International Master of Science in Business Economics

Economics of Business and Markets

Problem Set 1

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Exercise 1

A. "In the United States concentration ratios are published by the government for specific industries and products based on aggregate national statistics. The interpretations of these concentration measures may misleadingly indicate that markets are less concentrated than it is true."

Discuss and present all the arguments that might sustain this statement.

B. In 1999, Fiat entered into an Agreement and Plan of Merger with *Case* for $4.3 billion. Prior to the merger, the market for four-wheel-drive tractors consisted of five firms. The market was highly concentrated, with a Herfindahl index of 0.3025. *Case*'s share of the market was 27%, while Fiat comprised just 13% of the market. If approved, by how much would the post-merger Hirfindahl index increase? Based only on this information, do you think the Justice Department unconditionally approved the merger? Explain.

(Final exam, 2009/2010)

C. Suppose that the (national domestic) four-firm concentration ratio of Industry X is much higher today that it was 50 years ago. Explain why Industry X may be more competitive today. Consider transportation cost and imports in your answer.

Exercise 2

A. Two firms compete on prices in an homogeneous product market. In this market there are N>0 consumers; each one buys one unit if the price of the product does not exceed 15 euros, otherwise he does not buy. Consumers buy from the firm that sells at a lower price. If both firms set the same price each one gets 50% of the market.
   Assume that the unit cost of firm 1 is 5 euros and the unit cost of firm 2 is 8 euros. Firms compete in the market for an infinite period of time.

   a) Define a strategy in prices (trigger strategy) for both firms such that the price equilibrium will be the collusive price level: 15 euros. If *r* is the discount rate then compute the maximum value of *r* that sustains the price strategy that you propose as the equilibrium of this non-cooperative game.

   b) Suppose that firm 2 invested in a new technology that allows for a reduction of the unit cost to the same level of firm 1's. Do you think that this new situation will help to implement the cooperative solution? Justify your answer.

B. After several years of severe price competition that damaged Boeing's and Airbus' profits, the two companies have recently pledged that they will not sink into another price war. However, in June 1999, Boeing made an unusual offer to sell 100 small aircraft to a leasing corporation at special discount prices. (Although customers never pay list prices, it was felt that this deal was particularly attractive.) Boeing's move follows a similar one by Airbus.
   Explain why do you think it is so difficult for aircraft manufacturers to collude and avoid price wars.

   in *Introduction to Industrial Economics*, L.Cabral, Chapter 8

C. Consider the following definition:

"A ***most favored customer clause*** is a provision in a sales contract that promises a buyer that it will pay the lowest price the seller charges."

Consider a duopoly consisting of two firms, Amalgamated Electric (AE) and Carnegie-Manheim (C-M), which sell products that are somewhat differentiated. Each firm sells to customers with different price elasticities of demand and, as a result, occasionally discounts below list price for the most price-elastic customers. Suppose, now, AE adopts a contemporaneous most favored customer policy, but C-M does not. What will happen to AE's average equilibrium price? What will happen to C-M's average equilibrium price?

in *Economics of Strategy*, Besanko at al, chapter 8

D. Explain why it is often argued that price wars may be more likely to occur during low- demand periods than high-demand periods. Are there factors that might reverse this implication? That is, can you think of reasons why the attractiveness of deviation from cooperative pricing might actually be greater during booms (high demand) than during busts (low demand)?

in *Economics of Strategy*, Besanko at al, chapter 8

Exercise 3

Suppose that in a certain region there is a single breakfast cereals producer. There are 3 millions of consumers in this region with preferences that are uniformly distributed along a (0,3) segment, where 0 represents the sweetest type of cereals and 3 represents the healthiest type of cereals. Due to technological restrictions firms can only introduce products at points {0, 1, 2, and 3} of the segment.

Firms in this market have negligible marginal costs, but significant sunk costs of entering the market that amount to 5 monetary units.

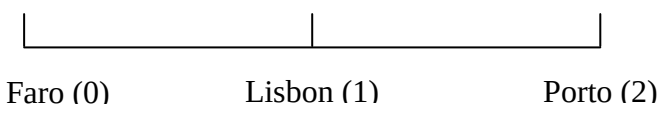
Each consumer buys a single unit and incurs in transportation costs that are equal to $(v-x)^2$, where v is the firm's location in terms of its product variety and x is consumer location in terms of its preferences. The consumers' reservation price is 12.

a) Suppose that firm A is the only producer in this region and is already located in point 1. Determine its optimal price and profits.
b) Firm B is thinking about entering the market with a new product and firm A is not anticipating firm B's entrance. Which location should firm B choose for its product? Calculate the optimal prices and profits arising from this new situation.
c) A consultant has informed Firm A about firm B's potential entrance. Firm A quickly developed a plan for the introduction of a new product in point 2 of the segment. What is the purpose of this strategy? Under which conditions will it be successful? Give a careful and clear explanation without explicitly solving the problem.

Exercise 4

Consider again the market for *cheap* smart phones in Portugal. The firms that want to enter the market plan to construct a store from where they distribute the smart phones to the customers. Once all the customers have bought one smart phone, they will keep that device for the rest of their life. For the purpose of the exercise, consider that the cost with the smart phones to the companies is insignificant. However, opening a store has an **installation cost** of 500€ (equal for both firms).

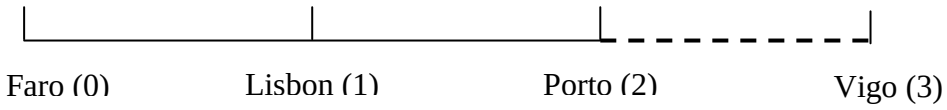
There are three possible equidistant locations for the stores of firms operating in this sector, namely Faro, Lisbon and Porto, and the Portuguese market for this product has 2000 customers uniformly distributed along the range [0, 2].



These customers decide to buy from the store that minimizes their total cost, that is, the price charged by the firm plus transportation costs. Those transportation costs are equal to $(v-x)^2$, where "v" is the location of the firm and "x" the location of the customer. The consumers will only buy the product if that total cost is not bigger than their reservation price, equal to 10 €.

Imagine that Alca-Tell decides first where to open the store, and that Sam-Sing observes this decision and chooses its location afterwards.

Consider now that with a probability of 50% the market is extended up to Vigo **after the firms have already chosen their locations**, adding another 1000 consumers to the relevant market (also uniformly distributed):



Note: that when the firms enter the market, it is not yet possible to open the store in Vigo.

a) When deciding to enter the market (at positions 0,1 or 2), will Alca-Tell be indifferent between Faro and Porto? Which locations will the firms choose? Explain in words (without calculations).
b) Compute the prices and the profits of both firms **if the expansion of the market occurs** and if both firms remain on the locations that they have chosen initially.

Assume that, after the expansion, only Alca-Tell has the opportunity to change the location of the store (it would have to destroy its previous store and open another one, paying again the installation cost). However, the Portuguese government demands that Alca-Tell decides **before entering** whether it will change its location or not in case of a market expansion, signing a contract that costs 1000€.

Furthermore, it knows the following information:

- If the expansion does not occur, both firms will practice a price equal to 4€.

- If the expansion occurs, and Alca-Tell changes its location, both firms practice a price equal to 9€

c) Should Alca-Tell sign the contract? Justify quantitatively.

(Final exam, 2009/2010)

Exercise 1

A

The main arguments to sustain the statement that aggregate domestic statistics might misleadingly indicate that markets are less concentrated, are:

- National statistics don´t look at the regional dimension of competition. For instance, in the presence of high transportation costs each firm might have a regional monopoly, while statistics suggest that firms share the national market.
- Domestic statistics might ignore the fact that some firms have significant control of other firms in the same sector (shareholders).
- Aggregating across product varieties can disguise higher concentration ratios in some particular product varieties.

B

Prior to the merger the Herfindahl index was:

$$0{,}27^2 + 0{,}13^2 + x = 0{,}3025 \Rightarrow x = 0{,}2127$$

(where x designates the sum of the squares of the market shares of the remaining firms).

Post-merger Herfindahl index:

$$0{,}4^2 + 0{,}2127 = 0{,}3727$$

The merger would represent a change in the Herfindahl index of 0,0702.

An unconditional approval is not very likely, since the market is already very concentrated, both in terms of Herfindahl index and in terms of the number of firms.

C

In this case a higher four-firm concentration ratio (C4-ratio) might be compatible with a more competitive market in the following circumstances:

- If the industry has witnessed a lowering of transportation costs. In this case, the firms lost competitive advantages due to their geographical location, decreasing their regional market power. Lower transportation costs make the existence of regional monopolies less likely.

- Consider the case where the globalization process promotes the import of the product produced in industry X. If we take into account that import data is excluded from national domestic statistics, the importance of imports may be neglected in the C4-ratio, indicating that the domestic market is dominated by few firms, while in reality imports mitigate the market power exercised by domestic firms.

