



## International Master of Science in Business Economics

### *Economics of Business and Markets*

### Final Exam

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#### **Exercise 1 (4 points)**

##### **1.A**

The case of *United States versus Continental Can Company* involved a merger between Continental Can, the nation's largest manufacturer of metal containers, and Hazerl-Atlas Glass Company, the third largest producer of glass containers in the country. The two largest can manufacturers accounted for about 55% of can and bottle sales.

Market definition was a crucial issue in this case. Three alternative market definitions were considered:

- A definition that considered metal containers and glass containers as separate markets.
- A definition that combined metal and glass containers.
- A definition that included paper and plastic as well as metal and glass.

- a) What evidence would you examine to decide which of these three definitions is the best? Explain your reasoning.
- b) Explain the implications of market definition on the US Government's decision about the merger between Continental Can and Hazerl-Atlas Glass Company.

(in *Industrial Organization: Theory and Practice*, D. Waldman and E. Jensen, Pearson Addison Wesley, 3rd ed., 2007)

**1.B**

Consider the following values for concentration ratios C4 and Herfindahl for two different manufacturing industries in the United States:

| Industry name                                      | C4   | Herfindahl |
|----------------------------------------------------|------|------------|
| Household refrigerator& home freezer manufacturing | 81.5 | 2025.1     |
| Automobile manufacturing                           | 79.5 | 2349.7     |

Source: "Concentration ratios in manufacturing", US Bureau of Census, 1997 Census of Manufacturing, June 2001

- a) Define the concentration indexes C4 and Herfindahl. Compare them briefly.
- b) How can you classify the market structure of these industries in terms of concentration level? Is there a contradiction in the information provided for each concentration index? How can you explain these values?

**Exercise 2 (4 points)**

Bodafone and Tugacom are the only two firms in the telecommunications sector and each one is considering the possibility of launching a promotion campaign, a new price scheme under which customers pay the same price when they make a voice call or send a SMS to someone that belongs to a different operator network. The two firms decide simultaneously to launch either no promotion campaign ('no campaign'), a price scheme that includes only voice calls ('voice call') or a price scheme that includes voice calls and SMS ('voice call + SMS'). Launching the 'voice call' scheme has a total net cost equal to  $c$ , that arises from all termination rates one operator must pay to the other operator each time one customer makes a voice call to someone that belongs to another network. The 'voice call + SMS' scheme is twice as expensive and implies a total net cost of  $2c$ .

The matrix below presents the profits of both firms for the next month, net of the cost with the new price schemes (profits in the upper left corner belong to Bodafone):

|          |                  | Tugacom         |                     |                        |
|----------|------------------|-----------------|---------------------|------------------------|
|          |                  | no campaign     | voice call          | voice call + SMS       |
| Bodafone | no campaign      | 6<br>6          | 7.5<br>$7 - c$      | 8.5<br>$8 - 2c$        |
|          | voice call       | $7 - c$<br>7.5  | $8 - c$<br>$8 - c$  | $9 - c$<br>$9 - 2c$    |
|          | voice call + SMS | $8 - 2c$<br>8.5 | $9 - 2c$<br>$9 - c$ | $10 - 2c$<br>$10 - 2c$ |

- a) Do the promotion campaigns of one firm harm the other one? Analyze the payoff matrix and describe the effect of these campaigns without solving the problem.
- b) If  $c > 1$  and this game is played only once, what are the strategies and the payoffs of the Nash equilibrium? Explain your solution instead of presenting just the final result.

Consider from now on that  $c = 1.5$  :

- c) Draw the resulting payoff matrix. Indicate the Nash equilibrium.
- d) Assuming that this game is repeated indefinitely, with a positive discount rate for each firm, is it more likely that firms collude on doing (i) both the ‘voice call’ scheme or (ii) both the ‘voice call + SMS’ scheme? Justify quantitatively.

### **Exercise 3 (5 points)**

Besides their advertising (dis)agreements, Bodafone and Tugacom have been fighting an intense war regarding the coverage of their mobile networks. The country in which they operate can be thought of as being a straight line, with 10 million consumers uniformly distributed along a  $[0, 4]$  segment. In order to transmit the mobile signal a company needs to install an antenna, which due to regulatory constraints can only be built on positions 1, 2 and 3. Installing an antenna costs 2 million € while maintenance of an antenna implies a fixed cost of 1 million € per period. All variable costs are negligible.

Consumers buy a mobile contract of the firm that is operating the closest antenna and will incur in a disutility  $3(v - x)^2$ , measured by the distance to the nearest antenna (which will affect the quality of the service). All consumers have a reservation price (including the disutility) of 30€. Assume that the market must always be covered, that each consumer already has one mobile phone and will only subscribe one contract.

