Written Exam for the M.Sc. in Economics 2012-II

Advanced Industrial Organization

Final Exam
(Re-exam)

August, 2012

(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.

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ALL QUESTIONS BELOW SHOULD BE ANSWERED

Problem 1.

1. Consider a Hotelling market with consumers uniformly distributed on the interval [0,1]. Consumer $x's$ location is x.

Two firms have entered the market, A and B, they have located at the end points of the line. Firm A in 0 and firm B in 1. Both firms have constant marginal costs, which are normalized to 0. The firms choose prices and are profit maximizing.

A consumer is interested in at most one unit of the (differentiated) good. Consumer $x's$ utility if she buys at the price p_A from firm A is

$$v - p_A - tx$$

and similarly it is

$$v - p_B - t(1-x)$$

if she buys at the price p_B from firm B. In this exercise, you shall just assume that the consumers' valuation of the good always is sufficiently high so that all consumers buy the good in equilibrium.

a. Find the symmetric equilibrium price.

We solve for the Nash equilibrium in prices.

first find the indifferent consumer

$$v - p_A - tx = v - p_B - t(1-x)$$

so she is located in

$$x = \frac{1}{2} + \frac{p_B - p_A}{2t}$$

Firm A's problem: Given p_B *Max* $_{p_A}$ $p_A\left(\frac{1}{2} + \frac{p_B - p_A}{2t}\right)$

The Foc gives the reaction fctn

$$p_A = \frac{1}{2}(p_B + t)$$

Now - after the foc - use symmetry, so that

$$p_A = p_B = p = \frac{1}{2}(p + t)$$

giving

$$p = t$$

Each firm sells to half of the consumers, so the profit to each firm is

$$\pi = \frac{t}{2}$$

b. Suppose that the firms cannot see the exact location of a consumer but they are able to identify which half of the line a consumer belongs to, i.e. whether $x \leq \frac{1}{2}$ or $x > \frac{1}{2}$. This enables them to price discriminate among the two groups of consumers (those with $x \leq \frac{1}{2}$ and those with $x > \frac{1}{2}$). Find the symmetric equilibrium with price discrimination. Is price discrimination good or bad for (all/some) consumers, is it beneficial for the firms? Does it affect welfare (comparing with the outcome in a)?

Let $\hat{p}_A$ denote the price A offers to consumers on its hometurf (consumers $x \leq \frac{1}{2}$) and p_A the price for consumers on B's hometurf (consumers $x > \frac{1}{2}$). Similarly B offers $\hat{p}_B$ on its hometurf and p_B on A's hometurf.

Look at A's hometurf where consumers face prices $(\hat{p}_A, p_B)$ The indifferent consumer is located at

$$x = \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t}$$

Firm A's problem

$$\max_{\hat{p}_A} \hat{p}_A \left(\frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right)$$

giving the reaction fctn

$$\hat{p}_A = \frac{1}{2}(p_B + t)$$

Firm B sells to all consumers to the right of the indifferent consumer and to the left of consumer $x = \frac{1}{2}$ (since we are considering A's hometurf). Hence, B's problem is

$$\max_{p_B} p_B \left(\frac{1}{2} - \left(\frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right) \right)$$

giving the reaction fctn

$$p_B = \frac{1}{2}\hat{p}_A$$

In equilibrium both firms choose prices according to their reaction fctn, so that we solve the two equations in two unknowns

$$\begin{aligned} \hat{p}_A &= \frac{1}{2}(p_B + t) \\ p_B &= \frac{1}{2}\hat{p}_A \end{aligned}$$

giving

$$\hat{p}_A = \frac{2}{3}t, p_B = \frac{1}{3}t$$

and the indifferent consumer is located at

$$x = \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} = \frac{1}{2} + \frac{\frac{1}{3}t - \frac{2}{3}t}{2t} = \frac{1}{3}$$

By symmetry, the same happens on B's turf, so that

$$\hat{p} = \hat{p}_A = \hat{p}_B = \frac{2}{3}t, \text{ and } p = p_A = p_B = \frac{1}{3}t$$

and the indifferent consumer on B's turf is located at $2/3$.

