below).

		Yourcap	
		Monopoly	P= \$4
Mycap	Monopoly	\$8, \$8	\$0,\$12
	P= \$4	\$12,\$0	\$6,\$6

- e. What is the dominant strategy for Mycap?

The dominant strategy for Mycap is to charge P= \$4.

- f. What is the dominant strategy for Yourcap?

The dominant strategy for Yourcap is to charge P= \$4.

- g. What is the outcome of this game?

The outcome for the game is (P= \$4, P= \$4).

h. Explain the intuition for your answer in part (g).

If any of the firms sets the monopoly price, its profit is zero since the other firm will set $P = \$4$. When the other firm sets $P = \$4$, the profit-maximizing price for the first firm is $P = \$4$. Thus, neither firm has an incentive to set the monopolistic price.

Monopolistic competition

4. Janet lives in Aberdeen and produces EcoIce, a brand of premium low-fat ice cream. The ice cream industry in Aberdeen is monopolistically competitive. In order to retain her market position and differentiate EcoIce from other products, Janet keeps introducing two new natural flavors on the second Friday of each month and offering innovative packaging. The chart below describes the demand for EcoIce at various prices. The marginal cost of producing one scoop of ice cream is \$0.40, and there are no fixed costs.

Price	Quantity demanded
\$2.00	0
\$1.60	2
\$1.20	4
\$0.80	6
\$0.40	8
\$0.00	10

a) How many scoops of ice cream should Janet produce in the short run to maximize profits? What price should she charge? (Hint, this problem will be easiest if you calculate an algebraic expression for demand, given the information in the table).

From the table we can get demand equation $P = 2 - Q/5$ and marginal revenue $MR = 2 - 2Q/5$. Set $MR = MC$ to get $Q = 4$, $P = 1.2$

b) Calculate her economic profits in the short run.

$$\text{Profit} = Q (P - ATC) = 4 * (1.2 - 0.4) = 3.2$$

c) What would be the long run price and quantity if instead this were a perfectly competitive market?

$$\text{Set } P = MC \text{ to get } P = 0.4, Q = 8$$

Since economic profits are positive, new firms are attracted to the industry. In particular, a new firm that makes ice cream from the Colorado Rocky Mountains' water, ColorIce, enters the industry and the demand for Janet's ice cream decreases by 2 units at each price.

d) Derive a new demand equation for EcoIce.

New demand equation is $Q = 8 - 5P$

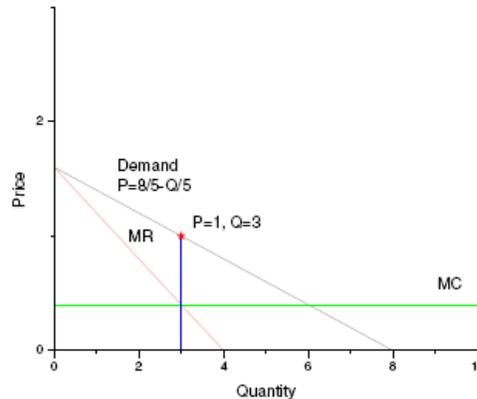
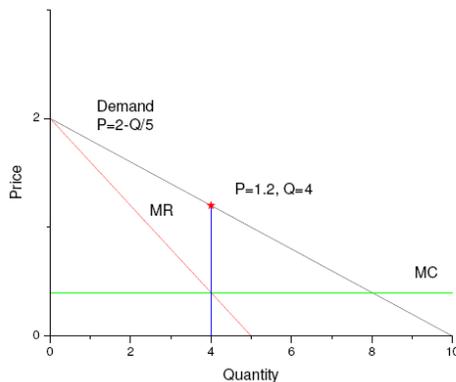
- e) According to the economic theory, what should happen to the price of EcoIce after ColorIce entered the market?

Price should fall

- f) Find Janet's new profit maximizing quantity, price, and profits.

$$MR = 8/5 - 2Q/5, \text{ from } MR = MC \text{ get } Q = 3, P = 1$$

- g) Illustrate your solution to parts (a) and (f) with a graph.



Examples of Externalities

5. For each of the following examples, state whether there are externalities (positive, negative, or none), and then explain your answer.

- a. Listening to a football game with a low quality earphone (not soundproof and quite noisy) at the same time that you are attending a class lecture.

