TSE
Toulouse School of Economics
École d'économie de Toulouse

UNIVERSITÉ TOULOUSE 1 CAPITOLE

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Session 1

Semestre 2

Master 1 Economics, Econometrics & Statistics & Economics & Law
Epreuve : Industrial Organisation
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M1 Industrial Organisation
2016-2017 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 16 pages long (including this one). Please check to make sure your copy has all 16 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 Durable good monopoly (20 points)

A monopolist sells a durable good over two periods, $t = 1, 2$. The marginal cost is zero. There is a mass 1 of consumers. Half of the consumers (L-types) value the good at 100 per period, while the other half (H-types) values it at 300 per period. There is no discounting ($\delta = 1$).

Question 1 Suppose that the firm **leases** the good at each period at prices r_1, r_2. What is the profit-maximizing (r_1, r_2)? What is the associated profit, consumer surplus, and total welfare?
Answer here:

1.1 Commitment

From now on we assume that the firm cannot lease the product, and must sell it.

Question 2 Give a reason why leasing may not be feasible.
Answer here:

Suppose that, at $t = 1$, the firm can commit to prices p_1 and p_2.

Question 3 Assuming that $600 \geq p_1 \geq p_2$, under which condition does a type H prefer to buy in the first period?
Answer here:

Question 4 If the firm tries to sell to all the consumers (at $t = 1$ for the H-types, at $t = 2$ for the low types), what is the optimal price schedule (p_1, p_2) under commitment? Should the firm try to sell to all consumers in that case?
Answer here:

1.2 No commitment

Suppose now that the firm cannot commit to p_2 at $t = 1$.

Question 5 What is the optimal strategy for the firm in that case? Compute equilibrium profit, consumer surplus and total welfare.
Answer here:

Question 6 Give one real-world example of a strategy used by firms to maintain high profits when selling durable goods.
Answer here:

2 Collusion and competition in quantities (30 points)

Consider a market for a homogenous good, with an inverse demand $P(Q) = 10 - Q$, where Q is the total quantity. There are n firms, $n \geq 1$, who produce at constant marginal cost $c = 2$. Firms choose their quantities q_i.

Question 1 Suppose that $n = 1$. Show that the monopoly's optimal quantity is $q^m = 4$. Compute the monopolist's profit π^m. Compute consumer surplus, social welfare and the deadweight loss.
Answer here:

Question 2 From now on, $n = 2$. What is the Nash equilibrium q^N of the static game? What is the associated profit π^N?
Answer here:

Question 3 Now suppose that the game is repeated until period T. Each firm maximizes the present-discounted value of its profit

$$\sum_{t=0}^{\infty} \delta^t \pi_t^i$$

where π_t^i is firm i's profit at period t and δ is the discount factor. What is the unique subgame-perfect equilibrium of this game? Is cooperation sustainable?
Answer here:

Question 4 From now on there is an infinite horizon: $T = \infty$. Firms try to collude to implement the symmetric monopoly outcome (where each firm produces $\frac{q^m}{2}$ units at each period). We focus on subgame-perfect equilibria involving trigger-strategies.

Define each firm's trigger strategy.

Answer here:

Question 5 If firm 2 produces the collusive quantity at period t, show that the optimal deviation for firm 1 is to produce $q^d = 3$. What is the deviation profit for that period π^d?

Answer here:

Question 6 Use your previous answers to write down the incentive-compatibility constraint for collusion to be sustainable.
Answer here:

Question 7 Simplify the previous condition to obtain a threshold δ^* above which collusion is sustainable. Interpret the result that collusion is sustainable if and only if $\delta \geq \delta^*$.
Answer here:

Question 8 Briefly outline a model in which price wars arise on the equilibrium collusive path.
Answer here:

3 Advertising (25 points)

Two firms A and B are located at opposite ends of a unit-length Hotelling line. Consumers are uniformly distributed along the line and are interested in buying one product. Firm A can send two different types of advert, called 1 and 2 (e.g. 1 could be online advertising, and 2 could be advertising in magazines). If firm A advertises an amount $\lambda_1 \geq 0$ on 1, and an amount $\lambda_2 \geq 0$ on 2, its total cost of advertising is $\frac{(\lambda_1)^2+(\lambda_2)^2}{2}$. Marginal production cost for both firms is zero.

A consumer who buys from firm $i = A, B$ receives a payoff

$$V - p_i - d_i t\left(\lambda_1 + \lambda_2, \mu\right) \ ,$$

where p_i is the price charged by firm i, and d_i is the distance between the consumer and firm i. The transportation cost $t\left(\lambda_1 + \lambda_2, \mu\right)$ is a function, which depends on both firm A's total advertising $\lambda_1 + \lambda_2$, and an exogenous parameter μ; the transportation cost is strictly positive for all levels of advertising. We also assume that V is sufficiently high that the market is covered in equilibrium.