The profit to a firm is

$$\frac{1}{3}\frac{2}{3}t + \left(\frac{2}{3} - \frac{1}{2}\right)\frac{1}{3}t = \frac{5}{18}t$$

This is less than if they did not price discriminate, cf a above, where each firm's profit is $t/2$.

Welfare is decreased as consumers in the middle switch supplier compared with a, so transportation costs increase. Consumers $x \in [\frac{1}{3}, \frac{1}{2}]$ buy from B and get increased transportation costs compared with a. Similarly consumers $x \in [\frac{1}{2}, \frac{2}{3}]$ buy from A and get increased transportation costs compared with a.

Consumer welfare is increased. All consumers are offered a price $\hat{p} = \frac{2}{3}t$ from the firm, they buy from in subquestion a, this is better than being offered at price $p = t$. Some consumers then switch suppier, but this is because it makes them even better of. So consumer welfare is increased .

c. Now suppose that firm A is able to distinguish whether consumers are located to the left ($x \leq \frac{1}{2}$) or the right ($x > \frac{1}{2}$) but firm B is not.

Find the equibrium prices in this asymmetric case and the profits to the firms.

Firm B is then posing the price p_B to all consumers and firm A is posing $\hat{p}_A$ on its hometurf and p_A on B's turf.

A's reaction function can be copied from above (where we have hometurf pricing and away turf pricing) it is

$$\begin{aligned} \hat{p}_A &= \frac{1}{2}(p_B + t) \\ p_A &= \frac{1}{2}p_B \end{aligned}$$

Firm B's reaction function, we need to work a bit on. The indifferent consumer on A's turf is located at

$$x = \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t}$$

and B' sells to $x \in \left[\frac{1}{2} + \frac{p_B - \hat{p}_A}{2t}, \frac{1}{2}\right]$ on A's turf

The indifferent consumer on B's turf is located at

$$x = \frac{1}{2} + \frac{p_B - p_A}{2t}$$

and B' sells to $x \in \left[\frac{1}{2} + \frac{p_B - p_A}{2t}, 1\right]$ on its hometurf.

So B's profit function is (assuming that $\hat{p}_A > p_B > p_A$, which we verify below)

$$\pi_B = p_B \left(\frac{1}{2} - \left(\frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} \right) + 1 - \left(\frac{1}{2} + \frac{p_B - p_A}{2t} \right) \right)$$

The first order condition gives the best reply

$$p_B = \frac{1}{4} \left(\hat{p}_A + p_A + t \right)$$

In equilibrium, both firms choose prices according to their reaction function, so in eq

$$\begin{aligned} \hat{p}_A &= \frac{1}{2} \left(p_B + t \right) \\ p_A &= \frac{1}{2} p_B \\ p_B &= \frac{1}{4} \left(\hat{p}_A + p_A + t \right) \end{aligned}$$

giving

$$\hat{p}_A = \frac{3}{4} t, p_A = \frac{1}{4} t, p_B = \frac{1}{2} t$$

The indifferent consumer on A's turf

$$x = \frac{1}{2} + \frac{p_B - \hat{p}_A}{2t} = \frac{1}{2} + \frac{\frac{1}{2} t - \frac{3}{4} t}{2t} = \frac{3}{8}$$

and on B's turf

$$x = \frac{1}{2} + \frac{p_B - p_A}{2t} = \frac{1}{2} + \frac{\frac{1}{2}t - \frac{1}{4}t}{2t} = \frac{5}{8}$$

Hence the profit to firm A is

$$\hat{p}_A \frac{3}{8} + p_A \left(\frac{5}{8} - \frac{1}{2} \right) = \frac{3}{4} t \frac{3}{8} + \frac{1}{4} t \left(\frac{5}{8} - \frac{1}{2} \right) = \frac{5}{16} t$$

and the profit to B is

$$p_B \left(\frac{1}{2} - \frac{3}{8} + 1 - \frac{5}{8} \right) = \frac{1}{2} t \left(\frac{1}{2} - \frac{3}{8} + 1 - \frac{5}{8} \right) = \frac{1}{4} t$$

A little check, which is not supposed to be part of a fully satisfactory answer. However, one could worry that it could be optimal for firm B altogether giving op competing on A's turf and just concentrate on its own turf. B's profit function would then be

$$\pi_B = p_B \left(1 - \left(\frac{1}{2} + \frac{p_B - p_A}{2t} \right) \right)$$

giving the best reply

$$p_B = \frac{1}{2} (p_A + t) = \frac{1}{2} \left(\frac{1}{4} t + t \right) = \frac{5}{8} t$$

giving profit

$$\pi_B = p_B \left(1 - \left(\frac{1}{2} + \frac{p_B - p_A}{2t} \right) \right) = \frac{5}{8} t \left(1 - \left(\frac{1}{2} + \frac{\frac{5}{8}t - \frac{1}{4}t}{2t} \right) \right) = \frac{25}{128} t$$

As $\frac{25}{128}t < \frac{1}{4}t$ this strategy is not worthwile and we found the correct solution above.

d. Now suppose that the firms are ignorant about consumers' locations, just like in subquestion a. above. However, they both individually have the option of making an investment in a market survey, which will enable them to identify whether a consumer is located to the left ($x \leq \frac{1}{2}$) or to the right ($x > \frac{1}{2}$) and thus enable them to price discriminate between the two groups.

Set up the investment game, i.e. the two by two game, where each firm has two options: invest or not invest in a market survey and use the profits you derived above as payoffs for the different cases.

The game looks like this

		B	
		invest	don't invest
A	invest	$\frac{5}{18}t$, $\frac{5}{18}t$	$\frac{5}{16}t$, $\frac{1}{4}t$
	don't invest	$\frac{1}{4}t$, $\frac{5}{16}t$	$\frac{t}{2}$, $\frac{t}{2}$

d. Find the pure strategy Nash equilibrium/equilibria to the investment game. Comment on the result.

There are two equilibria, (invest, invest) and (don't invest, don't invest). The best equilibrium for the firms is the one where neither of them invest. However, if each firm expects the other firm to invest, the best decision is to invest.

In game theory lingo, the game is a coordination game with two Nash equilibria, where one of the equilibria Pareto dominates the other.

e. The tricky one. Suppose that firm A can make a decision on whether to invest or not before firm B and that A can communicate its decision to B. Which decision will A then take, and how will B react to that ?

A should not invest. When A moves first it can then ensure coordination on the non-investment outcome, which is best for both firms. when A does not invest best reply for B is not to invest.

Exercise 2: Consider a Cournot oligopoly with two firms, $i = 1, 2$, producing a homogenous good. We call their quantities q_1 and q_2, respectively. They are facing the inverse demand curve $P = 1 - Q$ where P is the price and $Q = q_1 + q_2$ is the total quantity sold. Both firms invest in R&D. Firm i chooses a reduction x_i in its marginal cost, which costs ½ x_i^2. The marginal cost of firm i becomes ½ - x_i.

(i) Find the subgame perfect Nash equilibrium of the game where the firms first choose R&D expenditures non-cooperatively and subsequently compete à la Cournot in the market for the produced good.

Answer: *We have that* $\pi_i = \frac{\left(\frac{1}{2}+2x_i-x_j\right)^2}{9} - \frac{1}{2}x_i^2$ *and* $q_i = \frac{\frac{1}{2}+2x_i-x_j}{3}$ *for given* x_i *and* x_j*. Solving for the R&D choices yields* $x_1^* = x_2^* = \frac{2}{5}$*. Hence,* $\pi_1^* = \pi_2^* = \frac{1}{100}$ *and* $q_1^* = q_2^* = \frac{3}{10}$.

Suppose now that the firms have the option of forming a research joint venture (RJV). The RJV does not allow the firms to coordinate their R&D investments. However, forming a RJV allows the firms to share the results of their R&D investments. In particular, the marginal costs of production for the firms are ½ - x_i - x_j. A firm thus benefits equally from a R&D investment made by itself and by its competitor.

(ii) Find the subgame perfect Nash equilibrium of the subgame where the firms form a RJV, choose R&D expenditures non-cooperatively (knowing that the R&D results are shared afterwards), and subsequently compete à la Cournot in the market for the produced good.

Answer: *We have that* $\pi_i = \frac{\left(\frac{1}{2}+x_i+x_j\right)^2}{9} - \frac{1}{2}x_i^2$ *and* $q_i = \frac{\frac{1}{2}+x_i+x_j}{3}$ *for given* x_i *and* x_j*. Solving for the R&D choices yields* $x_1^* = x_2^* = \frac{1}{5}$*. Hence,* $\pi_1^* = \pi_2^* = \frac{1}{50}$ *and* $q_1^* = q_2^* = \frac{3}{10}$.

(iii) Do the firms form a RJV in equilibrium? Is a RJV advantageous to the consumers? Is it welfare improving?

Answer: *The consumers are indifferent whether the firms form a RJV or not as the quantities produced (and thus the price) are the same. The firms strictly prefer a RJV as it allows them to save on R&D costs. Forming a RJV is welfare-enhancing.*

Exercise 3: In June of 2010 Illinois Attorney General Lisa Madigan opened an antitrust investigation of the popular Chicago music festival. The basis for this investigation is the exclusivity clause which artists playing the festival must sign, restricting them from playing any public or private concerts within 300 miles of the festival for 180 days prior to and 90 days past the summer event. There exists the rumor that Roskilde Festival, the largest music festival in Northern Europe, also asks the major bands to sign a similar exclusivity clause.

Suppose that you were asked to assist the Danish Competition Policy Authority in its investigation of the use of exclusivity clauses by the Roskilde Festival:

(i) Discuss whether there is a market for music festivals or whether there is a broader market for concerts.

Answer: *The excellent answer should discuss the degree of demand and supply side substitution between concerts at a festival and standalone concerts at music venues. The answer should refer to the SSNIP test. The following considerations could enter into the discussion:*

- *A festival is essentially a bundle of concerts that are offered within a few days whereas venues offer concerts spread over the year. The experience of going to a music festival is also quite different from a concert at a venue. Concerts at a festival and at music venues are, therefore, differentiated goods. This suggests a narrow market definition.*
- *There are likely to be significant entry barriers to starting a music festival in terms of financing, organization, and reputation. Hence, a SSNIP is unlikely to trigger entry by a new festival. This also points to a narrow market definition.*
- *However, if the Roskilde Festival uses exclusivity clauses similar to those employed by the Chicago music festival, this would suggest that concerts are perceived to be competing by the market participants. This would suggest that concerts in close proximity in time and space belong to the same market as the concerts at the festival.*

(ii) Discuss whether exclusivity clauses can have anti-competitive effects in this market.

Answer: *The artists might face the problem that once they have sold a concert, they have an incentive to sell another one. They are thus effectively competing with themselves as in the model of foreclosure by Hart and Tirole (covered in the article by Rey and Tirole). The artists may thus have an interest in* *entering into exclusivity in order to commit themselves to reducing the number of concerts sold. However, this argument applies independently of whether the artists enter into exclusivity with the festival or a music venue.*

Another issue, which was the concern in the US case, is that the exclusivity contracts may foreclose the music venues' access to essential inputs, artists. The festival may thus be able to use exclusivity clauses to reduce the competition in the market for concerts; with fewer venues there will be fewer concerts as well. Following the Chicago critique of exclusive dealing, a key issue is whether the festival is willing to compensate the artists sufficiently to make exclusivity an equilibrium outcome. The cost of running a music venue is likely to have an important fixed component. Hence, we know from Rey and Tirole that if the festival is able to reduce the profit of the music venues by foreclosing their access to artists, an anti-competitive exclusionary equilibrium may exist.