Written Exam at the Department of Economics summer 2021

Industrial Organization

Final Exam

June 3, 2021

(three-hour closed-book exam)

Answers only in English.

This exam question consists of three pages in total

Falling ill during the exam

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

- 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.
Make sure that you explain all the steps of your analysis and that you define any new notation that you use.
Show all the calculations that your analysis relies on.

Question 1: 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 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).

Question 2: Behavior-based price discrimination and bundling

This is a variation of the two-period monopoly model of behavior-based price discrimination that we studied in the course. We here assume that the monopoly firm sells *two* goods, although these are *sold in a bundle* (both in the first and in the second period).

There are two time periods, $t = 1, 2$. In each period, a profit-maximizing monopoly firm is producing and selling two goods, A and B. The firm has no production costs. The consumers of the model form a continuum, and an individual consumer is characterized by the pair (r_A, r_B), where $r_i \in [0, 1]$ is the consumer's gross utility from consuming good $i \in \{A, B\}$. In the population of consumers, each one of the parameters r_A and r_B is uniformly distributed on the unit interval $[0, 1]$, and they are statistically independent of each other. Moreover, the total mass of consumers equals one. These assumptions imply that we can think of the consumers as being spread out evenly on the unit square. The firm cannot observe an individual consumer's (r_A, r_B); however, a given consumer has the same (r_A, r_B) in each of the two periods. Although the firm sells two goods, it sells them as a bundle; that is, in each of the two periods, the consumers can purchase both goods or no good at all, but they cannot buy only one of the goods. A consumer's per-period net utility if buying the bundle, given a price p, equals $r_A + r_B - p$; not buying yields the utility zero. When making decisions in period 1, the consumers *do not* discount their second-period utilities (i.e., their common discount factor equals one). In other words, the consumers assign equal weight to the first- and second-period utilities. Similarly, when making decisions in period 1, the firm discounts its second-period profits *fully* (i.e., its discount factor equals zero): it only cares about the first-period profits when making decisions in that period.

Although the firm cannot observe individual consumers' valuations, it can keep track of whether an individual consumer purchased the bundle or not in period 1. Hence, in period 2, the firm can make its price for the bundle contingent on that decision: those who bought in period 1 are in period 2 charged the price $p_2^H \in [0, 2]$, while those who did not buy in period 1 are charged the price $p_2^L \in [0, 2]$. Letting the first-period price be denoted by $p_1 \in [0, 2]$, the sequence of events is thus as follows.

1. *Period 1 starts here.* The consumer valuations (r_A, r_B) are realized. Each consumer observes its own valuations. However, the firm only knows the distributions from which the valuations are drawn.
2. The monopolist chooses the first-period price for the bundle, p_1.
3. The consumers (simultaneously) choose whether or not to purchase the bundle.
4. *Period 2 starts here.* The firm chooses the two second-period prices, p_2^L and p_2^H.
5. The consumers observe the prices and then (simultaneously) choose whether to purchase the bundle.

In an equilibrium of the model, a consumer with valuations (r_A, r_B) who expects the second-period prices p_2^L and p_2^H, and who has observed the first-period price p_1, will choose to purchase the bundle in period 1 if, and only if, the following inequality holds:

$$r_A + r_B - p_1 + \max\left\{0, r_A + r_B - p_2^H\right\} \geq r_A + r_B - p_2^L. \tag{1}$$

Clearly, whether a consumer buys or not in period 1 depends only on the sum of r_A and r_B. Let $\widehat{r}$ denote the critical value of $r_A + r_B$ such that a consumer buys if $r_A + r_B > \widehat{r}$ and does not buy if $r_A + r_B < \widehat{r}$. Moreover, suppose that we are looking for an equilibrium where[1]

$$\widehat{r} \geq 1 \qquad \text{and} \qquad \widehat{r} \geq p_2^H. \tag{2}$$

(a) Solve the firm's profit-maximization problem in the second-period H market. That is, derive an expression for p_2^H, as a function of $\widehat{r}$, in an equilibrium where the conditions in (2) hold (assuming that such an equilibrium exists).

(b) Solve the firm's profit-maximization problem in the second-period L market. That is, derive an expression for p_2^L, as a function of $\widehat{r}$, in an equilibrium where the conditions in (2) hold (assuming that such an equilibrium exists). You should assume that the firm's optimal value of p_2^L satisfies $p_2^L \leq 1$.

(c) Does there exist an equilibrium of the model where the conditions in (2) hold? Show that such an equilibrium exists, or show that such an equilibrium does not exist.

(d) Suppose we solved for an equilibrium of the model described above (not necessarily one where (2) holds). Suppose that we also solved for the equilibrium of a variation of that model where the firm, in both periods, sells the two goods separately (but all other assumptions are the same). In which one of the two models should we expect the firm to earn the highest equilibrium profits—the model with bundling or the model with separate prices?

- You do not need to answer with a definite "bundling" or a definite "separate prices." Instead, discuss different reasons—perhaps by referring to related models that we have studied in the course—for why we should expect either the first model or the second model to yield the highest equilibrium profits.

End of Exam

[1] Note that the inequality $\widehat{r} \geq p_2^H$ implies that a consumer who purchased in period 1 has at least a weak incentive to do so also in period 2.