The timing of the game is as follows:

- At Stage 1, firm A chooses λ_1 and λ_2. They then become public knowledge.
- At Stage 2, firms A and B simultaneously choose their price.
- At Stage 3, consumers make their purchase decision.

Question 1 Write out the profit function for each firm at Stage 2, as a function of $p_A, p_B, \lambda_1, \lambda_2, \mu$.
Answer here:

Question 2 Solve for Nash Equilibrium prices and profits at Stage 2, as a function of $\lambda_1, \lambda_2, \mu$. You must show all your derivations. You do not need to check second order conditions.
Answer here:

Question 3 Prove that at Stage 1 firm A will choose $\lambda_1 = \lambda_2$. You should NOT assume anything about the function $t(\lambda_1 + \lambda_2, \mu)$ e.g. you should not assume it is differentiable. [*Hint: recall the lectures.*]
Answer here:

Henceforth we will assume that

$$t(\lambda_1 + \lambda_2, \mu) = 1 + \mu(\lambda_1 + \lambda_2) \ .$$

Question 4 Solve for firm A's optimal choice of λ_1 and λ_2 at the first stage of the game.
Answer here:

Let λ_1^0 and λ_2^0 denote the optimal λ_1 and λ_2 that you have solved for in question 4.

Question 5 Calculate the direct effect of a marginal change in λ_1 on firm A's final profit, starting from $\lambda_1 = \lambda_1^0$ and $\lambda_2 = \lambda_2^0$. You must show all your derivations.
Answer here:

Question 6 Calculate the strategic effect of a marginal change in λ_1 on firm A's final profit, starting from $\lambda_1 = \lambda_1^0$ and $\lambda_2 = \lambda_2^0$. You must show all your derivations.
Answer here:

Question 7 Explain why your answers to Questions 5 and 6 sum to zero.
Answer here:

4 Product differentiation and merger (25 points)

Consider the circular city model. Consumers are located uniformly on a circle with a perimeter equal to 1. Density is unitary along the circle. There are four firms: each firm is located at one point of the circle and the distance between two adjacent firms' locations is equal to 1/4. More precisely, we assume that firm 1 is located at point 0, firm 2 at 1/4, firm 3 at 1/2 and firm 4 at 3/4. All the firms have the same marginal cost c.

Each firm sells an identical good and consumers have a unit demand. We assume that the gross surplus that each consumer obtains from the good (say,s) is high enough that the market is covered in any equilibrium: each consumer ends up buying a good. If a consumer located at x buys the good of firm i, she pays the price p_i and also incurs the transportation cost td_i where d_i is the distance between the consumer and firm i (all travel occurs along the circle!). For simplicity, we set $t = 1$. We study a game in which each firm simultaneously chooses its price.

1. Before the merger

Question 1 (a) Given the prices chosen by two adjacent firms (p_i, p_j), compute the location of the consumer who is indifferent between buying the good from firm i and firm j.
Answer here:

Question 1 (b) From 1 (a), find the demand for firm 2 (for instance) as a function of (p_1, p_2, p_3).
Answer here:

Question 1 (c) Write the expression of firm 2's profit π_2 as a function of (p_1, p_2, p_3).
Answer here:

Question 1 (d) From the FOC, find the price in the symmetric equilibrium. What is the profit per firm at the equilibrium?
Answer here:

2. Merger

Suppose now that two firms (firm 1 and firm 2) merge. We assume that (a) the locations of the firms are not affected by the merger, (b) the merging firms continue to choose prices (p_1, p_2). We keep studying the game in whch both the merging firms and the outsiders (i.e., firm 3 and firm 4) choose their price(s) simultaneously.

Question 2 (a) Given (p_1, p_2, p_3, p_4), write the expression of the profit of the merging firms $\pi_1 + \pi_2 \equiv \pi_I$ and write the expression of the profit of an outisder say π_3.
Answer here:

Question 2 (b) From the first order conditions, find the equilibrium prices $p_1 = p_2 = p_I$ and $p_3 = p_4 = p_O$.
Answer here:

Question 2 (c) (Incentive to merge) Does the merger increase or decrease the merging firms' joint profits? Give an economic intuition for your answer to the question.
Answer here:

Question 2 (d) Does the merger increase or decrease social welfare? Give an economic intuition for your answer to the question.
Answer here: