

Written Exam at the Department of Economics summer 2019

Industrial Organization

Final Exam

June 3, 2019

(3-hour closed book exam)

Answers only in English.

This exam paper consists of three pages in total, including this one

Falling ill during the exam

If you fall ill during an examination at Peter Bangs Vej, you must:

- contact an invigilator who will show you how to register and submit a blank exam paper.
- leave the examination.
- contact your GP and submit a medical report to the Faculty of Social Sciences no later than five (5) days from the date of the exam.

Be careful not to cheat at exams!

You cheat at an exam, if during the exam, you:

- Make use of exam aids that are not allowed
- Communicate with or otherwise receive help from other people
- Copy other people's texts without making use of quotation marks and source referencing, so that it may appear to be your own text
- Use the ideas or thoughts of others without making use of source referencing, so it may appear to be your own idea or your thoughts
- Or if you otherwise violate the rules that apply to the exam

Attempt both questions.

Explain all the steps of your analysis and define any new notation that you use.

Show all the calculations that your analysis relies on.

Question 1: Leasing a durable good

There are two time periods, 1 and 2. In each period, a profit-maximizing monopoly firm can produce a good. *The good is durable.* Hence, if a person could purchase it in period 1, she would be able to consume the good in both periods. However, the firm does not sell the good to the consumers but *leases* it for one period at a time. This means that those consumers who in period 1 choose to lease the good must, at the end of that period, return it to the firm. In period 2, all consumers—so those who previously leased it as well as those who did not—have the opportunity to lease the good (again).

The firm's per-unit cost of production is constant and equal to $c \in [0, 1)$. When making decisions in period 1, the firm discounts second-period profits with the discount factor $\delta \in [0, 1]$. The firm is not able, when making decisions in period 1, to precommit to any particular period 2 price.

The consumers form a continuum. A consumer's per-period utility is given by

$$u = \begin{cases} r - p & \text{if consuming} \\ 0 & \text{if not consuming,} \end{cases}$$

where p is the leasing price of the good and $r \in [0, 1]$ is the gross utility from consuming one unit of the good. There is heterogeneity with respect to r . The distribution of r values in the consumer population is uniform on $[0, 1]$. The mass of all consumers equals one. When making decisions in period 1, consumers use the discount factor $\delta \in [0, 1]$.¹

A given consumer's valuation r is the same across the two periods. Moreover, while the consumer knows her own r , the firm cannot observe it. However, the firm can keep track of individual consumers' leasing decisions, which means that the

¹That is, the firm and the consumers use the same discount factor.

second-period leasing price can be made contingent on whether or not a consumer leased the good in period 1.

The timing of events is as follows.

- (1) In the beginning of period 1, the firm chooses a first-period leasing price p_1 .
- (2) Thereafter, still in period 1, the consumers observe p_1 and then, simultaneously, choose whether to lease the good (during period 1) or not.
- (3) The firm observes whether the individual consumers chose to lease the good and after that, in the beginning of period 2, chooses two second-period leasing prices: p_2^H and p_2^L . The former price must be paid by those who leased the good in period 1 while the latter price must be paid by those who did not lease in period 1.
- (4) Finally, consumers observe p_2^H and p_2^L and then, simultaneously, choose whether or not to lease in period 2. For the consumers who did not lease in period 1 (and thus face the price p_2^L), the firm incurs the per-unit production cost c . However, for the consumers who did lease in period 1 (and thus face the price p_2^H), the firm does not incur any new production cost, as these goods are already in existence.

Consider an equilibrium of the game that is characterized by an endogenous cutoff value $\hat{r} \geq \frac{1}{2}$, such that consumers lease the good in period 1 if and only if $r \geq \hat{r}$.

- (a) Solve for the equilibrium value of \hat{r} and show that the solution you have found is indeed part of an equilibrium. You may assume that the second-order conditions are satisfied.

(b) Denote total surplus (i.e., the sum of firm profit and consumer surplus) for the market in period t by W_t , for $t = 1, 2$. Write up expressions for W_1 and W_2 , as functions of \hat{r} , p_1 , p_2^L , and p_2^H (i.e., do *not* plug in the equilibrium values of this cutoff value and these prices).

- You are encouraged to attempt this question also if you have failed to answer part (a).

the other manager's instruction before making the output decision?

- You are encouraged to attempt this question also if you have failed to answer part (a).

End of Exam

Question 2: Strategic delegation

Consider a market in which there are two firms, firm 1 and firm 2. The firms produce identical products and they face the following indirect demand function: $p = 45 - 9(q_1 + q_2)$, where p is market price, q_1 is firm 1's output, and q_2 is firm 2's output. Both firms' marginal cost of producing the product is constant and equal to 9, and there are no fixed costs. Moreover, the firms compete in quantities. Firm i ($i = 1, 2$) is owned by individual O_i and managed by some other individual M_i . Each owner O_i can give an instruction to his or her own manager M_i whether to try to maximize the firm's profits or its revenues. The sequence of events of the game is as follows.

1. O_1 and O_2 simultaneously choose whether to instruct its manager to maximize profits (P) or revenues (R).
2. M_1 and M_2 observe their own instruction and the other manager's instruction. Then they simultaneously choose their own firm's output, trying to maximize either the profits or the revenues (depending on the instruction they received).

The objective of each owner is to maximize their own firm's profits.

(a) Solve for all subgame-perfect Nash equilibria of the game described above.

(b) Interpret your results: What is the economic logic that explains why the owners make the choices they make in the equilibrium (or the equilibria) that you derived? Are the managers' choice variables strategic substitutes or strategic complements, and what is the significance of this? What is the significance of the assumption that each manager can observe also