Economics 101
Summer 2016
Answers to Homework #5
Due Wednesday, June 15, 2016

**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. Late homework will not be accepted so make plans ahead of time. **Please show your work.** Good luck!
**Please realize that you are essentially creating "your brand" when you submit this homework. Do you want your homework to convey that you are competent, careful, professional? Or, do you want to convey the image that you are careless, sloppy, and less than professional. For the rest of your life you will be creating your brand: please think about what you are saying about yourself when you do any work for someone else!**

1. Suppose Jane and Lee are running for an elected position and are busy campaigning. Prior to the election the two candidates will debate several times and each candidate is considering what strategy they plan to take when their positions are questioned. One strategy is to respond with an aggressive rebuttal that defends the position that the candidate holds while a second strategy is to redirect the conversation and debate toward a new topic without addressing the issue. Both candidates have done research on the impact of these two strategies on likely voting outcomes and this is what they find. If Jane takes the aggressive rebuttal strategy while Lee simultaneously adheres to the same strategy, Jane sees her votes increase by 10 votes while Lee sees her votes increase by 8 votes. If Jane adheres to the redirect strategy while Lee adheres to the aggressive rebuttal strategy, Jane sees her votes increase by 6 votes while Lee sees her votes increase by 6 votes. If Jane adheres to the aggressive strategy while Lee adheres to the redirect strategy, Jane sees her votes increase by 7 votes while Lee sees her votes increase by 5 votes. If both candidates adhere to the redirect strategy, then both candidates see their votes increase by 5 votes each.

a) Given the above information fill in the following payoff matrix where each entry indicates the number of points won (a positive numeric value) or points lost (a negative numeric value).

Lee's Strategies

| Jane's Strategies | Aggressive Rebuttal | Redirect to New Topic |
|---|---|---|
| Aggressive Rebuttal | | |
| Redirect to New Topic | | |

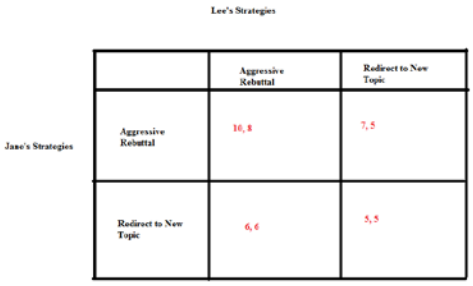
b) Examine the payoff matrix you created in (a). Does Jane have a dominant strategy? Explain your answer.

c) Examine the payoff matrix you created in (a). Does Lee have a dominant strategy? Explain your answer.

d) Suppose Jane follows her dominant strategy, can you predict what Lee will do given the above information? Explain your answer.

e) You plan to watch Jane and Lee debate each other this weekend. Describe the debate you anticipate seeing. Who do you predict will win the election given this analysis?

Answers:
a)




b) Jane's dominant strategy is to adopt an aggressive rebuttal strategy. To see this think about Jane looking at this table as two separate columns: a column where Lee plays "Aggressive Rebuttal" and a column where Lee plays "Redirect to New Topic". If Lee plays "Aggressive Rebuttal", then Jane will win 10 votes with an aggressive rebuttal and only 6 points with a redirection to a new topic. If Lee plays "Redirect to New Topic", then Jane will win 7 votes with an aggressive rebuttal and only 5 votes with a redirection to a new topic. Jane has a better outcome no matter what strategy Lee adopts if Jane adopts the "Aggressive Rebuttal" strategy.

c) Lee's dominant strategy is to adopt an aggressive rebuttal strategy. To see this think about Lee looking at this table as two separate rows: a row where Jane plays "Aggressive Rebuttal" and a row where Jane plays "Redirect to New Topic". If Jane plays "Aggressive Rebuttal", then Lee will win 8 votes with an aggressive rebuttal and only 5 votes with a redirection to a new topic. If Jane plays "Redirect to New Topic", then Lee will win 6 votes with an aggressive rebuttal and only 5 votes with a redirection to a new topic. Lee has a better outcome no matter what strategy Jane adopts if Lee adopts the "Aggressive Rebuttal" strategy.

d) If Jane follows her dominant strategy of “Aggressive Rebuttal” then the payoff matrix shows us that Lee is better off when he pursues his “Aggressive Rebuttal” strategy: he’s still losing votes relative to the number of votes that Jane is getting but his alternative scenario leaves him even further behind in vote getting.

e) At the debate you can anticipate lots of loud voices, aggressively rebuttals, and incendiary words: should make for an exciting evening although it may not be the best path to reaching consensus and negotiating the political landscape.

