APEC3001 **Spring 2021**

Problem Set 7 – Answer Key

Due Date: Thursday April 29, 2021 by 10 PM

Please submit a single file via Canvas with your answers in the correct order.

1. Suppose you and a rival are the only producers of oysters in an isolated town. Every morning you both dive for oysters that you will sell in the market that afternoon. Each morning, you both have a choice of bringing up 10 or 20 dozen oysters; each dozen you bring up has a marginal cost of $10. If 20 dozen oysters are brought to market in total, they will sell for $35 each. If 30 dozen oyster are brought to market, they will sell for $25 each. If 40 dozen oysters are brought to market, they will sell for $20 each.

   a. Create a payoff matrix table showing the profit you and a rival can expect to earn based on your choice of bringing up 10 or 20 dozen oysters each, given how many your rival has.
   Solution:

   $$\pi = (P - MC) * Q$$

   - 20 dozen oysters: 10 each; $\pi = (35 - 10) * 10 = \$250$ for both you and rival
   - 30 dozen oysters: you bring 10, rival brings 20; $\pi = (25 - 10) * 10 = \$150$ for you and $\pi = (25 - 10) * 20 = \$300$ for rival
   - 30 dozen oysters: you bring 20, rival brings 10; $\pi = (25 - 10) * 20 = \$300$ for you and $\pi = (25 - 10) * 10 = \$150$ for rival
   - 40 dozen oysters: 20 each; $\pi = (20 - 10) * 20 = \$200$ for both you and rival

		Your Rival	
		10 dozen	20 dozen
You	10 dozen	250 , 250	150 , (300)
	20 dozen	(300) , 150	(200) , (200)

   b. What is the Nash equilibrium in this situation?
   Solution:
   Nash equilibrium occurs where you and your rival each supply 20 dozen because neither person can do any better given what the other person is doing. (See red circles in payoff matrix above: if rival chooses 10 dozen, your best option is to choose 20 dozen; if rival chooses 20 dozen, your best option is to still choose 20 dozen. If you choose 10 dozen, your rival's best option is to choose 20 dozen; if you choose 20 dozen, your rival's best option is to still choose 20 dozen.)

c. If you and your rival discuss production before diving each day and agree on the amount to produce, what would you agree to do? Explain whether or not the collusive agreement is a Nash equilibrium.
Solution:
If you and your rival could collude, you would each agree to supply 10 dozen because it maximizes *total* profits. However, if you believe your rival is going to supply only 10 dozen, it would enhance your *own* profit to supply 20 dozen instead of the agreed upon 10 dozen. Thus, the collusive agreement is not a Nash equilibrium.

2. Suppose that the inverse market demand for pumpkins is given by $P = 10 - 0.05Q$. Pumpkins can be grown by anybody at a constant marginal cost of $1.

a. If there are lots of pumpkin growers in town so that the pumpkin industry is competitive, how many pumpkins will be sold, and what price will they sell for?
Solution:
When the pumpkin industry is competitive, the price equals the marginal cost. **Therefore, the price is $1 and the quantity of pumpkins sold is:**

$$1 = 10 - 0.05Q$$
$$\boldsymbol{Q = 180\ pumpkins}$$

b. Suppose that a freak weather event wipes out the pumpkins of all but two producers, Linus and Lucy. Both Linus and Lucy have produced bumper crops, and have more than enough pumpkins available to satisfy the demand at even a zero price. If Linus and Lucy collude to generate monopoly profits, how many pumpkins will they sell, and what price will they sell for?
Solution:
If Linus and Lucy collude to generate the monopoly profits, the profit-maximizing quantity satisfies the $MC = MR$ condition. The marginal revenue is $MR = 10 - 0.1Q$; thus:

$$MC = MR$$
$$1 = 10 - 0.1Q$$
$$\boldsymbol{Q = 90\ pumpkins}$$

The profit-maximizing price is:

$$P = 10 - 0.05(90)$$
$$\boldsymbol{P = \$5.50}$$

c. Suppose that the predominant form of competition in the pumpkin industry is price competition. In other words, suppose that Linus and Lucy are Bertrand competitors. What will be the final price of pumpkins in this market—in other words, what is the Bertrand equilibrium price?
Solution:
The market outcome of Bertrand competition with identical goods is the same as that in a perfectly competitive market. **Hence, the Bertrand equilibrium price is $1.**

