Written Exam at the Department of Economics summer 2018

Industrial Organization

Final (Resit) Exam

August 7, 2018

(3-hour closed book exam)

Answers only in English.

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

NB: If you fall ill during an examination at Peter Bangsvej, you must contact an invigilator in order to be registered as having fallen ill. In this connection, you must complete a form. Then you submit a blank exam paper and leave the examination. When you arrive home, you must contact your GP and submit a medical report to the Faculty of Social Sciences no later than seven (7) 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: Collusion in Hotelling's linear city model

The following is an infinitely repeated game, where the stage game is a standard version of Hotelling's linear city model with exogenous locations.

In a market there are two ex ante identical firms, indexed by $i \in \{1, 2\}$. Each firm has a constant marginal cost $c \geq 0$. There are infinitely many, discrete time periods t (so $t = 1, 2, 3, \ldots$) and at each t the firms simultaneously choose their respective price, p_i^t. The firms' common discount factor is denoted by $\delta \in [0, 1)$. The consumers in the market make up a continuum with mass one. They differ from each other with respect to a variable $x \in [0, 1]$, which we can think of as a consumer's location. The consumers' locations are uniformly distributed on $[0, 1]$. Firm i's location is denoted by l_i, and it is assumed that $l_1 = 0$ and $l_2 = 1$. The consumers have so-called unit demand, meaning that they purchase one unit of the good that is at sale in this market or nothing at all. A consumer with location x has the following per-period utility function:

$$v(x) = \begin{cases} r - \tau |x - l_i| - p_i^t & \text{if buying from firm } i, \\ 0 & \text{if not buying at all.} \end{cases}$$

The function $\tau |x - l_i|$, with parameter $\tau > 0$, measures a transportation cost or "mismatch" cost. The parameter $r > c$ represents a consumer's gross per-period utility from consuming the good.

The timing of events within each period is as follows:

1. The firms simultaneously choose their prices, p_1^t and p_2^t.
2. The consumers observe the prices and then choose from which firm to buy (or they choose not to buy at all).
3. The firms receive their profits (each firm can also observe the rival's profits).

In the course we showed that, if the parameters are such that the market is covered (i.e., all consumers choose to buy), the one-shot game has an equilibrium in which each firm charges the price $p^n = c + \tau$ and earns the profit $\pi^n = \tau/2$. Thus, in the limit as $\tau \to 0$, there is marginal cost pricing and the firms earn zero profits.

Suppose the firms collude by choosing $(p_1^t, p_2^t) = (p^m, p^m)$ in all periods, where p^m is the price that maximizes the sum of their per-period profits; moreover, suppose the optimal collusive price p^m is such that the market is covered (to ensure this, assume that $\tau < \frac{2}{3}(r - c)$). The collusion is sustained with the help of the following trigger strategy, involving Nash reversion forever. In any period t:

(i) If both firms, in all periods $t' < t$, have chosen the price p^m, then firm i also in this period chooses the price p^m.

(ii) Otherwise, firm i chooses the price $p^n = c + \tau$.

By standard arguments, a subgame-perfect Nash equilibrium in which both firms follow the above strategy exists if, and only if,

$$\frac{\pi^m}{1-\delta} \geq \pi^d + \delta \frac{\pi^m}{1-\delta} \Leftrightarrow \delta \geq \frac{\pi^d - \pi^m}{\pi^d - \pi^n} \stackrel{\text{def}}{=} \delta_0,$$

where π^m is the per-period profit each firm earns when both firms charge the price p^m, and π^d is the per-period profit a firm earns when it chooses the optimal deviation price p^d and the rivals chooses p^m. That is, δ_0 is the critical value of the discount factor that is required for collusion to be possible.

(a) Compute $\lim_{\tau \to 0} \delta_0$. Solve as much as you need of the model, in order to obtain an expression (in terms of exogenous parameters) for this limit value.

Answer the following question verbally only.

(b) Suppose we ("society") could move from a collusive situation where the firms charge the price p^m, to a competitive situation where they charge p^n. How should we expect this change to affect total surplus in the market? Explain your answer.

Question 2: A market with vertically related firms

Consider a market in which consumers have unit demand,[1] with valuations r. The r's are uniformly distributed on the unit interval $[0,1]$ and the total mass of consumers equals one. The good in this market is sold by a monopoly retailer, Firm D (the downstream firm). At the outset of the game the consumers are not aware of the existence of this firm and therefore they do not know about their opportunity to purchase the good. However, by choosing an advertising level $\lambda \in [0,1]$, at a cost $\frac{1}{2}\lambda^2$, Firm D can reach a fraction λ of all consumers and thereby make them aware of their opportunity to buy the good at the price p (all consumers on the unit line have the same likelihood of being reached). All the other consumers, making up the fraction $1-\lambda$, can by assumption not buy the good. The utility of a consumer with valuation r is given by:

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

All the units of the good that Firm D sells are supplied by an upstream firm, Firm U. The price that Firm D must pay Firm U to obtain q units of the good equals $T = wq$, where w is the (constant) per-unit wholesale price chosen by Firm U. In order to produce the quantity q of the good, Firm U must incur the production cost cq, where $c \in [0,1)$ is an exogenous parameter. Firm D does not have any costs on top of the costs of buying the goods from Firm U and the advertising costs. Each firm wants to maximize its profits. The profit functions of the two firms can be written as

$$\pi^D = \lambda(1-p)(p-w) - \frac{1}{2}\lambda^2$$

and

$$\pi^U = \lambda(1-p)(w-c),$$

respectively.

The sequence of events is as follows.

1. Firm U chooses w.
2. Firm D observes w and then chooses p and λ.
3. Each consumer is reached, or not reached, by the advertisements. Those who are reached decide whether to buy.

Answer the following questions:

(a) Solve for the subgame-perfect equilibrium values of p, w and λ. You may assume that the second-order conditions are satisfied.

(b) Suppose the firms integrate and become one single firm. Calculate again the subgame-perfect equilibrium values of p and λ. You may assume that the second-order conditions are satisfied.

(c) Would you expect aggregate consumer surplus to be largest under integration or under non-integration? Spell out your reasons and the logic. Answer verbally only.

(d) Suppose now that, as under (a), the firms are not integrated. Moreover, the retail price p is now chosen *not* by Firm D at stage 2, but by Firm U at stage 1 (we can interpret this as resale price maintenance, RPM). Everything else in the model is unchanged. Would you expect RPM, modeled like this, to give rise to the same outcome (i.e., the same equilibrium values of p and λ) as under integration? Spell out your reasons and the logic. Answer verbally only.

End of Exam

[1] This means that the consumers demand either exactly one unit of the good or no unit at all.