2. Consider two firms in an industry consisting solely of these two firms. Lane Products and Forsyth Products produce identical products. Both firms are trying to decide whether they want to offer coupons or not offer coupons. They know that when they offer coupons the other firm is hurt by this policy since they are selling identical products.

Lane Products knows that if Forsyth Products offers coupons then Lane Products will earn a profit of $200,000 for the year if it also offers coupons and a profit of $80,000 for the year if it does not offer coupons. Lane Products knows that if Forsyth Products does not offer coupons then Lane Products will earn a profit of $120,000 for the year if it offers coupons and a profit of $100,000 for the year if it does not offer coupons.

Forsyth Products knows that if Lane Products offers coupons then Forsyth Products will earn a profit of $80,000 for the year if it also offers coupons and a profit of $60,000 for the year if it does not offer coupons. Forsyth Products knows that if Lane Products does not offer coupons then Forsyth Products will earn a profit of $100,000 for the year if it offers coupons and a profit of $60,000 for the year if it does not offer coupons.

a) Given the above information, construct a payoff matrix for this situation. Put Lane Products on the left hand side of the payoff matrix and Forsyth Products on the top of the matrix. Make sure your payoff matrix identifies the strategies that each firm faces as well as the payoff from each combination of strategies.

b) Identify if these two firms have the dominant strategies and, if so, what these dominant strategies are. Explain your answer.

c) Given the above information, can you predict what these two firms will do? Explain your answer.

Answers:

a)

| | | Forsyth Products: Offers Coupons | Forsyth Products: Does Not Offer Coupons |
|---|---|---|---|
| Lane Products | Offers Coupons | $200,000; $80,000 | $120,000; $60,000 |
| Lane Products | Does Not Offer Coupons | $80,000; $100,000 | $100,000; $60,000 |

b) Lane Products has a dominant strategy of “offer coupons”: no matter what Forsyth Products does, Lane Products is better off “offering coupons”. Forsyth Products has a dominant strategy of “offer coupons”: no matter what Lane Products does, Forsyth Products is better off “offering coupons”.

c) Both firms will pursue their dominant strategies and both firms will therefore offer coupons. And, we will all have lots of paper in our mailboxes!

3. Suppose there are two firms in a market and these two firms agree to form a cartel and divide up the market evenly. The two firms know the following:

Market Demand for the Product: P = 1000 – 2Q
Marginal Cost of producing the good: MC = 200
Fixed Cost of production: FC = 0

a) What is the profit maximizing quantity and price for the cartel? Explain your answer and provide a graph of this market to illustrate your answer.

b) What are the industry profits given your answer in (a)? Show your work.

c) What is the level of production for each firm if both firms adhere to the cartel agreement? What are the profits for each firm? Explain your answer.

d) Suppose one of the firms decides to cheat on the cartel agreement and sell the product for $580 per unit. How many units can this firm sell at this price and what will be its profits when it follows this pricing strategy? Assume that the other firm does not drop its price and consumers know all prices, so the other firm sells zero units.

e) Suppose that one of the firms drops its price as described in (d), but now the other firm matches this price decrease. If the two firms continue to split the market evenly, what will the profit for each firm equal now that both firms are selling the good for $580 per unit? Explain your answer.

f) Make a payoff matrix for these two firms with each firm having a choice of charging the profit maximizing price (see (a)) or the "cheating on cartel" price of $580. Put Firm A on the left hand side of the payoff matrix and Firm B at the top of the matrix.

g) Does each firm have a dominant strategy? Explain your answer.

h) What do you predict will be the outcome of this game? Explain your answer.

i) If you apply the above logic many times to successively lower prices (e.g. $580, $560, …), what will the price eventually be?