Exercise 2

A

a)

Collusive solution (Price: P=15)

$$\Pi_1 = (15-5)\cdot\frac{N}{2} = 5N$$

$$\Pi_2 = (15-8)\cdot\frac{N}{2} = 3{,}5N$$

If firm 1 deviates, it will set P=14,999…≈15, and firm 2 will leave the market.

$$\Pi_1 = (15-5)\cdot N = 10N$$

$$\Pi_2 = 0$$

If firm 2 deviates, it will set P=14,999…≈15, and firm 1 will leave the market.

$$\Pi_1 = 0$$

$$\Pi_2 = (15-8)\cdot N = 7N$$

In the Nash equilibrium of this game, firm 1 will set P=7,999…≈8 and firm 2 will leave the market.

$$\Pi_1 = (8-5)\cdot N = 3N$$

$$\Pi_2 = 0$$

The **trigger strategies** can be defined in the following way:

- Firm 1
  - 1st period: choose the collusive price of P=15.
  - Following periods: choose the collusive price of P=15, if all the previous periods have led to the collusive outcome; choose a price equal to P=7,999…≈8 otherwise.
- Firm 2
  - 1st period: choose the collusive price of P=15.
  - Following periods: choose the collusive price of P=15, if all the previous periods have led to the collusive outcome; choose a price

equal to P=8 otherwise (for firm 2 this strategy will imply that it will leave the market if firm 1 chooses a price of P=7,999…≈8).

Firm 1 will not deviate if

$$5N + \frac{5N}{1+r} + \frac{5N}{(1+r)^2} + ... > 10N + \frac{3N}{1+r} + \frac{3N}{(1+r)^2} + ... \Rightarrow r < 40\%$$

Firm 2 will not deviate if

$$3{,}5N + \frac{3{,}5N}{1+r} + \frac{3{,}5N}{(1+r)^2} + ... > 7N + \frac{0}{1+r} + \frac{0}{(1+r)^2} + ... \Rightarrow r < 100\%$$

Hence, the maximum discount rate 'r' that sustains the collusive outcome is r = 40%.

b)

Collusive solution (Price: P=15)

$$\Pi_1 = \Pi_2 = (15-5) \cdot \frac{N}{2} = 5N$$

If firm 1 deviates, it will set P=14,999…≈15, and firm 2 will leave the market.

$$\Pi_1 = (15-5) \cdot N = 10N$$
$$\Pi_2 = 0$$

If firm 2 deviates, it will set P=14,999…≈15, and firm 1 will leave the market.

$$\Pi_1 = 0$$
$$\Pi_2 = (15-5) \cdot N = 10N$$

In the Nash equilibrium both firms will set a price equal to 5and will share the market.

$$\Pi_1 = \Pi_2 = (5-5) \cdot \frac{N}{2} = 0$$

Firm 1 will not deviate if

$$5N + \frac{5N}{1+r} + \frac{5N}{(1+r)^2} + ... > 10N + \frac{0}{1+r} + \frac{0}{(1+r)^2} + ... \Rightarrow r < 100\%$$

Firm 2 will not deviate if

$$5N + \frac{5N}{1+r} + \frac{5N}{(1+r)^2} + ... > 10N + \frac{0}{1+r} + \frac{0}{(1+r)^2} + ... \Rightarrow r < 100\%$$

The maximum discount rate 'r' that sustains the collusive outcome is r = 100%.

Yes, the innovation helped to sustain the collusive solution. The innovation constitutes a threat to firm 1 since it knows that the non-cooperative equilibrium will imply zero profits to both firms (previously, firm 1 would have a profit of 3N in the non-cooperative solution).

B

Arguments to justify the difficulty of aircraft manufacturers to collude:

- Selling airplanes are necessarily large value transactions that occur with a low frequency. Deviating from a collusive solution will imply a large gain for the firm that deviates.
- Sales occur with a temporal lag therefore the punishment occurs later in time.
- The large investment incurred can put additional pressure on the airplane manufacturer to sell as soon as possible, giving a higher negotiation power to the buyer to demand special discounts in exchange for a large value transaction.
- Given the large value dimension, buyers may tend to be very price sensitive, not distinguishing the quality and perceiving the airplanes as homogeneous.
- The existence of negotiation with individual buyers makes it difficult to collude on a certain price level, since that information will not be publicly available.
- Airplanes are a durable good. This allows for the build-up of a stock that enables a firm to deviate and absorb the additional market share without needing to change its production capacity.
- Existence of economies of scale can make it more attractive to produce in large quantities while practicing a lower price.