Negative. You also distract other students from concentrating on the lecture.

- b. Asking good questions in class.

Positive. Asking good questions not only benefits the person asking the question, but also benefits everyone else in the class who may learn from both the question and the answer.

- c. Smoking in your own bedroom (suppose there is no smoke sensor in your room).

None, as long as smoking is a rational decision and you are the only one to consume the smoke and there are no health consequences. But, if there are health consequences (for

example, your decision to smoke leads to an earlier death and your five children are left destitute) then there is an externality to your smoking and it is negative.

d. The laboratory dumps toxic chemicals from its research project into Lake Mendota.

Negative. The whole community suffers the potential damage brought by the chemical.

e. The fraternity next to your dorm plays loud music, keeping you from studying.

Negative. The noise disturbs your studies while your neighbor is enjoying the loud music.

An Externality Problem

6. Watertown is a small town surrounded by many small lakes. Winters in Watertown are very cold but (for some unknown reason) people love to ice-fish on the lakes around Watertown. People travel from nearby cities to ice-fish in the winter. As a result of this influx of people too many fish are caught in the Watertown lakes. Fishing experts estimate that the external costs of this over fishing is equal to \$10 per fish caught. Suppose that the marginal private benefit (MPB) of fishing is given by the demand curve $P = 250 - Q$ and that the marginal private cost (MPC) of the fishing is given by the curve $MPC = Q$.

a. Assume that the optimal output is produced at where $P=MPC$. Find the market equilibrium price and quantity for ice-fishing.

**Answer: To find the equilibrium, set $P=250-Q$ equals to $MPC=Q$
 $250-Q=Q \rightarrow Q=125; P=\125**

b. Given your answer in part (a), what is the numerical value for the external cost from fishing?

The external cost of the fishing is equal to \$10 per fish times the number of fish being caught. The external cost of fishing is therefore equal to \$1250.

c. Given your answer in part (a), and the fact that there is an external cost that the market is not internalizing, are too many or too few fish being caught in Watertown?

Because there is an external cost that is not being accounted for in the market, too many fish are being caught in Watertown.

d. Now, suppose that there is a movement to consider the external costs of this fishing. Provide an equation that expresses the marginal social cost of fishing: this equation would be equal to the horizontal summation of the marginal private cost curve and the external cost of fishing.

The marginal social cost (MSC) of fishing is given by the equation $MSC = 10 + Q$.

e. What would the socially optimal amount of fishing be in Watertown if the external costs associated with this fishing were taken into account? To find the socially optimal amount of fishing in Watertown you will want to equate the Marginal Social Benefit to the Marginal Social Cost. In this example, the Marginal Social Benefit is equal to the Marginal Private Benefit and you have found the MSC in step (b) of this problem.

The socially optimal amount of the good is where $MSC = MSB$, or where $10 + Q = 250 - Q$. Solving for this quantity, we get $Q = 120$.

f. Given your answers in parts (a) through (e), what is the deadweight loss in the market for fishing in Watertown when the externality is not accounted for in the market?

The fishing creates a deadweight loss since the marginal social cost of the last fish being caught is greater than the marginal social benefit from catching this last fish. To find the deadweight loss you have identified the socially optimal amount of the good (120 units). Now, you need to identify the optimal price for this good: $P = 250 - Q$ or $P = 130$. Notice that since you are using the MSC curve and the demand curve to find the optimal quantity that the price in the market is now taking into account the externality cost of harvesting the fish. The net price (net of the externality cost) is 120 since \$130 per fish minus the \$10 per fish externality cost gives us \$120 per fish. Deadweight loss is thus equal to $(1/2)(\$130 \text{ per fish} - \$120 \text{ per fish})(120 \text{ fish}) = \25 .

g. What size excise tax would Watertown need to impose on the fishing market in order for the socially optimal amount of fish to be caught?

Since the external cost per fish is \$10, this is exactly the amount of excise tax that needs to be imposed to get the market to internalize the externality.

Basic Monopoly, First & Second Degree Price Discrimination

7. Suppose you know the following about an industry that is a monopoly.

$$\text{Market Demand: } P = 200 - .5Q$$

$$\text{Marginal Cost} = 40$$

There are no fixed costs

a) What is the marginal revenue curve for this monopoly?

