[redacted] 14-12-2021

Exam name: Microeconomics IB

Part I: Multiple Choice Questions:

Question	Answer
1	A
2	B
3	C
4	A
5	A*
6	C
7	D
8	C
9	A
10	C
11	D
12	A
13	B
14	A
15	B
16	C
17	D
18	B
19	B
20	C

Part II:

I answered questions: 2 and 3

Question 2:

Rosa sells flowers in a perfectly competitive market. Her short run total cost function is $TC = 0{,}1q^2 + 5q + 250$. ($VC = 0{,}1q^2 + 5q$ and $FC = 250$).

a) *What is the minimum price for which Rosa would be willing to participate in the market?*

I assume Rosa would only be willing to participate in the market if she can make a profit (or at least break even)

We know the $TC = 0{,}1q^2 + 5q + 250$

Thus $AC = 0{,}1q + 5 + \frac{250}{q}$

We differentiate AC to find the bottom of the AC curve and set it zero.

$$\frac{dAC}{dq} = 0{,}1 - \frac{250}{q^2} = 0$$

$$0{,}1 = \frac{250}{q^2}$$

$$0{,}1q^2 = 250$$

$$q^2 = 2500$$

$$\boldsymbol{q^* = 50}$$

Now we know she would minimize her cost at a quantity of 50. So we insert it into the AC curve, to find the minimum price.

$$AC(q^*) = 0{,}1(50) + 5 + \frac{250}{50}$$

$$AC(q^*) = 5 + 5 + 5 = 15$$

$$P = 15$$

Thus, Rosa will participate if $p > 15$, as that is when she has her costs covered.

b) *Find the equation that describes her short run supply curve. In the short run there are 20 firms in the market, what is the short run market supply curve?*

We know that for a firm in the short run, then the supply curve equals the marginal cost when it is above the AVC.

$$TC = 0{,}1q^2 + 5q + 250$$

$$MC = 0{,}2q + 5$$

$$AVC = 0{,}1q + 5$$

We can see that MC>AVC, since:

$$0{,}2q + 5 > 0{,}1q + 5$$

And thus, we can use our MC curve as supply curve for the individual firm.

In a competitive market, P=MC

$$P = 0{,}2q + 5$$

We solve for q

$$0{,}2q = P - 5$$

$$q = 5P - 25$$

This is Rosa's supply curve.

We know there are 20 firms in the market, which is $Q^S = 20 * q$

$$Q^S = 5P * 20 - 25 * 20$$

$$Q^S = 100P - 500$$

So, the short run supply curve for Rosa is $q = 5P - 25$ and the short run market supply with 20 firms in the market is $Q^S = 100P - 500$

c) *The market demand is $Q^D = 900 - 100p$. What is Q and p in market equilibrium?*

$$Q^S = Q^D$$

$$900 - 100p = 100p - 500$$

$$1400 = 200p$$

$$p^* = 7$$

To find the equilibrium quantity, we insert equilibrium price.

$$Q^* = 100(7) - 500$$

$$Q^* = 700 - 500$$

$$Q^* = 200$$

Thus, we can now conclude that the Q and p in market equilibrium is:

$\boldsymbol{Q^* = 200}$ **and** $\boldsymbol{p^* = 7}$

d) *What will Rosa's optimal production be, given the market price? What will her profits be? Will she participate in this market or will she shut down her production (explain your answer)?*

We have a competitive market, so Rosa is a price taker. Since we know her individual supply curve was $q = 5P - 25$, then we insert the price.

$$q = 5P - 25$$

$$q = 5 * 7 - 25$$

$$q = 35 - 25$$

$$q = 10$$

She would supply 10 units.

Her profits with this quantity would be:

$$\pi = R - TC$$

$$\pi = p * q - TC$$

$$\pi = 7 * 10 - (0{,}1 * 7^2 + 5 * 7 + 250)$$

$$\pi = 70 - (4{,}9 + 35 + 250)$$

$$\pi = 70 - 289{,}9$$

$$\pi = -219{,}8$$

Thus, Rosa would have a loss of 219,8 if she participates in the market.

