SOLUTIONS
EC302 - INTERMEDIATE MICROECONOMICS
Loyola University
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Problem Set 4

1. A firm produces output q in a competitive industry that is in long run equilibrium. Now, suppose that an output tax is levied on this firm *only*, so that the firm must pay $t to the government per unit of output produced. Assume that the marginal cost of the firm is increasing in output and its average cost has the standard, "u" shape.

a. Illustrate in a diagram the effect of the tax on the firm's costs and its short run and long run supply curves.
b. Suppose that the tax is levied on all firms in this industry. Illustrate the effect of the tax on the short run equilibrium price and output in this industry.
c. In the long run, does the equilibrium industry price rise by the full amount of the tax? Why or why not?

Solution

a) Refer to the diagram presented in the text regarding this question. A verbal answer is: suppose that all firms start in long run equilibrium. The output tax raises the marginal and average variable cost curves of the firm by t. This shifts the short run supply curve upwards to SMC + t (above the new average variable cost curve, AVC + t). The firm to which the tax has been applied reduces its output and earns negative profits in the short run. If this continues to be the only firm to which the tax is applied, it will exit in the long run.

b) If the tax is levied on all firms in the industry, all firms cut back their output and the industry supply curve shifts up by t. As long as demand is downward-sloping, industry price will not rise the full amount of the tax. Equilibrium quantity falls.

c) In the long run, entry and exit occur until the minimum of the new average cost curve equals price. Since average cost has shifted up by exactly the amount of the tax, the tax will be fully passed on to consumers (we assume this is a constant cost industry).

2. Suppose $Q=K^{0.2}L^{0.8}$ If the firm is a price taker and buys its inputs at the given market price prove that total wages paid by the firm in the long run will be equal to 80% of total revenue.

Find the amount of labor that the firm will hire to maximize profit.

Solution

Firms hire labor and capital such that

$$\frac{MP_L}{MP_K} = \frac{w}{r}$$

$$\frac{0.8K}{0.2L} = \frac{w}{r}$$

You can show that this is equal to

$$4\frac{K}{L} = \frac{w}{r}$$

$$4rK = wL$$

TC = $rK + wL = rK + 4rK = 5rK$

Assuming perfect competition in the long-run

$\Pi = TR - TC = PQ - TC = PQ - 5rK = 0$

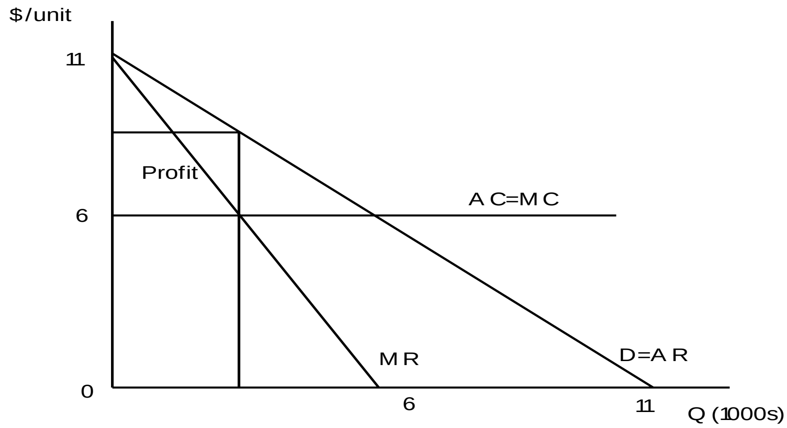
$rK = 0.2PQ$ so $wL = 0.8PQ$

3. A monopolist faces the demand curve P = 11 - Q, where P is measured in dollars per unit and Q in thousands of units. The monopolist has a constant average cost of $6 per unit.

Draw the average and marginal revenue curves, and the average and marginal cost curves. What are the monopolist's profit-maximizing price and quantity, and what is the resulting profit? Calculate the firm's degree of monopoly power using the Lerner index (look it up).

Solution:

Because demand, or average revenue (AR), can be described as P = 11 - Q, we know that the marginal revenue function is MR = 11 - 2Q. We also know that if average cost (AC) is constant, then marginal cost is constant and equal to average cost. So, MC = 6. This is graphed below.



To find the profit maximizing level of output, set marginal revenue equal to marginal cost: MR = MC or 11 - 2Q = 6. So, Q = 2.5, i.e., quantity is 2,500 units, and P = 11 - 2.5 = $8.50. Profits are equal to total revenue minus total cost,

$$\pi = TR - TC = PQ - AC(Q) \quad = (11 - Q)Q - 6Q$$
$$= (11 - 2.5)2.5 - 6(2.5) = 6.25$$

The monopolist's profits are 6.25 times $1,000. The degree of monopoly power is often represented by the Lerner index. It is defined as (P-MC)/P. In this case

$$\frac{P - MC}{P} = \frac{8.5 - 6}{8.5} = 0.294.$$

4. Fly-by night airways (FNA) fly only one route: Baltimore to Nowhereville. The demand for each flight on this route is Q = 500 - P. FNA's cost of running each flight is $30,000 (TFC) plus $100 per passenger (MC).

a) What is the profit-maximizing price FNA will charge? How many people will be on each flight? What would FNA's profit be for each flight?

b) The company accountant informs the airline that the fixed costs per flight are in fact $41,000 instead of $30,000. Will the airline stay in this business long?

c) Wait! FNA has figured out that two different types of people fly to Nowhereville. Type A is business people who have a demand of Q = 260 - (0.4)P. Type B is students whose total demand is Q = 240 - (0.6)P. The students are easy to spot, so FNA decides to charge them different prices. What price does FNA charge the students? What price does it charge the other customers? How many of each type are there on each flight?

Solution:

(a) To find the profit maximizing price, first note that $P = 500 - Q$. Total revenue is $500Q - Q^2$ and marginal revenue is $500 - 2Q$. The marginal cost of carrying one more passenger is \$100, so $MC = 100$. Setting marginal revenue to equal marginal cost, $500 - 2Q = 100$. Solving for the profit maximizing number of passengers, $Q = 200$, yielding $P = \$300$. At this price and quantity, total revenue is $300(200) = \$60{,}000$ and total cost is $30{,}000 + 200(100) = \$50{,}000$. Profit is \$10,000 per flight.

(b) If fixed cost per flight is \$41,000, FNA would lose \$1,000 on each flight. The profit maximizing price and quantity would not change because of this increase in fixed cost, if it was forced to offer some flights even if it was making losses. The revenue generated, \$60,000, would now be less than total cost, \$61,000.

c) For Type A passengers, demand is $P = 650 - 2.5(Q_A)$, implying marginal revenue of $650 - 5(Q_A)$. Setting MR = MC and solving for quantity: $Q_A = 110$ with a price of \$375. For Type B passengers, demand is $P = 400 - 1.67(Q_B)$, implying marginal revenue of $400 - 3.33(Q_B)$. Setting MR = MC and solving for a quantity: $Q_B = 90$ and a price of \$250. When FNA is able to distinguish the two groups and ensure they cannot trade with one another, FNA finds it is profit maximizing to charge a higher price to the Type A travelers, i.e., those who have a less elastic demand at any price.

5. Suppose that two identical firms produce widgets (new product) and that they are the only firms in the market. Their costs are given by $C_1 = 30Q_1$ and $C_2 = 30Q_2$, where Q_1 is the output of Firm 1 and Q_2 the output of Firm 2. Price is determined by the following demand curve:

$P = 150 - Q$ Where $Q = Q_1 + Q_2$.

Find the Cournot-Nash equilibrium. Calculate the profit of each firm at this equilibrium.

Solution: To determine the Cournot-Nash equilibrium, we first calculate the reaction function for each firm, then solve for price, quantity, and profit. Start with firm 1.