C

The most favored consumer clause (MFCC) means that a firm commits itself to match any discount it will make to other consumer. Therefore the cost of making future discounts will increase (because AE must reimburse consumers that benefit from this clause) and AE has incentives to maintain high prices. By adopting the MFCC, AE precludes itself from discriminating between price-elastic and price-inelastic customers. Whereas before it was price discriminating, now it will charge the same price. Now the common price for AE will most higher than the average price before the MFCC.
Now that AE will charge a higher price to the elastic customers, CM does not have to discount as aggressively in order to compete for these customers. As a result CM's average equilibrium price will increase as well.

D Price wars are more likely to occur during low-demand periods:

- During low-demand periods the cost of deviating from a collusive situation is lower since the difference in the profits in the cooperative situation and the profits in the "punishment" period will be lower.
- During low-demand periods firms usually have excess capacity which is a strong incentive to cut price to steel business. This is particularly true when firms face high fixed costs and significant economies of scale.
- A low demand period can put additional pressure on the firm to attract new customers, leading to aggressive pricing strategies.
- If the low demand is due to an economy downturn, customers tend to be more sensitive to prices and spend more time comparing prices. This increases the incentive of firms to decrease price in order to attract those price-elastic customers.
- If the low demand period was not anticipated by the firms, they will tend to lower their prices in order to sell the additional production. This is particularly true for non-durable goods.

Arguments to explain why price wars can be more likely during booms:

- During periods of high demand gaining a dominant market share position will capture a higher percentage of industry profits.
- Recognizing the inevitable downturn in the market following a boom period, a firm may be tempted to capture profits to serve as a cushion during an economic downturn.
- Gaining a dominant market share is more profitable during a boom than during a downturn.
- If the firm can retain some of it increased share after the boom (through reputational effects, switching costs, etc) it will be in a better position during the downturn.
- High demand periods can incentive the entrance of new firms. Particularly, if those new firms enter the market by just 'copying' the product of incumbent firms, it will increase the tendency to generate price wars.

Exercise 3

a) In order to compute the profits we assume that the firm wants to serve the entire market. Under this assumption the optimal price for the firm is a price such that the consumer on location 3 pays exactly the reservation price.

$$P_A + (1-3)^2 = 12 \Leftrightarrow P_A = 8$$

$$\Pi_A = P_A \cdot 3 \cdot \frac{N}{3} = 8 \cdot 1.000.000 = 24.000.000$$

b) Since the principle of maximum differentiation will apply, firm B should locate itself at location 3.

As usual, the indifferent consumer needs to be computed:

$$P_A + (1-x)^2 = P_B + (3-x)^2 \Leftrightarrow x = \frac{P_B - P_A + 8}{4}$$

Each firm will try to maximize its own profits, taking the competitor´s price as given. This problem is summarized in the following mathematical problem.

Firm A:

$$\underset{P_A}{Max} \qquad \Pi_A = P_A \cdot x \cdot \frac{N}{3} = P_A \cdot \left[\frac{P_B - P_A + 8}{4}\right] \cdot \frac{N}{3}$$

$$FOC \qquad \frac{\partial \Pi_A}{\partial P_A} = 0 \Leftrightarrow P_A = \frac{P_B}{2} + 4$$

Firm B:

$$\underset{P_B}{Max} \qquad \Pi_B = P_B \cdot [3-x] \cdot \frac{N}{3} = P_B \cdot \left[3 - \frac{P_B - P_A + 8}{4}\right] \cdot \frac{N}{3}$$

$$FOC \qquad \frac{\partial \Pi_B}{\partial P_B} = 0 \Leftrightarrow P_B = \frac{P_A}{2} + 2$$

The values for each of the prices result from solving the system with the two optimal conditions that come from the maximization problems:

$$\begin{cases} P_A = \frac{P_B}{2} + 4 \\ P_B = \frac{P_A}{2} + 2 \end{cases} \Leftrightarrow \begin{cases} P_A = \frac{20}{3} \\ P_B = \frac{16}{3} \end{cases} \Rightarrow x = \left[\frac{P_B - P_A + 8}{4}\right] = \frac{5}{3}$$

These prices result in the following profits for the two firms:

Firm A: $$\Pi_A = \frac{100.000.000}{9} = 11.111.111,(1)$$

Firm B: $$\Pi_B = \frac{64.000.000}{9} = 7.111.111,(1)$$

c) The purpose of the strategy is to create an entry barrier through product proliferation and market preemption. This strategy will imply an additional threat

to firm B since it can expect a higher degree of price competition in the market. Particularly, if firm B faces high sunk costs, increasing the price competition in the market and decreasing firm B's market share, can bring its profits down in a way that it may no longer be viable to enter the market.