Now, I assume that she is already in the market, since as mentioned in the start, Rosa is already producing flowers. However, to determine if she shut down or keep running, we most look at the price compared to the AVC. Assuming she already participates in the market, since that is stated by the introductory text, I understand this question as "Should she keep participating?" -And to answer that, we must look at price compared to AVC.

$$AVC = 0{,}1q + 5$$

$$AVC(q^*) = 0{,}1(10) + 5$$
$$AVC(q^*) = 6$$
$$p = 7$$

To sum up, Rosa's optimal production would be $q^* = 10$ and she would earn a loss of 219,8 in her current situation. However, because p is greater than the AVC (7 > 6), Rosa can reduce her current loss of 219,8 if she keeps producing.

e) *A shock on the demand side leads the price to increase to 25. What will Rosa's optimal quantity be, given this new price? What will her profits be? Given that the demand curve stays at this new level, do you think that the price will increase or decrease in the long run? (explain intuitively).*

With the new price, Rosa will produce at a new quantity:

$$q = 5P - 25$$
$$q = 5(25) - 25$$
$$q^* = 100$$

Her profits will be:

$$\pi = p * q - TC$$
$$\pi = 25 * 100 - (0{,}1 * 100^2 + 5 * 100 + 250)$$
$$\pi = 2500 - (1000 + 500 + 250)$$
$$\pi = 2500 - 1750$$
$$\pi = 750$$

So, to sum up, Rosa's optimal quantity will now be $q^* = 100$ and she will earn an accounting profit of 750. Given the demand curve stays at this level, I do not think the price will stay at this level. Because the firms in the market are earning a profit, more firms will enter in the long run, and that will shift the market supply curve to the right (due to more being supplied). This pushes equilibrium price down and will eventually lead the market price down to an equilibrium where no firm makes profits.

Question 3

In a small isolated town there are two burger joints: Bill's burgers and Ted's burgers. The demand for burgers is p=150-Q. Each of the burger joints has marginal cost of production = 15 dkk.

a) *If Bill and Ted simultaneously choose how many burgers they will each of them produce and what will the price of burgers be?*

We have to players in the market, and they choose quantity simultaneously; thus we have a Cournot Duopoly.

First, we find the inverse residual demand function.

$$p = 150 - q_1 - q_2$$

Then we find the MR_1 for firm 1. We know it has twice the slope as the inverse residual demand with regards to firm 1.

$$MR_1 = 150 - 2q_1 - q_2$$

We are given the Marginal cost MC_1.

$$MC = 15$$

Now we set $MR_1 = MC_1$ and solve for q_1.

$$150 - 2q_1 - q_2 = 15$$

$$135 - q_2 = 2q_1$$

$$q_1 = 67{,}5 - 0{,}5q_2$$

This is the Best response function for firm 1.

Since we have identical firms, we know that in a Cournot duopoly the two best response functions are similar. So the best response function for firm 2 is:

$$q_2 = 67{,}5 - 0{,}5q_1$$

We now insert one of them into the other, and solve to find q_1.

$$q_1 = 67{,}5 - 0{,}5(67{,}5 - 0{,}5q_1)$$

$$q_1 = 67{,}5 - 33{,}75 + 0{,}25q_1$$

$$\frac{3}{4}q_1 = 33{,}75$$

$$\boldsymbol{q_1 = 45}$$

The same can be done for firm 2:

$$q_2 = 67{,}5 - 0{,}5(45)$$

$$q_2 = 67{,}5 - 22.5$$

$$\boldsymbol{q_2 = 45}$$

When we have the quantities we can find price.

$$p = 150 - q_1 - q_2$$

$$p = 150 - 45 - 45$$

$$\boldsymbol{p = 60}$$

So, to conclude, each of the two firms produces $q_1 = q_2 = 45$ and the market price equals $p = 60$.

b) *What would be the equilibrium price and quantities if Bill was a leader in the market, i.e., he had the opportunity to choose his production before Ted?*

Now we are talking about a Stackelberg Duopoly. Firm 1 is the leader, i.e. Bill and firm 2 is the follower, i.e. Ted. Since nothing has changed with their costs or demand, we can reuse the followers Best response function.

$$q_2 = 67{,}5 - 0{,}5q_1$$

We insert it into the inverse residual demand function.