To find the reaction function, find marginal cost and marginal revenue and equate them.
From the cost function, $C(Q_1) = 30Q_1$, so we see that marginal cost is $MC = 30$. To get marginal revenue, notice that revenue is price times quantity where price is determined by the demand function $P = 150 – Q = 150 – Q_1 – Q_2$. The quantity relevant for firm 1 is Q_1. (Note that in the Cournot model, firm 1 takes the quantity of the other firm to be a fixed constant.) Thus, total revenue is given by

$TR = PQ_1 = (150 – Q_1 – Q_2) Q_1 = 150 Q_1 - Q_1^2- Q_2 Q_1$

So marginal revenue is
$MR = d(TR)/dQ_1 = 150 –2Q_1 – Q_2$

Then MR = MC leads to

$150 –2Q_1 – Q_2 = 30$ or $Q_1 = 60 – 0.5Q_2$

That last equation is firm 1's reaction curve.

Solving for firm 2's reaction function we can see that $Q_2 = 60 – 0.5 Q_1$.

The Cournot solution is found by solving these two reaction curves for the two variables, Q1 and Q2:

Substituting the second equation into the first yields
$Q_1 = 60 – 0.5Q_2 = 60 – 0.5(60 – 0.5Q_1) = 30 + 0.25Q_1$ $\quad Q_1 = 30/0.75 = 40$

You can show that $Q_2 = 40$.

Substituting Q_1 and Q_2 into the demand equation to determine the price at profit maximization:

P= 150 – 40 – 40 = $70.

Substituting the values for price and quantity into the profit function,
$\pi_1 = TR_1 – TC_1 = P Q_1 – 30Q_1 = 70(40) - 30(40) = 1600$.
$\pi_2 = TR_2 – TC_2 = P Q_2 – 30Q_2 = 70(40) - 30(40) = 1600$.

Summarizing, in the Cournot-Nash equilibrium each firm produces 40 units, the market price is 70, and each firm earns a profit of $1600.

6. Some experts have argued that there are too many brands of beverages in the market. Given an argument to support this view. Give an argument against this view.

Solution:

The argument supporting this view can be found using the model of monopolist competition. In the model in the long-run firms are not producing on the minimum points of their long-run average cost function. This implies there is excess capacity in the industry and an inefficient allocation of resource. (Refer to diagrams for monopolistic competition and discussion in text).

The argument against this statement is that the existence of monopolistic competition creates product diversity (see discussion in text).

7.

		Firm 1	
		Lease Building	Buy Building
Firm 2	Lease	F1 = 500 F2 = 500	F1 = 750 F2 = 400
	Buy	F1 = 300 F2 = 600	F1 = 600 F2 = 200

The dominant strategy for firm 1 is to buy the building, since regardless of firm 2's strategy, firm 1 is better off buying the building. Firm 2, on the other hand, is better off buying the building only if firm 1 leases; since firm 1 will not lease, firm 2 should lease. Nash equilibrium occurs when firm 1 buys and firm 2 leases, since this is the best strategy for each player given the strategy chosen by the other player.

8. The trade dispute arising between the USA and China can be looked at as a form of prisoner's dilemma. The USA's position is that China is unfair and has asked the WTO to impose tariffs on Chinese textiles. If the US wins the case China may consider retaliatory policies to close their market.

The two countries are considering policies to open or close their import markets. The payoff matrix is shown here:

	CH Open Markets	CH Close Markets
US Open Markets	50, 50	20, 20
US Close Markets	-50, 20	10, 10

a. Assume that each country knows the payoff matrix and believes that the other country will act in its own interest. Does either country have a dominant strategy? What will be the equilibrium policies if each country acts rationally to maximize its welfare?

Solution:

a) Choosing "Open" is a dominant strategy for both countries. If CN chooses Open, the US does best by choosing Open. If CN chooses Close, the US does best by choosing Open. Therefore, the US should always choose Open. Similarly for China. Both countries
will choose to have Open policies in equilibrium.

b. Now assume that China is not certain that the US will behave rationally. In particular, China is concerned that US politicians may want to penalize China even if that does not maximize US welfare. How might this affect China's choice of strategy? How might this change the equilibrium?

Solution: The irrationality of US politicians could change the equilibrium to (US Close, China Open). If the US wants to penalize China they will choose Close, but China's strategy will not be affected since choosing Open is still China's dominant strategy.