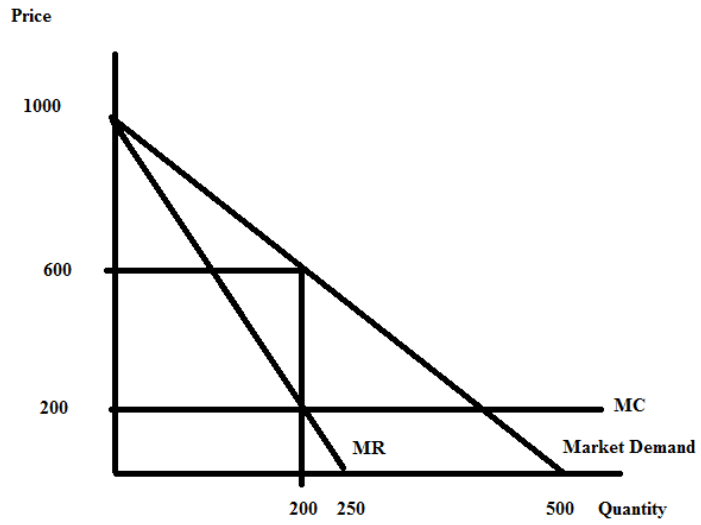
Answers:

a) The cartel will maximize its total profits by producing that quantity where MR = MC and then pricing this quantity off the market demand curve. So, we first need to find the MR curve for the cartel: MR = 1000 – 4Q. We can get this equation by remembering that for a downward sloping linear demand curve the MR curve shares the same y-intercept and has twice the slope as the demand curve. Then, set MR equal to MC:

1000 – 4Q = 200
4Q = 800
Q = 200 units

So the cartel should produce a total of 200 units: one firm will produce 100 units and the other firm will produce another 100 units since they have agreed to split the market. To find the profit maximizing price, plug this quantity into the demand curve:
P = 1000 – 2Q
P = 1000 – 2(200) = $600 per unit

Here's a graph to illustrate this answer:




b) Profits = TR – TC
TR = P*Q = ($600 per unit)(200 units) = $120,000
TC = ATC*Q = MC*Q since there are no FC
TC = ($200 per unit)(200 units) = $40,000
Profits = $80,000

c) Each firm will produce half of the total amount produced: so each firm will produce 100 units of the good. Since each firm is selling 100 units at a price of $600 per unit, each firm will earn profits of $40,000 (TR for each firm is $60,000 and TC for each firm is $20,000) or half of the total profits earned by the cartel.

d) If the price is $580 per unit, then 210 units of the good will be demanded (use the demand curve and the price of $580 per unit to find this quantity). So, the cheating firm will be the only firm selling in this market: it will sell 210 units at a price of $580 per unit. The cheating firm's profit will therefore be equal to ($580 per unit)(210 units) – ($200 per unit)(210 units) = $79,800.

e) If both firms drop their price to $580 per unit and split the market, then each firm will sell 105 units (half of the total of 210 units demanded at this price). Each firm will earn profit equal to ($580 per unit)(105 units) – ($200 per unit)(105 units) = $39,900 (or half of the $79,800).

f)

Firm B

| Firm A | | P = $600 | P = $580 |
|---|---|---|---|
| | P = $600 | $40,000; $40,000 | $0; $79,800 |
| | P = $580 | $79,800; $0 | $39,900; $39,900 |

g) Yes, each firm has a dominant strategy of cheating on the cartel price and charging $580 per unit.

We can see this from Firm A's perspective by looking at the payoff matrix as two columns: if Firm B holds to a price of $600, Firm A will earn more profit by charging a price of $580 ($79,800 versus $40,000); if Firm B goes to a price of $580, Firm A will earn more profit by charging a price of $580 ($0 versus $39,900). No matter what Firm B does, Firm A is better off charging a price of $580.