$$p = 150 - q_1 - 67{,}5 - 0{,}5q_1$$

$$p = 82{,}5 - 0{,}5q_1$$

Now we use this to find the Marginal Revenue. (Again with the twice slope trick)

$$MR_1 = 82{,}5 - q_1$$

$$MC = 15$$

$$MR = MC$$

$$82{,}5 - q_1 = 15$$

$$\boldsymbol{q_1 = 67,5}$$

Now we know how much firm 1 produces. We can insert it into the best response for firm 2.

$$q_2 = 67{,}5 - 0{,}5(67{,}5)$$

$$q_2 = 67{,}5 - 33{,}75$$

$$\boldsymbol{q_2 = 33,75}$$

When we have the quantities we can find price.

$$p = 150 - q_1 - q_2$$

$$p = 150 - 67{,}5 - 33{,}75$$

$$p = 48{,}75$$

So, to conclude, Bill produces $\boldsymbol{q_1 = 67,5}$ and Ted produces $\boldsymbol{q_2 = 33,75}$. The market price equals $\boldsymbol{p = 48,75}$.

c) *Now Bill decides to only sell vegetarian burgers. Now is costs increase such that $MC = AC = 25$ dkk, while for Ted the costs remain the same, i.e. $MC = AC = 15$ dkk. While Ted's and Bill's burgers are still quite close substitutes, they are not perfect substitutes anymore. The demand for Bill's burgers is now $q_B = 110 - 2p_B + p_T$ and the demand for Ted's burgers is $q_T = 110 - 2p_T + p_B$. They now compete by choosing their prices. How much will each of them produce, and which prices will they choose?*

Now we have a Bertrand Duopoly.

We have our two demand functions:

$$\boldsymbol{q_B = 110 - 2p_B + p_T}$$

$$\boldsymbol{q_T = 110 - 2p_T + p_B}$$

Now we need to find the profit function for Bill to get the best response function for Bill.

$$\pi = R - TC$$

$$\pi = p * q - AC * q$$

So, this means if we want to calculate profit function for Bill, it's:

$$\pi_B = p_B * q_B - AC_B * q_B$$

So, we insert what we have:

$$\pi_B = p_B(110 - 2p_B + p_T) - 25(110 - 2p_B + p_T)$$

This becomes:

$$\pi_B = 110p_B - 2p_B^2 + p_T p_B - 2750 + 50p_B - 25p_T$$

$$\pi_B = 160p_B - 2p_B^2 + p_T p_B - 2750 - 25p_T$$

To find the point where profit is maximized, we differentiate the profit function with regards to p_B and set it equal to 0.

$$\frac{d\pi_B}{dp_B} = 160 - 4p_B + p_T = 0$$

We solve:

$$160 + p_T = 4p_B$$

$$\boldsymbol{p_B = 40 + \frac{1}{4}p_T}$$

Now we have the best response function Bill's price!

We do these steps again for Ted. His demand function is:

$$q_T = 110 - 2p_T + p_B$$

$$\pi = p * q - AC * q$$

So, this means if we want to calculate profit function for Ted, it's:

$$\pi_T = p_T * q_T - AC_T * q_T$$

So, we insert what we have:

$$\pi_T = p_T(110 - 2p_T + p_B) - 15(110 - 2p_T + p_B)$$

This becomes:

$$\pi_T = 110p_T - 2p_T^2 + p_T p_B - 1650 + 30p_T - 15p_B$$

$$\pi_T = 140p_T - 2p_T^2 + p_T p_B - 1650 - 15p_B$$

To find the point where profit is maximized, we differentiate the profit function with regards to p_T and set it equal to 0.

$$\frac{d\pi_T}{dp_T} = 140 - 4p_T + p_B = 0$$

We solve:

$$140 + p_B = 4p_T$$

$$\boldsymbol{p_T = 35 + \frac{1}{4} p_B}$$

Now we also have the best response function for Ted's price, thus we know both best responses.

