Written Exam for the B.Sc. in Economics Summer 2010

# Industrial Organization

Final Exam

June 16, 2010

(3-hour closed book exam)

Please note that the language used in your exam paper must correspond to the language of the title for which you registered during exam registration. I.e. if you registered for the English title of the course, you must write your exam paper in English. Likewise, if you registered for the Danish title of the course or if you registered for the English title which was followed by “eksamen på dansk” in brackets, you must write your exam paper in Danish.

If you are in doubt about which title you registered for, please see the print of your exam registration from the students’ self-service system.

**Attempt all three questions**

## Question 1

a) Consider a firm that has a monopoly in a market where demand is given by $q = D(p)$. Let $C(q)$ denote the firm's cost function. Define the Lerner index and then derive the inverse elasticity rule. Explain the intuition behind this rule — how and why does the elasticity matter?

b) State the Coase conjecture. Explain the intuition.

c) Explain briefly the conjectural-variations approach to modelling an oligopoly.

d) Consider the circular city model (as described by Tirole).

   (i) Explain in words (you do not need to derive the result formally) how the equilibrium number of entering firms relates to the socially optimal number of entering firms (i.e., the number of firms that minimizes the sum of the firms' entry costs and the consumers' transportation costs). What is the intuition?

   (ii) In the circular city model the locations of the firms are given exogenously. However, in other models they are not. In his discussion, Tirole mentions one force that tends to make firms differentiate, and three forces that oppose product differentiation. Briefly discuss these four forces.

**Question 2**

Consider two vertically related monopoly firms. The upstream firm produces its good using the cost function $C(q) = \frac{1}{2}q^2$, where $q$ is the quantity produced. It chooses a linear wholesale price, denoted $p_w$. The downstream firm is a retailer and sells the good that the upstream firm produces to the final consumers. The demand of the final consumers is given by $D(p) = 30 - p$, where $p$ is the price chosen by the downstream firm. This firm does not to have any additional costs on top of the costs of purchasing the good from the upstream firm at the wholesale (per unit) price $p_w$. The sequence of events is as follows. First the upstream firm chooses $p_w$; thereafter, knowing $p_w$, the downstream firm chooses $p$.

a) Solve for the subgame perfect Nash equilibrium of the model described above. Calculate the equilibrium level of profits of each firm and the equilibrium level of consumer surplus in the market.

b) Suppose the firms merge. Solve for the retail price that maximizes the profits of the integrated firm. Calculate the equilibrium level of profits of the integrated firm and the equilibrium level of consumer surplus in the market.

c) *[You are encouraged to attempt parts c) and d) even if you have not been able to answer parts a) and b).]* Explain in words what is meant by "double marginalization" and the intuition behind this phenomenon. Relate your answer to the results you have provided under a) and b).

d) Suppose the two firms remain separate as in a). Specify a two-part tariff that — if this is charged by the upstream firm instead of the linear price — gives rise to the same consumer price and level of joint profits (i.e., the sum of upstream and downstream profits) as under integration. Also explain why the two-part tariff achieves that outcome.

**Question 3**

Consider Tirole's version of the Green-Porter model (exactly the same version as we studied in the course). In a market there are two identical firms, firm 1 and firm 2. They produce a homogeneous good and 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, $p_1^t$ and $p_2^t$. The firms' common discount factor is denoted $\delta \in (0, 1)$. As the good is homogeneous, demand is a function of the lowest price, $p^t = \min\{p_1^t, p_2^t\}$. Demand is stochastic: with probability $1 - \alpha$ (where $\alpha \in (0, 1)$), demand in period $t$ is high, $q^t = D(p^t)$ $(> 0)$; and with probability $\alpha$, demand in period $t$ is low — indeed, equal to zero. Demand realizations are independent across time. If the firms charge the same price they share demand equally between themselves. Therefore, firm 1's demand is (the expression for firm 2's demand is analogous):

$$D_1\left(p_1^t, p_2^t\right) = \begin{cases} D\left(p_1^t\right) & \text{if } p_1^t < p_2^t \text{ and high state} \\ \frac{1}{2} D\left(p_1^t\right) & \text{if } p_1^t = p_2^t \text{ and high state} \\ 0 & \text{if } p_1^t > p_2^t \text{ or low state.} \end{cases}$$

The firms cannot observe the price charged by the rival firm (not even the prices charged in previous periods). Moreover, the firms cannot observe the state of demand. However, in each period, after having chosen their prices, the firms observe their own demand, although not their rival's demand.

a) Let $p^m$ be the high demand monopoly price, i.e., the price that maximizes $(p - c) D(p)$. Consider a trigger strategy (the same one as we studied in the course) where each firm charges $p^m$ until at least one firm makes a zero profit; the occurrence of a zero profit triggers a punishment phase, which lasts for $T$ periods; after the $T$ periods the firms revert to the collusive phase and charge $p^m$ as long as they both make positive profits. Suppose that $\alpha < \frac{1}{2}$. Derive a condition (stated in terms of a critical level of $\delta$) under which a subgame perfect Nash equilibrium in which the firms follow the trigger strategy exists. Interpret your result.

b) *[You are encouraged to attempt part b) even if you have not been able to answer part a).]* In the course we studied two theories that give rise to specific predictions about the relationship between the business cycle and the likelihood of a price war. The Green-Porter model was one of these. Give a brief account (in words) of the other theory and explain how and why the predictions of the two theories differ from each other.

END OF EXAM