We can see this from Firm B's perspective by looking at the payoff matrix as two rows: if Firm A holds to a price of $600, Firm B will earn more profit by charging a price of $580 ($79,800 versus $40,000); if Firm A goes to a price of $580, Firm B will earn more profit by charging a price of $580 ($0 versus $39,900). No matter what Firm A does, Firm B is better off charging a price of $580.

h) Firm A and Firm B will both pursue their dominant strategies and charge a price of $580. They will make $39,900 in profit at each firm which is less than they would make if they would cooperate and adhere to the cartel agreement.

i) The same logic works for any price: if both firms charge a price above zero, charging a positive price below the current price dominates charging the current price, regardless of what the other firm does. If we apply this logic many times we see that the price must approach zero! This is known as the "Bertrand paradox": if firms are competing by choosing prices, even two firms are sufficient to drive price down to marginal cost. You can learn more about this if you take a later course in Industrial Organization.

4. Joe, Barb, and Cam live in the same community (they are the only residents) and they are debating installing some lighthouses. Thankfully each of these individuals is willing to reveal their preferences and demand for lighthouses, but the community is still trying to decide how many lighthouses they should buy. Here is the relevant information that they have gathered:

Joe's demand for lighthouses: $Q = 10 - 2P$
Barb's demand for lighthouses: $Q = 40 - 4P$
Cam's demand for lighthouses: $Q = 10 - P$
Marginal social cost of a lighthouse: $MSC = \$18$

a) Given the above information draw an illustration of these three demand curves plus the market demand curve for lighthouses. In your illustration provide four different graphs that are vertically

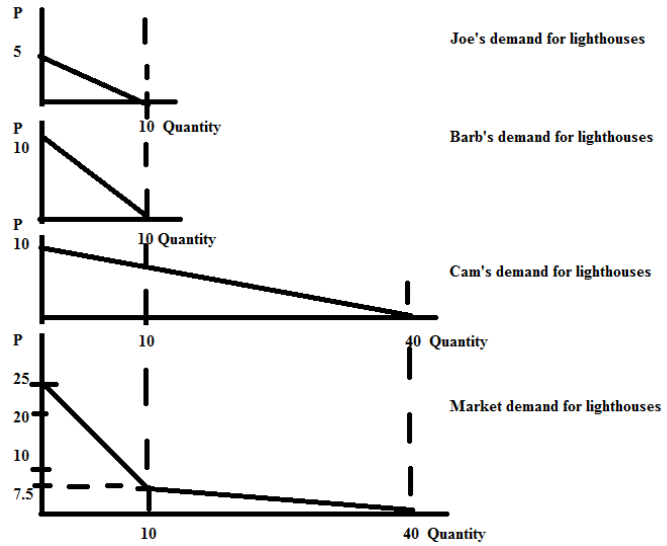
stacked with the market demand curve the bottom graph in the stack. Make sure all your graphs are clearly and completely labeled. Describe verbally how you found the market demand curve.

b) Write the equation(s) for the market demand curve and provide a range or domain for any segments of the demand curve. Show how you found these equations.

c) What is the socially optimal amount of lighthouses for this community? Explain how you found your answer. How much will Joe pay per lighthouse? How much will Barb pay per lighthouse? How much will Cam pay per lighthouse?

Answers:

a)




To find the market demand curve, we need to hold the quantity constant and then add the prices each of these individuals are willing to pay for this quantity of the good. We do this because the lighthouses are non-rival goods: that is, one person's use of the lighthouse does not diminish another person's ability to also consume this lighthouse. Thus, when the quantity is 10 units, Joe is willing to pay \$0 per lighthouse, Barb is willing to pay \$7.5 per lighthouse, and Cam is willing to pay \$0 per lighthouse: this implies that the point (Q, P) = (10, 7.5) is on the market demand curve. We can repeat this process for Q = 40 and Q = 0 to get the different end points of the market demand curve.

b) The market demand curve has two linear segments so we need two equations. For prices greater than or equal to 7.5 the market demand curve is P = 25 – (7/4)Q. For prices less than or equal to 7.5 we need to do a bit more work. First, the slope of this lower segment is equal to rise/run = (-7.5/30) = (-1/4). Then, we know that the points (Q, P) = (10, 7.5) and (40, 0) sit on this lower segment. So, use the slope-intercept form and go to work!