We insert p_T into the best respond function for p_B. That way we can calculate p_B

$$p_B = 40 + \frac{1}{4} p_T$$

$$p_B = 40 + \frac{1}{4}(35 + \frac{1}{4} p_B)$$

$$p_B = 40 + 8{,}75 + \frac{1}{16} p_B$$

$$p_B = 48{,}75 + \frac{1}{16} p_B$$

$$\frac{15}{16} p_B = 48{,}75$$

$$\boldsymbol{p_B = 52}$$

We now insert p_B into the best respond function for p_T and calculate p_T.

$$p_T = 35 + \frac{1}{4} p_B$$

$$p_T = 35 + \frac{1}{4}(52)$$

$$p_T = 35 + 13$$

$$\boldsymbol{p_T = 48}$$

Now we know the prices each firm charges.

To find quantities, we insert the prices in each of the two demand functions we were given at the start, and this way we can calculate the demand for each good.

$$q_B = 110 - 2p_B + p_T$$

$$q_B = 110 - 2(52) + 48$$

$$q_B = 110 - 104 + 48$$

$$\boldsymbol{q_B = 54}$$

$$q_T = 110 - 2p_T + p_B$$

$$q_T = 110 - 2(48) + 52$$

$$q_T = 110 - 96 + 52$$

$$\boldsymbol{q_T = 66}$$

Now we know the two equilibrium quantities: Bill will produce $q_B = 54$ and Ted will produce $q_T = 66$. Their market prices are $p_B = 52$ for Bill and $p_T = 48$ for Ted.

d) *Both Ted and Bill are thinking about how they can increase their share of the market. They have different strategies in mind: Bill is considering opening a second restaurant while Ted is considering advertising in the local newspaper. The estimated payoff of their strategies depend on what the other does, as described in the payoff matrix below. Find the mixed strategy Nash equilibrium.*

Bill

Ted

	Open	Not open
Adv.	90, 10	20, 80
Not Adv.	30, 70	60, 40

To calculate the mixed strategy Nash equilibrium, we expect firm Ted to have a θ_{TA} chance of choosing "Advertise", such that firm Bill is indifferent between choosing his strategies (and vice versa)

If the chance of Ted to choose Advertise is θ_{TA}, then his chance of choosing "Not advertise" is 1- θ_{TA}.

To calculate θ_{TA} in practice, we say that Bill expects a payoff of the following when it chooses "Open":

$$\theta_{TA} * 10 + (1 - \theta_{TA}) * 70$$

and expects a payoff of the following when it chooses "Not Open":

$$\theta_{TA} * 80 + (1 - \theta_{TA}) * 40$$

At the mixed strategy Nash equilibrium these expected payoffs are equal:

$$\theta_{TA} * 10 + (1 - \theta_{TA}) * 70 = \theta_{TA} * 80 + (1 - \theta_{TA}) * 40$$

$$10\theta_{TA} + 70 - 70\theta_{TA} = 80\theta_{TA} + 40 - 40\theta_{TA}$$

$$-60\theta_{TA} + 70 = 40\theta_{TA} + 40$$

$$30 = 100\theta_{TA}$$

$$\theta_{TA} = \frac{30}{100} = 30\%$$

This means that Ted has a 30% chance of choosing strategy "Advertise" and 70% chance of choosing "Not advertise".

We do the same thing for Bill. Ted expects a payoff of the following when he chooses "Advertise" of:

$$\theta_{BO} * 90 + (1 - \theta_{BO}) * 20$$

and expects a payoff of the following when it chooses "Not advertise":

$$\theta_{BO} * 30 + (1 - \theta_{BO}) * 60$$

At the mixed strategy Nash equilibrium these expected payoffs are equal:

$$\theta_{BO} * 90 + (1 - \theta_{BO}) * 20 = \theta_{BO} * 30 + (1 - \theta_{BO}) * 60$$

$$90\theta_{BO} + 20 - 20\theta_{BO} = 30\theta_{BO} + 60 - 60\theta_{BO}$$

$$70\theta_{BO} + 20 = -30\theta_{BO} + 60$$

$$100\theta_{BO} = 40$$

$$\theta_{BO} = \frac{40}{100} = 40\%$$

This means that Bill has a 40% chance of choosing to "Open" and a 60% chance of choosing "Not open".

<u>**So to conclude, Ted has a 30% chance of choosing strategy "Advertise" and 70% chance of choosing "Not advertise", while Bill has a 40% chance of choosing to "Open" and a 60% chance of choosing "Not open".**</u>