M1 Industrial Organisation
2015-2016 Final Examination

Please write your candidate number here: _____

PLEASE READ THESE INSTRUCTIONS CAREFULLY:

- This exam is for M1 Industrial Organisation.
- You have 3 hours. You should answer *all* questions, and you should answer them *in this booklet*.
- This exam has 4 questions, and is 23 pages long. Please check to make sure your copy has all 23 pages.
- The total number of points on the exam is 100. Each problem states the number of points it is worth. Allocate your time accordingly.
- Show your work. Unless otherwise indicated, partial credit may be given for partially correct work.
- Place your answer to each question in the space provided. Answers not provided in the correct space will not be marked.
- Write answers neatly. Illegible writing cannot be graded.
- **Good Luck!**

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1 Multiple Choice (12 points)

You will receive 2 points for each correct answer. However you will lose 2 points for each incorrect answer. If you leave a question blank, you get 0 points for that question.

1. True or false: Third-degree price discrimination (or group pricing) always increases total welfare.
   Answer:

2. True or false: First-degree price discrimination (or personalized pricing) always reduces consumer surplus relative to uniform pricing.
   Answer:

3. True or false: Collusion is easier to achieve when firms can observe each other's prices.
   Answer:

4. True or false: In a location game with fixed prices, the equilibrium exhibits maximal differentiation.
   Answer:

5. True or false: When two firms' actions are strategic substitutes, both their reaction functions slope up.
   Answer:

6. True or false: As the cost of entering a market tends to zero, at most a finite number of horizontally-differentiated firms will choose to enter.
   Answer:

2 Short questions (28 points)

1. Suppose that a firm sells a good over two periods. Consumers can either buy it in the first or the second period, with a discount factor. Does having the ability to change the price between periods benefit or hurt the firm? Discuss the effect of consumers' rationality. (100 words max)

   Answer

2. Consider a market in which 3 firms operate. Firms 1 and 2 announce a merger. The following day, firm 3's stock market valuation drops by 10%. (a) Is this consistent with what economic theory would predict, and if so, under which circumstances? (b) Can the information about the stock market reaction be of any relevance to the antitrust authority?

   Answer

3. Consider a market in which two firms, 1 and 2, compete à la Bertrand using different technologies to produce the same good. Firm 1 uses technology A, which allows to produce at marginal cost c_A. Firm 2 uses technology B, with a marginal cost c_B. We assume that $c_A < c_B$. The number of consumers is normalized to 1, and their willingness to pay is $v > c_B$.

   Suppose that an inventor obtains a patent over an innovation that allows to reduce the cost of technology B to $c'_B < c_A$. The inventor sells the patent to the highest bidder.

   We consider two cases: (i) firm A can costlessly switch to technology B at cost c'_B if it acquires the patent; (ii) firm A cannot use technology, even if it acquires the patent. In each case, when does firm 1 win the auction the auction? Does this allocation of the patent maximize consumer surplus? Does it maximize total profits? Discuss.

   Case (i) Answer

   Case (ii) Answer

4. Consider an industry with two firms located at opposite ends of a unit length Hotelling line. Consumers are uniformly distributed along the line. A consumer's payoff from buying from firm i is $V - p_i - td_i$ where $t > 0$ and d_i is the distance between the consumer and firm i. The outside option is zero; we assume V is sufficiently large such that the market is covered. Each firm's marginal cost is zero. Consider a two stage game. At the first stage firm 1 chooses an advertising level λ_1. This generates a transportation cost parameter $t = \bar{t} + \lambda_1$. At the second stage the firms observe t and then simultaneously each choose their price.

   Is the 'strategic effect' of λ_1 on firm 1's profits positive or negative? Explain your answer carefully.

   Answer

3 R&D and collusion (30 points)

Two firms produce a homogeneous good whose inverse demand function is given by $P = a - Q$, where $Q = q_1 + q_2$ is the sum of individual outputs.

Firm i has marginal cost $c_i = C - x_i - lx_j$, where x_i is the R&D investment made by firm i and $l \in [0, 1]$ is a parameter that indicates the spillover from R&D investment x_j made by the rival firm (for instance, because firm i can reverse-engineer some of firm j's innovations). The cost of R&D is $\phi(x) = x^2$.

The timing is the following: at $t = 1$, firms simultaneously choose x_i. At $t = 2$, firms simultaneously choose q_i.

We will compare two cases: in the first case, firms behave non-cooperatively in both periods. In the second case, they co-operate in their R&D investment decisions (period 1) only and choose q_i non-cooperatively.

Period 2: Quantity competition

1) For given costs c_i and c_j, what is the equilibrium of the second period (quantities, profits)? Use these expressions to find q_i and π_i as functions of x_i and x_j.