$y = mx + b$

$P = (-1/4)Q + b$

$0 = (-1/4)(40) + b$

$b = 10$

So, the market demand equation for the lower segment is P = 10 – (1/4)Q.

c) To find the socially optimal amount of lighthouses we need to equate the marginal social benefit curve (the market demand curve) to the marginal social cost curve. We know that MSC is given as MSC = 18. We need to use the equation for the upper segment of the market demand curve for our MSB: MSB = 25 – (7/4)Q. Thus,
18 = 25 – (7/4)Q where Q is the socially optimal quantity of lighthouses
7 = (7/4)Q
Q = 4 lighthouses = socially optimal quantity of lighthouses

Using Joe's demand curve: Q = 10 – 2P
4 = 10 – 2P
2P = 6
P = $3 per lighthouse is the amount that Joe will pay per lighthouse.

Using Barb's demand curve: Q = 40 – 4P
4 = 40 – 4P
4P = 36
P = $9 per lighthouse is the amount that Barb will pay per lighthouse.

Using Cam's demand curve: Q = 10 – P
4 = 10 – P
P = $6 per lighthouse is the amount that Cam will pay per lighthouse.

Lest you be concerned about this: notice that Joe, Barb, and Cam's contribution per lighthouse sums to $18 which is the MSC of providing an additional lighthouse. So, we will be able to collect enough money to pay for the lighthouses and all three individuals will enjoy having the socially optimal amount of lighthouses in their community.

5. Consider the market for college education in the economy of Grandville. The market demand curve for a year of college education is given by P = 50,000 – 2Q where P is the price per year of college and Q is the quantity of students attending college per year. This market demand curve expresses the marginal private benefit of going to college but does not include the social benefits derived from this education. The market supply curve for a year of college education is given by P = 2Q. This market supply curve expresses the marginal social cost of going to college. The social benefit of going to college for a year is equal to $10,000 per year per student, in addition to the private benefit that goes to the student directly.

a) Given the above description is there a negative or positive externality in this market? Explain your answer.

b) Given the above description, is this a consumption or a production externality? Explain your answer.

c) What quantity of students will attend college this year and what price will they pay given the above information? Show your work.

d) Suppose that the described externality is internalized in this market. Write the new equations we will need in order to find the socially optimal amount of college education to provide this year. Explain how you got these equations.

e) What is the socially optimal amount of college education to provide this year given the above information? What is the "right" (the one that corresponds to the socially optimal amount of the good) price for a year of college? Explain your answer.

f) What is the deadweight loss that occurs when the externality is not internalized in this market? Show your work.

Answers:
a) This is a positive externality since the economy derives extra social benefits from the education of its students.

b) This is a consumption externality. We know this because the market supply curve is the MSC of producing this good while the market demand curve is the marginal private benefit (MPB) rather than the marginal social benefit (MSB) of consuming the good.

c) We can find the market solution by equating the market supply curve to the market demand curve: thus,
$2Q = 50{,}000 - 2Q$
$4Q = 50{,}000$
$Q = 12{,}500$ college students this year will be the market outcome
$P = \$25{,}000$ per college student or
$P = 50{,}000 - 2Q = 50{,}000 - 2(12{,}500) = \$25{,}000$ per college student

d) The market supply curve does not change since this curve expresses the MSC of providing the good: Market supply curve = marginal social cost = MSC = 2Q.

The market demand curve expresses only the marginal private benefits from consuming a college education for the year. We need to add in the social benefit which is $10,000 per student per year. So, the new marginal social benefit curve (MSB) will be $P = 60{,}000 - 2Q$ (the MSB curve is effectively shifting up from the MPB by $10,000 per student).

e) Using these two equations from (d) we get:
$2Q = 60{,}000 - 2Q$ where Q is the socially optimal amount of the good
$4Q = 60{,}000$
$Q = 15{,}000$ college students per year is the socially optimal amount of the good
Note: the market, left alone, under produces this good since the market fails to take into account the social benefits derived from the consumption of this good.

$P = \$30{,}000$ or
$P = 60{,}000 - 2Q = 60{,}000 - 2(15{,}000) = \$30{,}000$

f) DWL = (1/2)($35,000 per student per year - $25,000 per student per year)(15,000 students per year – 12,500 students per year) = $25,000,000 = $25 million