Final Exam

Industrial Organization (ECO 312)

Total points: 41 | Weightage towards final grade: 40%

Date: 25/04/2019 | Time: 9:00 AM - 11:00 AM

- Show all your steps.
- If you attempt extra questions in either or both parts, you must state which two you want graded.
- Calculators are allowed.
- No cheat sheets or any other material are permitted.

Part I. Answer the following in brief (Any 8). $(8 \times 2.5 = 20)$

1. **Hotelling vs Salop.** Explain how the number of firms n is determined in the Salop circle model. How is this different in the way it is determined in Hotelling? Why does this difference arise?

   Answer. Major differences:

   - In the Salop circle the number of firms is determined by the point at the point at which an additional firm entering would yield negative profits. At equilibrium, firm profits are 0.
   - In Hotelling, the number of firms is given as 2, at least in the basic version of the model.
   - Hotelling exhibits characteristics of a duopoly model and there is no free entry, while Salop is monopolistic competition with free entry. Free entry leads to 0 profits which in turn determines n

2. **Upstream and downstream firms.** Consider the case of Uber. Here, we have taxi drivers, the firm Uber, and the consumers. Explain the market structure. Who is the upstream firm and how is the downstream firm here? Assume Uber is a monopoly.

   Answer. Here, both the consumer and the taxi driver pay Uber. This is not a setting of an upstream and a downstream firm, as in upstream and downstream firms the producer sells to the retailer who in turn sells to the consumer (or one firm sells to another who in turn sells to another firm). Here, both agents pay Uber.

3. **Capacity constraints.** Show the mathematical condition under which a capacity constraint still leads to Bertrand pricing. Explain with a real world example.

   Answer. The basic idea is that as long as capacities are enough to satisfy demands a constraint will become non-bending. A mathematical condition should show that aggregate demand is less than capacity of each individual firm at marginal cost pricing., i.e. $D(P = MC) \leq \overline{q}_i$. A variation of this condition is acceptable as long as it conveys the idea

4. **Externality from competition.** We have seen the externality one firm imposes on another in quantity competition in the case of a duopoly. Explain this externality if there is price competition.

   Answer. The externality in quantity competition was that as one firm produces more, it reduces the price overall due to law of demand, thus affecting the price obtained by all the firms in the market. In price competition, as the firm reduces prices, it takes away demand from its rival. In the extreme case of identical goods, the reduction in pricing has no externality except at the point when one firm undercuts another firm with its price, where it takes away all the demand from the other firm. (Note that we use the term externality here a bit loosely, as I had mentioned in class)

5. **Partial vs adverse view on advertising.** Consider two firms competing in a market. They can invest in a certain amount of advertising a_i, where $i \in \{1, 2\}$. The consumers

have a belief about the quality of good i being θ_i. Higher the value of θ_i, higher the quality of the good. Once the consumer has observed the ad, we get $(\theta_i | a_i) > \theta_i$. Does this represent the partial view or the adverse view of advertising?

Answer. This information does not contain any information about whether advertising is of the partial or adverse type.

6. **Double marginalization.** We have seen that there are issues caused from double marginalization when upstream and downstream firms interact. We know that RPM can be used to address the problem. How does the downstream firm benefit from this?

   Answer. Double marginalization leads to lesser aggregate profits but an RPM mechanism means that all the surplus is accumulated by the upstream firm. Hence, the downstream firm, at least in this specific setting, does not benefit even though aggregate profits go up.

7. **Welfare in third degree price-discrimination.** Explain the intuition and conditions that determine whether there is welfare loss or gain in moving from third degree to uniform pricing. Give the mathematical condition that helps us interpret the necessary condition for welfare increase.