You can find this by doubling the slope of the market demand curve, so $MR = 200 - Q$

b) Find the profit maximizing quantity for this monopolist if it charges a single price for the good.

$$\text{Set } MR = MC, \quad 200 - Q = 40, \quad Q = 160$$

c) Find the profit maximizing price for this monopolist if it charges a single price for the good.

Plus $Q = 160$ into the Market Demand Curve to find the price the monopolist can charge, which is \$120

- d) What do profits equal for this single price monopolist?

Profit = $(P - ATC)Q$. Here we don't have the ATC right away, but whenever the marginal cost curve is flat (like it is here, $MC = 40$), the MC is equal to the ATC. So, we can use this information in the profit equation to find:

$$\text{Profit} = (120 - 40)(160) = \$12800$$

- e) What is the value of consumer surplus for this single price monopolist?

$$CS = (1/2)(200-120)(160) = (1/2)(80)(160) = \$6400$$

- f) What is the value of deadweight loss for this single price monopolist? (Hint: you will want to determine the efficient quantity that should have been produced by equating marginal cost to demand first).

You can find $Q_{\text{efficient}}$ by setting the MC equal to demand. Then $200 - .5Q = 40$, and $Q_{\text{efficient}} = 320$ units. Deadweight loss is then: $(1/2)(120 - 40)(320 - 160) = (1/2)(80)(160) = \6400

Suppose now that this monopoly can perfectly price discriminate (1st degree price discrimination).

- g) What is the profit maximizing level of output for this monopolist if they practice first degree price discrimination?

The monopolist can now sell units to everyone at their maximum willingness to pay, so they will provide all 320 units.

- h) When this firm practices first degree price discrimination, what is the value of its profits?

The monopolist's profits equal \$25600, which is the entire area beneath the demand curve and above the marginal cost curve.

- i) What is the value of consumer surplus in this market when the firm practices first degree price discrimination?

The monopolist is able to extract the full consumer surplus as profits, so consumer surplus equals \$0

- j) What is the value of deadweight loss generated in this market when the firm practices first degree price discrimination?

Remarkably there is no deadweight loss, and there is allocative efficiency with a first degree price discriminating monopolist. Deadweight loss is then \$0.

Suppose now that the monopolist cannot perfectly price discriminate, and instead decides to be a 2nd degree price discriminator.

The monopolist decides to sell some units of the good at \$120, and other units of the good at \$80.

- k) How many units will the monopolist sell at \$120?

Plug \$120 into the demand curve to find that they sell 160 units

- l) How many additional units does the monopolist sell at \$80?

Plug \$80 into the demand curve to find that they sell 240 units, so there are 80 additional units being sold

- m) Calculate profits for this monopolist.

They will make some profits on the items priced at \$120 and additional profits on the items priced at \$80. Calculating profit is then:

$$\text{Profit at } \$120 = (P - ATC)Q = (120 - 40)(160) = \$12800$$

$$\text{Profit at } \$80 = (P - ATC)Q = (80 - 40)(80) = \$3200, \text{ so total profits are } \$16000$$

- n) Calculate consumer surplus in this industry.

Consumer surplus also appears in two places, once for the consumers who are buying the good at \$120, and then again for the consumers who are paying \$80.

$$\text{CS at } \$120 = (1/2)(200-120)(160) = (1/2)(80)(160) = \$6400$$

$$\text{CS at } \$80 = (1/2)(120-80)(80) = (1/2)(40)(80) = \$1600, \text{ so total consumer surplus is } \$8000$$

- o) Calculate deadweight loss in this industry when this firm practices second degree price discrimination as described in this problem.

$$\text{Deadweight loss} = (1/2)(80-40)(80) = (1/2)(40)(80) = \$1600$$

Suppose now that the monopolist decides to sell additional units at \$40.

- p) How many additional units does the monopolist sell at \$40?

Plug \$40 into the demand curve, and find that the monopolist produces 320 units. This means that the monopolist sells an additional 80 units at \$40.

- q) Calculate consumer surplus in this industry now that the monopolist is selling the good at these three different prices.

Take the consumer surplus that you found in part (n) and just add additional consumer surplus generated in part (p). Additional consumer surplus = $(1/2)(80-40)(80) = \$1600$ + Total Consumer Surplus in part (n) = $\$1600 + 8000 = \9600 .

