Written Exam at the Department of Economics summer 2019

Industrial Organization

Final (Resit) Exam

August 20, 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: Selling a durable good

There are two time periods, 1 and 2. In each period, a profit-maximizing monopoly firm produces and sells a good. *The good is durable*, which means that if a consumer purchases it in period 1, she can consume it and get utility from this consumption also in period 2. 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.

There is a continuum of consumers who differ from each other in terms of r, the gross per-period utility from consuming one unit of the good. The r values are uniformly distributed on the interval $[0, 1]$ and the total mass of consumers equals one. 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. When making decisions in period 1, consumers use the discount factor $\delta \in [0, 1]$.[1]

The timing of events is as follows.

1. In the beginning of period 1, the firm chooses a price p_1.
2. After that, still in period 1, the consumers observe p_1 and then decide whether to purchase the good or not. A consumer who does purchase receives utility from it during both period 1 and 2. Her net utility (from the perspective of period 1) is thus given by $(1+\delta)r - p_1$. If the consumers jointly purchase the quantity q_1 in period 1, the firm must produce this quantity and thus (in period 1) incur the cost cq_1.
3. In the beginning of period 2, the firm chooses a price p_2.
4. The consumers observe the price p_2, and those who did not buy the good in period 1 have the opportunity of doing it now instead at that price. A consumer who does this receives the net utility $r - p_2$. If the consumers jointly purchase the quantity q_2 in period 2, the firm must produce this quantity and thus (in period 2) incur the cost cq_2.

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

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

(a) Solve for the equilibrium value of $\widehat{r}$ 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 $\widehat{r}$, p_1, and p_2 (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).

In the course, we studied a model of behavior-based price discrimination (BBPD) that is similar to the model above. (In contrast to the model above, in the BBPD model the good was not durable and the firm served two groups of consumers in period 2 and could make them pay different prices.) When studying the BBPD model, we identified two effects that made BBPD (as we had modeled it) good for consumer welfare.

(c) What were these two effects? Explain briefly the logic of the effects and why and how they improved consumer welfare.

- You should not show any mathematics when answering this question (and you will not get any credit if you nevertheless do that).
- You are encouraged to attempt this question also if you have failed to answer parts (a) and (b).

Question 2: Collusion in a Cournot oligopoly with a fixed production cost

Consider a market with two profit-maximizing, quantity-setting firms, indexed by $i = 1, 2$. Firm i's cost function is given by

$$C(q_i) = \begin{cases} 0 & \text{if } q_i = 0 \\ q_i + 8 & \text{if } q_i > 0, \end{cases}$$

where $q_i \geq 0$ is firm i's output. The inverse demand function is given by $p = 13 - q_1 - q_2$, where p is the market price. Also assume that there are infinitely many discrete time periods and that in each period the firms simultaneously choose their quantities. The firms' (common) discount factor is denoted by $\delta \in (0, 1)$. After each period the firms perfectly observe the rival's chosen quantity.

Consider the following grim trigger strategy for player 1:

$$q_{1,t} = \begin{cases} 6 & \text{...if } t \text{ is } \textbf{odd} \text{ and there have been} \\ & \text{no deviations in any period } \tau < t; \\ 0 & \text{...if } t \text{ is } \textbf{even} \text{ and there have been} \\ & \text{no deviations in any period } \tau < t; \\ 4 & \text{...if there has been at least one} \\ & \text{deviation in any period } \tau < t, \end{cases}$$

where $q_{1,t}$ is firm 1's quantity in period t. And consider the following grim trigger strategy for player 2:

$$q_{2,t} = \begin{cases} 6 & \text{...if } t \text{ is } \textbf{even} \text{ and there have been} \\ & \text{no deviations in any period } \tau < t; \\ 0 & \text{...if } t \text{ is } \textbf{odd} \text{ and there have been} \\ & \text{no deviations in any period } \tau < t; \\ 4 & \text{...if there has been at least one} \\ & \text{deviation in any period } \tau < t, \end{cases}$$

where $q_{2,t}$ is firm 2's quantity in period t.

(a) Investigate under what conditions the strategies above constitute a subgame-perfect Nash equilibrium of the infinitely repeated game.[2]

(b) In the context of infinitely repeated games, what is meant by the so-called folk theorem? Also, discuss briefly some criteria used by IO economists to select among multiple equilibria in an infinitely repeated oligopoly game.

End of Exam

[2] You may want to use the formula for an infinite geometric series: $\sum_{t=0}^{\infty} \delta^t = 1/(1-\delta)$ for $\delta \in (0, 1)$.