$q_i^*(x_i, x_j) = ...$ $\pi_i^*(x_i, x_j) = ...$

Calculations

Period 1: non-cooperative R&D

2)In the first stage, what is firm i's best response to x_j? Focusing on cases where $x_1 = x_2$, write the equilibrium investment level x^*.

$x^* = ...$

Calculations

3) Check that x^* is decreasing in l. Why?
Answer

4) We have $Q^* = \frac{1}{3}(a-c)(1+\frac{(1+l)(2-l)}{9-(2-l)(1+l)})$. How does Q^* change with l? Discuss.

Answer

Period 1 : Co-operation at the R&D stage

We now assume that in the first stage firms set their investment levels in a cooperative way. More specifically, they choose x_1 and x_2 so as to maximize their joint profit. We focus on symmetric decisions where $x_1 = x_2$.

5) Given the equilibrium of the second stage (found in (1)), write firms' program in the first stage. Compute the optimal value $\hat{x}$.

$\hat{x} = ...$

Calculations

6) Under which condition do we have $\hat{x} > x^*$?

$\hat{x} > x^*$ if .....

Calculations

7) Discuss the two opposite effects that cooperation has on the incentives to invest.

Answer

8) Under which condition do we have $\hat{Q} > Q^*$? If the competition authority wishes to maximize consumer surplus, when should it allow cooperation at the R&D stage?

Answer

4 Vertically differentiated products (30 points)

Consider the following model of vertical product differentiation. There is a unit mass of consumers, who are interested in buying one unit of a product. A consumer's type θ is uniformly distributed on the interval $[0, 1]$ i.e. the cumulative distribution function of θ is $F(x) = \Pr(\theta \leq x) = x$. The payoff to a consumer of type θ who buys a product of quality s_i at price p_i is

$$\theta s_i - p_i \ .$$

The payoff to a consumer who buys nothing is 0.

There is one firm in the market. There are two products, denoted 1 and 2. Product 1 has quality $s_1 > 0$, and product 2 has quality $s_2 > s_1$. The marginal cost to the firm of producing good 1 is c_1, where $0 < c_1 < s_1$. The marginal cost to the firm of producing good 2 is c_2, where $\frac{s_2}{s_1} c_1 < c_2 < s_2 + c_1 - s_1$.

1) Suppose the monopolist sells only product 1 (i.e. consumers cannot buy product 2). Calculate the firm's optimal price p_1^* and output q_1^*. Show your calculations. [*There is no need to check second order conditions.*]

$p_1^* =$ ..... $q_1^* =$ .....

Calculations

2) Suppose the monopolist sells only product 2 (i.e. consumers cannot buy product 1). Calculate the firm's optimal price p_2^* and output q_2^*. Show your calculations. [*There is no need to check second order conditions.*]

$p_2^* =$ ..... $q_2^* =$ .....

Calculations

3) Now suppose that the monopolist sells **both** products. Let p_1 and p_2 denote the prices of the two products. You may assume that p_1 and p_2 are such that some consumer types buy nothing, other consumer types buy product 1, and other consumer types buy product 2 (since this will be the case at the monopolist's optimum).

3i) Prove that there exist two thresholds θ' and θ'', such that consumer types below θ' buy nothing, consumer types between θ' and θ'' buy product 1, and consumer types above θ'' buy product 2. [*Hint: the proof that we discussed in lectures is sufficient. As implied earlier, you may assume* $\theta' < \theta''$.] What are the values of θ' and θ'', as a function of (p_1, p_2, s_1, s_2)?

$\theta' =$ ..... $\theta'' =$ .....

Proof

3ii) Using your previous answer, write out the monopolist's profit function $\pi(p_1, p_2, s_1, s_2, c_1, c_2)$. Show your calculations.

$\pi(p_1, p_2, s_1, s_2, c_1, c_2) =$

Calculations

3iii) Solve for the monopolist's profit-maximising prices (p_1^{**} and p_2^{**}) and outputs (q_1^{**} and q_2^{**}) for each good. Show all your calculations. [*There is no need to check second order conditions.*]

p_1^{**} = ... p_2^{**} = ...

q_1^{**} = ... q_2^{**} = ...

Calculations

3iv) Let $\pi^*(s_1, s_2, c_1, c_2)$ denote the monopolist's profits after optimally choosing p_1 and p_2 i.e. given the p_1^{**} and p_2^{**} that you have solved for.

Use the envelope theorem to find the effect on the monopolist's profits of a small increase in c_2 i.e. derive an expression for $\frac{d\pi^*(s_1,s_2,c_1,c_2)}{dc_2}$. Show all your workings.

$\frac{d\pi^*(s_1,s_2,c_1,c_2)}{dc_2} =$

Calculations

4) Finally, suppose the monopolist initially sells only product 1. Without doing any detailed calculations, explain why consumer surplus strictly increases if the monopolist starts selling both products.

Answer