   Answer. When there is uniform pricing, as opposed to third degree price discrimination, the uniform price will lie somewhere between the discrimination prices charged to each type. Hence, while loss of consumer surplus will go down for the high type of consumer, the low type now could have to pay more or even be priced out of the market. Additionally, producer surplus falls. The following condition when one moves from third degree to uniform pricing illustrates that

$$\Delta W \in \left[\sum_i (p_i - c)\Delta q_i, (\overline{p} - c)\left(\sum_i \Delta q_i \right) \right]$$

   This shows that the total change in quantities must be positive for there to even be a possibility of welfare increase under uniform pricing.

8. **Lean and hungry look.** Suppose an incumbent firm 1 can make a choice in period 1 F. Based on F, firms in period 2 will decide $x_1(F)$ and $x_2(F)$ if firm 2 (potential entrant) enters, and just $x_1(F)$ if firm 2 does not enter. Explain through a mathematical setup (i.e., the relevant reaction functions, entry conditions, effect on profit given F) the situations that would lead to a "Lean and hungry look" strategy.

   Answer. In case that there are strategic substitutes, i.e., $R' < 0$, and investment F by firm 1 makes it look soft (i.e., $\frac{\partial \Pi_2}{\partial F} > 0$), then the firm must use the "Lean and hungry look" strategy regardless of whether it is optimal to accommodate or deter entry. In the case that the reaction function yields $R' > 0$, i.e., strategic compliments, and investment makes firm 1 looks soft, it will only use the "Lean and hungry look" strategy if it wants to deter entry. This strategy is not optimal if investment makes firm 1 looks tough, regardless of other conditions.

9. **War of attrition.** Explain the concept of burning one's bridges in the war of attrition. How does this affect player 2's decision in the Stackelberg framework?

   Answer. The idea behind "burning one's bridges" is that when a first mover commits (by say producing a large amount of a good as in the Stakelberg case)

10. **Bilateral monopoly with asymmetric information.** Consider the following setting of a bilateral monopoly. There is one good to be traded, which is produced by the supplier at a cost c. The valuation of the buyer is given by v. v is common knowledge, but c is known only to the supplier. $f(c) > 0$ on the interval $[\overline{c}, \overline{c}]$. $F(\overline{c}) = 1$. $v \in [\overline{c}, \overline{c}]$. Suppose the supplier has all the bargaining power, and makes a "take it or leave it" offer. What is the price the supplier will offer? Is the expected volume of trade here different than it would be in a full information game with equal bargaining power? What about CS and PS? Assume that trade occurs as long as CS and PS are both non-negative.

Answer. Since $c \in [\overline{c}, \overline{c}]$, $c = \overline{c}$ (I know that his is a slightly strange thing to write in an interval but the idea is quite clear mathematically). Similarly, since $v \in [\overline{c}, \overline{c}]$, $v = \overline{c}$. Hence, the game is effectively a full information game and since $v = c = \overline{c}$, regardless of who hast he bargaining power, trade will take place and both CS and PS will be 0.

11. Explain the following (1.25 points each):

    (a) Inter-temporal pricing and goodwill.

    Answer. The basic idea is that firms form a reputation of not reducing their prices in period 2, which allows them to charge higher prices in period 1. In such a case, consumers do not expect prices to drop and the high demand consumers do not wait for future periods. A common example is Apple. You may show this with equations as well.

    (b) The Coase problem

    Answer. The intuition behind the Coase problem is that when a monopolist enters a durable goods market where consumers have different valuations, he will initially set a high price, but in the second period, he is likely to "flood the market" by selling off the rest of the goods at a lower price. Consumers of intermediate valuation who anticipate this behaviour may hold off on purchasing the product at a higher piece in the initial period, causing the firm to lose some of its monopoly power. Common examples are clothes that are later sold in clearance sales, or video games like FIFA 19.

12. **Empirical IO.** Two local firms are competing in a Cournot duopoly. You have been hired as a consultant to the government to estimate producer surplus. In this regard, discuss how you would approach this in the context of

    - The economic model.
    - What data do you need?

- What variables would you need to estimate?
- How would you report results within this framework?

  Answer. This question is fairly open and will be graded depending upon your approach. There is no specific solution.

Part II. Answer the following in detail (Any 3). $(3 \times 7 = 21)$

1. **Price discrimination.** Suppose IIIT is about to host a live event by TVF, and is selling tickets to the event strictly to students and faculty. IIIT knows that students (S) and faculty (F) have different WTP for this. The demand functions are as follows:

$$q_S = 240\left(\frac{1}{p_S^2}\right) \quad \text{and} \quad q_F = 540\left(\frac{1}{p_F^3}\right)$$

   The cost function for IIIT is given by $C(Q) = 2Q$ where $Q = q_S + q_F$, i.e., the total number of tickets sold. Compute the ticket prices set by IIIT for each type, and find the equilibrium quantities sold. Note that IIIT can price discriminate and there is no arbitrage, as the guests need to provide their ID along-with the tickets.

   Answer. Since we know $C(Q) = 2Q = 2(q_1 + q_2)$ and we know the demand function, we can find the components of the Lerner index ϵ (using the formula for elasticity) and C' (taking a derivative of aggregate cost) to find p. Since there is no arbitrage, we can treat each as individual monopolies with different elasticites. The price elasticity for -2 for students and -3 for faculty. Based on this, we can easily find p and then find q for each type. We get

$$p_S = 4, q_S = 15 \quad \text{and} \quad p_F = 3, q_F = 20$$

   ***If you did it some other way and got the answer, it's fine.*

2. **Uniform pricing in among heterogeneous consumers.** Consider a phone man-

ufacturer selling a new phone. There are two types of consumers, each of them with different demand functions. The demand function is $q_i = \lambda_i - p$ where $i = \{1, 2\}$ and $\lambda_1 > \lambda_2$. Consider $\lambda_i > c > 0$, where c is marginal cost. Assume $\lambda_2 > \frac{\lambda_1 + c}{2}$. The ratio of high demand consumers is γ and low demand consumers is $1 - \gamma$. Find the optimal uniform price.

Answer. Objective function:

$$\max_p \gamma[(p-c)(\lambda_1 - p)] + (1-\gamma)[(p-c)(\lambda_2 - p)]$$

$$p = \frac{\gamma\lambda_1 + (1-\gamma)\lambda_2 + c}{2}$$

$$\Pi = \frac{(\gamma\lambda_1 + (1-\gamma)\lambda_2 - c)^2}{4}$$

Now, alternately, the seller can price it so high that only the high type buys. This way the seller gains on profit per unit but will lose on aggregate quantity sold.

$$\max_p \gamma[(p-c)(\lambda_1 - p)]$$

This would yield

$$p^H = \frac{\lambda_1 + c}{2}; \quad \Pi^H = \frac{\gamma(\lambda_1 - c)^2}{4}$$

Therefore, he will choose a price to sell only to the high type if

$$\gamma > \frac{(\lambda_2 - c)^2}{(\lambda_1 - \lambda_2)^2}$$

Else, he will serve both types.

3. **Stackelberg with three firms.** Consider a Stackelberg game with 3 firms entering, one after another. $p(Q) = 1 - Q$ and $Q = q_1 + q_2 + q_3$. Cost of production is $1 > c > 0$. Find the equilibrium output levels. What can you say about profits?

Answer. Firm 3:

Objective function is:

$$\max \pi_3 = (1 - q_1 - q_2 - q_3)q_3 - cq_3$$

BRF is

$$q_3(q_1, q_2) = \frac{1 - c}{2} - \frac{1}{2}(q_1 + q_2)$$

Firm 2:

Objective function is:

$$\max \pi_2 = (1 - q_1 - q_2 - q_3(q_1, q_2))q_2 - cq_2$$

BRF is

$$q_2(q_1) = \frac{1 - c}{2} - \frac{1}{2}q_1$$

And firm 3's BRF now simplifies to:

$$q_3(q_1) = \frac{1 - c}{4} - \frac{1}{4}q_1$$

Firm 1:

Objective function is:

$$\max \pi_1 = (1 - q_1 - q_2(q_1) - q_3(q_1))q_1 - cq_1$$

Thus,

$$q_1^* = \frac{1 - c}{2}$$

Additionally,

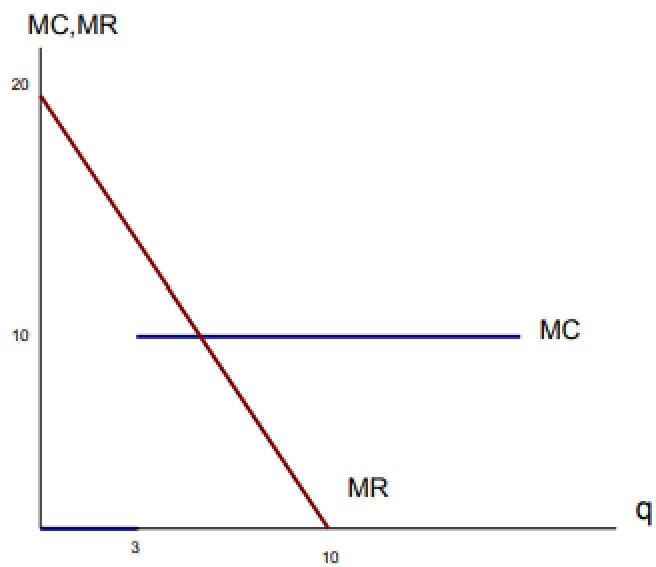
$$q_2^* = \frac{1 - c}{4} \quad \text{and} \quad q_3^* = \frac{1 - c}{8}$$

Since price is same for all firms and cost of production is constant, it is clear that producing an extra good will always yield more profits. Hence, the firm producing more goods (firm 1) earns most profits, firm 2 earns the second most and firm 3 earns the third most. You can also show this by calculating profits.

4. **Capacity constraints and entry accommodation/deterrence.** In a market for a homogeneous product, let the inverse demand function be given by $p = 50 - q_1 - q_2$. The incumbent firm's unit cost of production is zero up to its capacity k_1. Beyond k_1, the unit cost of production is 10. A potential entrant produces the same good with a cost function $C(q_2) = 10q_2 + 256$. **(Boğaziçi University, Department of Economics.)**

   (a) Draw the MC function for $k_1 = 3$ and the MR curve for $q_2 = 30$ for the incumbent on the same graph. (2)

   Answer.



   (b) Find the level of capacity $\overline{k}$, that induces the entrant firm to break even if it enters. Will the incumbent firm choose to deter entry? (5)

   Answer.

Answer: For a given k_1, the entrant's best response is $q_2 = 20 - (k_1/2)$. To see this maximize entrant's profit: $\pi_2 = (p - 10)q_2 - 256 = (40 - k_1 - q_2)q_2 - 256$. The first order condition yields $40 - k_1 - 2q_2 = 0$, which gives $q_2 = 20 - (k_1/2)$. So the $\overline{k}_1$ that leaves the entrant zero profit is found by plugging the entrant's best response function into its profit function and solve for k_1: $(40 - k_1 - 20 + k_1/2)(20 - k_1/2) - 256 = 0$, which gives $\overline{k}_1 = 8$.

Note that the Stackelberg leader's output is $q_S^L = 20$. Since $\overline{k}_1 = 8 < 20$, there will be no entry when $k_1 = 20$. Thus, with $k_1 = q_1 = q_S^L = 20$, the incumbent will be on its own in the market receiving monopoly profits. In fact, the intersection of $BR_1^{w+r} = 20 - (q_2/2)$ and $BR_2^{w+r} = 20 - (q_1/2)$ occurs at $q_1 = 40/3$ which is also larger than $\overline{k}_1 = 8$. Thus, in fact, there is no entry regardless of k_1.