d. At the Bertrand equilibrium price, what will be the final quantity of pumpkins sold by both Linus and Lucy individually, and for the industry as a whole? How profitable will Linus and Lucy be?
Solution:
At the Bertrand equilibrium price, the final quantities of pumpkins sold by both Linus and Lucy individually are the same. **Each of them will sell half of the competitive equilibrium quantity; that is, 90 pumpkins. The industry produces 180 pumpkins. Both Linus and Lucy make zero (economic) profit as they sell each pumpkin at a price equal to marginal cost.**

e. Would the results you found in parts (c) and (d) be likely to hold if Linus let it be known that his pumpkins were the most orange in town, and Lucy let it be known that hers were the tastiest? Explain (no calculations needed)
Solution:
The results would not hold in this case. The results hold if the goods are identical. However, that would change if Linus's pumpkins were the most orange in town and Lucy's pumpkins were the tastiest. This would represent a differentiated-products Bertrand market. In that case, the eventual outcome depends on the extent to which customers are willing to substitute among the products. If they are completely unwilling to substitute, then Linus would have a monopoly in the market for pumpkins that look good and Lucy would have a monopoly in the market for pumpkins that taste good.

3. Mimi's Mangos produces smoothies in a monopolistically competitive market. The inverse demand for its product is P=8-0.05Q where quantity is measured in smoothies per day, and price is measured in dollars. Assume Mimi's Mangos has a constant marginal cost of $2 per smoothie.

a. To maximize profit, how many smoothies should Mangos produce each day?
Solution:
Mangos maximizes profit by setting marginal revenue equal to marginal cost; since the inverse demand curve is linear, the marginal revenue curve is also linear, with the same intercept and twice the slope:

$$MR = 8 - 0.1Q$$
$$MR = MC$$
$$8 - 0.1Q = 2$$
$$6 = 0.1Q$$
$$\boldsymbol{Q = 60\ smoothies\ per\ day}$$

b. What price will smoothies sell for?
Solution:
Plugging 60 in to the inverse demand curve gives the price:

$$P = 8 - 0.05(60)$$
$$\boldsymbol{P = \$5\ per\ smoothie}$$

c. What will be Mimi's Mangos' daily producer surplus?
Solution:
Mimi's Mangos' producer surplus is the quantity produced times the price, net of the constant marginal cost:

$$PS = Q \times (P - MC)$$
$$PS = 60 \times (5 - 2)$$
$$\boldsymbol{PS = \$180\ per\ day}$$

d. In reality, firms in monopolistic competition usually face fixed costs in the short run. Given the answers to the previous questions, what would Mangos' fixed costs have to be in order for this industry to be in long-run equilibrium?
Solution:
Long-run equilibrium occurs when industry profits are zero, or when Mangos' daily fixed costs are exactly equal to its producer surplus of $180 per day.

4.

a. Suppose that the market demand for organic specialty rose hip jelly is given by ***P* = 100 – *Q*.** There are only two firms, A and B, producing this product, each at a constant marginal and average total cost of $5. Fill in the table below for each market structure. Show your work. Round off to two decimal places when needed.
Solution:

	Collusive Monopoly	Cournot Oligopoly	Bertrand Oligopoly	Stackelberg Oligopoly (A is first mover)
A's Quantity	**23.75 units**	**31.67 units**	**47.5 units**	**47.5 units**
B's Quantity	**23.75 units**	**31.67 units**	**47.5 units**	**23.75 units**
Industry Quantity	**47.5 units**	**63.33 units**	**95 units**	**71.25 units**
Price	**$52.50**	**$36.67**	**$5**	**$28.75**
A's Profit	**$1,128.13**	**$1,002.78**	**$0**	**$1,128.13**
B's Profit	**$1,128.13**	**$1,002.78**	**$0**	**$564.06**
Industry Profit	**$2,256.25**	**$2,005.56**	**$0**	**$1,692.19**

Below here (and on the back) show your work for each of the columns. Then answer the following question.

4) $P = 100 - Q$, $MC = ATC = \$5$

Collusive Monopoly:

$P = a - bQ \Rightarrow MR = a - 2bQ$

$MR = 100 - 2Q$

$MR = MC$

$100 - 2Q = 5$

$2Q = 95$

$Q = 47.5$ units → split Q evenly between firms

$q_A = 23.75$ units , $q_B = 23.75$ units

$P = 100 - 47.5$

$P = \$52.50$

$\pi = (P - ATC) * Q$

$\pi_A = (52.5 - 5) * 23.75 = \$1,128.13$

$\pi_B = (52.5 - 5) * 23.75 = \$1,128.13$

$\pi = (52.5 - 5) * 47.5 = \$2,256.25$

Cournot Oligopoly:

$P = 100 - Q$, $Q = q_A + q_B$

$P = 100 - q_A - q_B$

$P = a - bq_A - cq_B \Rightarrow MR_A = a - 2bq_A - cq_B$

$P = a - bq_A - cq_B \Rightarrow MR_B = a - bq_A - 2cq_B$

$MR_A = 100 - 2q_A - q_B$ | $MR_B = 100 - q_A - 2q_B$

$MR_A = MC$ | $MR_B = MC$

$100 - 2q_A - q_B = 5$ | $100 - q_A - 2q_B = 5$

$2q_A = 95 - q_B$ | $2q_B = 95 - q_A$

$q_A = 47.5 - 0.5q_B$ | $q_B = 47.5 - 0.5q_A$

$q_A = 47.5 - 0.5(47.5 - 0.5q_A)$

$q_A = 47.5 - 23.75 + 0.25q_A$

$0.75q_A = 23.75$

$q_A = 31.67$ units

$q_B = 47.5 - 0.5(31.67)$ $q_B = 31.67$ units

$Q = 31.67 + 31.67 = 63.33$ units

$P = 100 - 63.33$ $P = \$36.67$

$\pi = (P - ATC) * Q$

$\pi_A = (36.67 - 5) * 31.67 = \$1,002.78$

$\pi_B = (36.67 - 5) * 31.67 = \$1,002.78$

$\pi = (36.67 - 5) * 63.33 = \$2005.56$

Bertrand Oligopoly (Assuming identical product):

$P = MC$

$P = \$5$

$P = 100 - Q \Rightarrow Q = 100 - P$

$Q = 100 - 5$

$Q = 95$ units → split Q evenly between firms

$q_A = 47.5$ units $q_B = 47.5$ units

$\pi = (P - ATC) * Q$

$\pi_A = (5 - 5) * 47.5 = \$0$

$\pi_B = (5 - 5) * 47.5 = \$0$

$\pi = (5 - 5) * 95 = \$0$

Stackelberg Oligopoly (A is first mover):

$P = 100 - Q \Rightarrow P = 100 - q_A - q_B \quad (Q = q_A + q_B)$

$P = a - bq_A - cq_B \Rightarrow MR_B = a - bq_A - 2cq_B$

$MR_B = 100 - q_A - 2q_B$

$MR_B = MC$

$100 - q_A - 2q_B = 5$

$2q_B = 95 - q_A$

$q_B = 47.5 - 0.5q_A$

$P = 100 - q_A - (47.5 - 0.5q_A)$

$P = 100 - q_A - 47.5 + 0.5q_A$

$P = 52.5 - 0.5q_A$

$P = a - bQ \Rightarrow MR = a - 2bQ$

$MR_A = 52.5 - q_A$

$MR_A = MC$

$52.5 - q_A = 5$

$q_A = 47.5$ units

$q_B = 47.5 - 0.5(47.5)$

$q_B = 23.75$ units

$Q = q_A + q_B = 47.5 + 23.75 = 71.25$ units

$P = 100 - 71.25 = \$28.75$

$\pi = (P - ATC) * Q$

$\pi_A = (28.75 - 5) * 47.5 = \$1,128.13$

$\pi_B = (28.75 - 5) * 23.75 = \$564.06$

$\pi = (28.75 - 5) * 71.25 = \$1,692.19$

b. Which of these outcomes do you think is most likely to occur? What information would be useful to know in order to decide which of these outcomes is the most likely to occur? (There's no exact answer to this question, the point is the think about the model assumptions and what things in the real world might affect how firms behave strategically.)
Solution:
A collusive monopoly seems unlikely to occur because it is illegal for firms to collude and they each have an incentive to cheat on the agreement. A Stackelberg oligopoly also seems unlikely because one firm needs to be the first mover, so unless one firm was in the industry before the other, it's not clear what would give one the first mover advantage over the other. Bertrand oligopoly seems most likely because firms compete on prices, with the result being the same as the perfectly competitive equilibrium. A Cournot oligopoly is possible if the firms know enough microeconomic theory (or game theory) to realize they should compete on market share (quantity) rather than price.