Queen Mary
University of London

Main examination period 2023

ECN 344 Economics of Technology and Innovation Duration: 2 hours

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Answer ALL questions.
Explain clearly your answers.

You are permitted to bring 20 x A4 pages of notes into your examination (i.e. 10 double sided pieces of paper). These can be typed or handwritten and can include graphs and images. They can include material from any source. Your notes must be stapled together and include your student ID number and the module code on the first page. You must submit your notes at the end of the examination with your answer booklet.

Calculators are permitted in this examination. Please state on your answer book the name and type of machine used. Complete all rough workings in the answer book and cross through any work that is not to be assessed.

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EXAM PAPERS MUST NOT BE REMOVED FROM THE EXAM ROOM

Examiner: Aniol Llorente-Saguer

Question 1 [25 marks]

The world renowned monopoly has two types of consumers: $\theta \in \{\theta_L, \theta_H\}$, with $\theta_L = 3$ and $\theta_H = 4$. (The parameter θ reflects how much they appreciate the good). The proportion of low demand consumers is $\lambda = \frac{1}{2}$.

The utility of the consumers is given by $\theta \ln q - p$ if they consume, and 0 otherwise, where q and p represent the quantity consumed and the price paid respectively. The monopoly wants to send two bundles: a cheap one with a low quantity, (q_L, p_L), and a more expensive with a higher quantity, (q_H, p_H).

The monopolist has a cost of production equal to $c(q) = q$ and, therefore, the total profits are given by $\Pi = \frac{1}{2}(p_L - q_L) + \frac{1}{2}(p_H - q_H)$.

(a) Find the two optimal bundles (q_L, p_L) and (q_H, p_H) when ERM can recognize the different type of consumers and can perfectly discriminate. **[6 marks]**

From now on, assume now that each consumer's type (H or L) is private information. Assume, furthermore, that the monopolist wants to optimally serve both types. [Note: in the next questions, assume that $\ln q_i > 0$ for both types.]

(b) Write the participation constraints and the incentive constraints for both types. **[8 marks]**

(c) Write the maximization problem of the monopolist as an unconstrained maximization problem and find the optimal prices and quantities. **[6 marks]**

(d) Discuss how the results in part (c) differ from part (a). Which of these features are typically found in optimal non-linear pricing? **[5 marks]**

Question 2 [35 marks]

Consider the homogeneous-products industry of pens. The inverse demand function is $p = 120 - Q$, where Q is the total quantity produced in the market. There are $n \geq 1$ firms, and the production costs are set equal to zero.

The government taxes output at a constant rate of $t < 1$. So, if firm i produces q_i units of output, then it must pay tq_i to the government. Note that, if $t < 0$, then $tq_i < 0$, i.e., the firm actually receives money from the government. Tax proceeds are rebated lump-sum to consumers. The government's objective is to maximize social welfare, defined as the sum of consumer surplus, producer surplus, and tax proceeds.

Suppose first that $n = 1$:

(a) Find the monopolist's optimal price and quantity as a function of the tax rate t. (You will hopefully find that, if t is sufficiently negative, then the monopoly price is negative. Do not worry about that.) **[5 marks]**

(b) Compute the social welfare at the monopoly's optimum as a function of t and find the government's optimal tax rate t_1^*. Explain your result. **[7 marks]**

Next, suppose there are $n = 2$ firms, competing in quantities.

(c) Find the Cournot equilibrium for a given tax rate t. **[7 marks]**

(d) Compute the social welfare at the monopoly's optimum as a function of t and find the government's optimal tax rate t_2^*. Explain your results and compare then to the ones obtained in part (b). **[6 marks]**

Finally, suppose there are $n > 2$ firms. In the next two parts, you do not need to solve the problem mathematically in order to obtain a full mark.

(e) How does the optimal tax rate t_n^* change as the number of firms n increases? And what is the limit of t_n^* as n tends to infinity? Explain the intuition behind your answer. **[10 marks]**

Question 3 [20 marks]

Two firms compete in prices in a market producing differentiated products. The demand for firm i's product ($i = 1, 2$) is given by $q_i(p_1, p_2) = 16 - 2p_i + p_j$, where $j \neq i \in \{1, 2\}$.
Firms are symmetric and have the same constant unit cost $c = 2$.

(a) Assume firms set their prices simultaneously. Solve for the Nash equilibrium prices, and compute the equilibrium profits. **[7 marks]**

(b) Assume firms move sequentially, firm 1 being the Stackelberg leader. Solve for the equilibrium prices and profits. **[7 marks]**

(c) Compare your answers to questions (a) and (b), and show that both firms charge higher prices and make higher profits under sequential timing. Explain the intuition. Why is this result different from the usual Stackelberg result in which firms compete in quantities? **[6 marks]**

Question 4 [20 marks]

(a) Explain how the incentives of monopolies to conduct Research & Development compare to the ones of competitive firms. **[10 marks]**

(b) Discuss the incentives of competing firms to differentiate their products. **[10 marks]**

End of Paper