This strategy will be successful if and only if there are entry sunk costs otherwise it will not prevent firm B to enter the market. Furthermore, firm B's post-entry profits must be lower than the entry sunk costs.

Exercise 4

a) Since Alca-Tell knows that Sam-Sing will also enter the market, and given that there are quadratic transportation costs, it will want to occupy one of the extremities of the market (locations 0 or 2). And since there is the possibility of a market expansion, location 2 is more attractive as it would enable to serve also the market up to Vigo (location3).

Hence, Alca-Tell will locate its store in Porto (2) and Sam-Sing will build its store in Faro (1).

b) Equilibrium after the market expansion has occurred.

As usual, the indifferent consumer needs to be computed:

$$P_S + (0-x)^2 = P_A + (2-x)^2 \Leftrightarrow P_S - P_A = 1 - 2x \Leftrightarrow x = \frac{4 + P_A - P_S}{4}$$

Each firm will try to maximize its own profits, taking the competitor´s price as given. This problem is summarized in the following mathematical problem.

Firm Alca-Tell:

$$\underset{P_A}{Max} \qquad \Pi_A = P_A[3-x]\cdot 1000 = P_A\left[3 - \frac{4 + P_A - P_S}{4}\right]\cdot 1000$$

$$FOC \qquad \frac{\partial \Pi_A}{\partial P_A} = 0 \Leftrightarrow P_A = \frac{P_S}{2} + 4$$

Firm Sam-Sing:

$$\underset{P_S}{Max} \qquad \Pi_S = P_S \cdot x \cdot 1000 = P_S \cdot \left[\frac{4 + P_A - P_S}{4}\right]\cdot 1000$$

$$FOC \qquad \frac{\partial \Pi_S}{\partial P_S} = 0 \Leftrightarrow P_S = \frac{P_A}{2} + 2$$

The values for each of the prices result from solving the system with the two optimal conditions that come from the maximization problems:

$$\begin{cases} P_A = \frac{P_S}{2} + 4 \\ P_S = \frac{P_A}{2} + 2 \end{cases} \Leftrightarrow \begin{cases} P_A = \frac{20}{3} \\ P_S = \frac{16}{3} \end{cases} \Rightarrow x = \left[\frac{4 + P_A - P_S}{4}\right] = \frac{4}{3}$$

These prices result in the following profits for the two firms:

Firm Alca-Tell: $\Pi_A = \frac{100.000}{9} = 11.111,(1)$

Firm Sam-Sing: $\Pi_S = \frac{64.000}{9} = 7.111,(1)$

c) The different situations that can occur need to be checked in order to decide whether the firm should sign the contract.

- No expansion.
  - $P_A = P_S = 4 \Rightarrow x = 1$
  - Each firm will stay on its original location.
  - Profits will be: $\Pi_A = \Pi_S = 4 \cdot 1 \cdot 1000 = 4000$
- Expansion occurs, but Alca-Tell does not change its location.
  - Equivalent to the result of question b).
  - Profits will be:
    - $\Pi_A = \frac{100.000}{9} = 11.111,(1)$
    - $\Pi_S = \frac{64.000}{9} = 7.111,(1)$
- Expansion occurs, and Alca-Tell changes its location to Vigo.
  - $P_A = P_S = 9 \Rightarrow x = 1{,}5$
  - But the indifferent consumer would pay a price that exceeds the reservation price of 10 ($9+1{,}5^2=11{,}25$). Hence the two firms will not cover all the market. Alca-Tell will only serve the market between location 2 and 3, while Sam-Sing will serve the customers between locations 0 and 1.
  - Profits will be: $\Pi_A = \Pi_S = 9 \cdot 1 \cdot 1000 = 9000$

Note: All these calculations assumed that the installation costs were *sunk costs*. But when deciding whether the firm should sign the contract, they are not *sunk* yet. So, they need to be taken into account for the following computations.

Assuming that Alca-Tell is risk-neutral, it will decide on whether to sign the contract based on the expected value of the profits:

⇨ Expected value of signing the contract

$= 0{,}5 \cdot (4000 - 500 - 1000) + 0{,}5 \cdot (9000 - 2 \cdot 500 - 1000) = 4750$

⇨ Expected value of not signing the contract

$= 0{,}5 \cdot (4000 - 500) + 0{,}5 \cdot (11111{,}(1) - 500) = 7055{,}(5)$

Hence, Alca-Tell should not sign the contract.