- r) Calculate deadweight loss in this industry now that the monopolist is selling the good at these three different prices.

There is no deadweight loss remaining, so $DWL = \$0$. The monopolists last units sold were made quantity equal the efficient level of 320 units.

Public Goods

8. Suppose that there are two people, Joe and Mary, who live in a town located on a rocky seashore. Both of the individuals who live in this town are commercial fishermen and they have both run aground on dark and stormy nights. They realize that their community would benefit greatly if there was a lighthouse in their town. Joe's demand for lighthouses is given by the

equation $P = 10 - L$ where P is the price of a lighthouse and L is the quantity of lighthouses. Mary's demand for lighthouses is given by the equation $P = 5 - .5L$. The marginal cost of providing a lighthouse is equal to \$3.

a. Are lighthouses in this community nonrival? Nonrival means that more than one person can enjoy the consumption benefits of a good without diminishing the consumption benefits that are available to other people. Is this true for lighthouses? Explain your answer.

Yes, they are nonrival since one person can enjoy the good without reducing the consumption benefits that another person can enjoy from consuming the same unit of the good. When the light from a lighthouse shines out across the night sky it is available to everyone who comes within its range: my use of the light from the lighthouse does not diminish your ability to use and enjoy the same light from the lighthouse.

b. Are lighthouses in this community non-exclusive? Nonexclusive means that once the good is provided, it is possible for people to enjoy and consume the good even if they did not pay for it. Is this true for lighthouses? Explain your answer.

Yes, they are non-exclusive since one person can enjoy the good even if they do not pay for it once the good is available. Once the lighthouse has been erected and turned on, it is possible for someone to enjoy the light from the lighthouse even if they have not paid to have the lighthouse lit. The lighthouse keeper is not apt to turn off the light even though there might be a boat navigating by the light whose owner has not contributed to the cost of providing the light.

c. Are lighthouses a public good? A public good is both nonrival and nonexcludable. Does a lighthouse meet both of these criteria? Explain your answer.

Yes, a public good needs to be both nonrival and non-exclusive and lighthouses possess both characteristics.

d. What is the equation(s) for the market demand for lighthouses? To find the market demand for lighthouses you need to vertically sum the individual demand curves. We vertically sum the demand curves because the good is nonrival: my consumption of the good does not diminish your ability to consume the good. So, the question becomes one of asking how much each of us is willing to contribute towards providing the public good. To vertically sum the demand curves, hold quantity constant and ask how much each individual will pay for that amount of the good. So, for example when $Q = 1$, Joe is willing to pay \$9 while Mary is willing to pay \$4.50. Together they are willing to pay \$13.50 for 1 lighthouse. To find another point of this market demand for lighthouses consider a different quantity of the good. [Careful here: it is possible that you could get a kink in the demand curve, although in this example we have constructed an easy situation with no kink!]

$$P = 15 - (3/2)L$$

When $Q = 0$, the y-intercept for Joe's demand curve is 10, while the y-intercept for Mary's demand curve is 5. The y-intercept is thus 15. When $Q = 4$, Joe is willing to contribute \$6

per lighthouse and Mary is willing to contribute \$3, for a total contribution of \$9. Thus, you have two points on the market demand curve (0,15) and (4, 9). You can write an equation for the market demand curve given these two points.

e. What is the socially optimal number of lighthouses? The socially optimal number of lighthouses will occur where the market demand curve (found by vertically summing the individual demand curves since the good is nonrival) is equal to the MC curve.

To find the socially optimal number of lighthouses equate MC to the market demand curve. So, $3 = 15 - (3/2)L$ or $L = 8$ lighthouses.

f. If the socially optimal number of lighthouses is provided, how much will Joe pay per lighthouse and how much will Mary pay per lighthouse?

The total cost of each lighthouse is \$3 and Joe will pay \$2 per lighthouse while Mary will pay \$1 per lighthouse. To see this, use Joe and Mary's demand curves and substitute $Q = 8$ into each demand curve. Thus, Joe is willing to pay $P = 10 - L$ or $P = 10 - 8 = 2$ for each lighthouse that is produced. Similar reasoning applies to Mary: she will pay $P = 5 - (1/2)L$ or $P = \$1$ per lighthouse that is provided.