Consider that each firm has already built one antenna, with Tugacom’s and Bodafone’s antennas situated on locations 1 and 3, respectively.

- a) Explain in words why none of the firms has built an antenna in location 2.
- b) Compute the equilibrium in terms of prices, market shares and profits.

Tugacom doesn’t expect to face other potential competitors and is studying the possibility of acquiring Bodafone before defining its price schedule. It knows that with a successful acquisition it is entitled (but not obliged) to disable, free of charge, Bodafone’s former antenna in order to avoid the additional maintenance costs.

- c) Should Tugacom disable Bodafone’s former antenna? How much is Tugacom willing to pay to purchase Bodafone?

Consider that Tugacom has successfully acquired Bodafone and has decided to keep both antennas. Tugacom is now preparing the pricing of the mobile phone contracts for the next period. Furthermore, it has approached the domestic regulator Alfacom

asking permission for the installment of new antennas on locations 0 and 4 in order to better serve their clients. Not surprisingly, Alfacom has declined that proposal.

- d) Explain the economic reasons for Tugacom's proposal and indicate why Alfacom has considered the proposal harmful for consumers.

#### **Exercise 4 (4 points)**

Concerned about the sustainability of the current business, Bodafone is thinking about developing a new mobile phone communications standard, called 5G, for which it will have a monopolist status. It expects to face light and heavy users with individual demand functions for minutes of phone calls given by  $q_L = 50 - p$  and  $q_H = 100 - p$ , respectively, where the unit price  $p$  is measured in cents. Furthermore, Bodafone expects to have a constant marginal cost for each minute of phone calls over the 5G network equal to 10 cents and the only fixed cost will be the investment to develop the infrastructure. Furthermore, it knows that, out of the total of  $N$  consumers, the proportion of light users will be equal to  $\beta$ , with  $0 < \beta < 1$ .

- a) Determine the optimal two-part tariff schedule if Bodafone is able to perfectly separate the two groups (e.g. through the age). How much profit can Bodafone get in this market? Use a graphical representation to illustrate your answer.
- b) Consider now that Bodafone has no way of distinguishing the consumer types and you are hired to advise the firm on the best two-part tariff. Which would be the best price schedule for Bodafone? Indicate the profit.
- c) Will profits be higher in a) or in b)? Explain.

#### **Exercise 5 (3 points)**

##### **5.A**

Titanium dioxide is a chemical whitener used to make products such as paint or paper either whiter or opaque. In the 1960's three different processes were used to manufacture titanium dioxide. The first two, the sulfate process and the generic chloride process, were available to all titanium dioxide producers. The third process, however, was the proprietary chloride process developed exclusively by *Du Pont*. Seven domestic firms were active in the titanium dioxide market during the 1970's. *Du Pont* was the largest with about 34% of the market, but *NL industries*, which used the sulfate procedure, was a close second. Because *Du Pont's* chloride process has low pollution control costs relative to the other two processes, *Du Pont's* costs were unaffected by tougher pollution control laws instituted in the 1970's, and *Du Pont's* technology was the industry's low-cost technology.

Between 1972 and 1977 *Du Pont* expanded production capacity using its proprietary chloride process by 114%. *Du Pont's* capacity expansions were clearly concentrated in plants using its proprietary chloride process. No other titanium dioxide producer

increased capacity by nearly as large percentage between 1972 and 1977. By 1977, *Du Pont's* market share had risen to 46%.

Discuss *Du Pont's* strategy in the titanium dioxide market.

(adapted from *Industrial Organization: Theory and Practice*, D. Waldman and E. Jensen, Pearson Addison Wesley, 3rd ed., 2007)

## **5.B**

Some years ago, an examination of the Coca-Cola website found a minimum of 17 different types of carbonated beverages that Coca-Cola produces (not to mention bottled water, Minute Maid fruit juice, etc). On February 25, 2003, Coca-Cola announced its launch of Sprite Remix, which was introduced in late spring 2003. The press release states "Sprite Remix will feature a new tropical version of the great taste of Sprite and will be launched with a unique graphic treatment of the signature Sprite logo." Sprite Remix was likely a response to the incredible popularity of Pepsi's Sierra mist.

Discuss the nonprice strategic behavior depicted in this example.

(in *Industrial Organization: Theory and Practice*, D. Waldman and E. Jensen, Pearson Addison Wesley, 3rd ed., 2007)

## Final Exam - Solutions

### Exercise 1

#### 1.A

a)

One should look at cross elasticities between the four products. If elasticity is high, they are substitutes and should enter the market definition.

Also, goods are close substitutes if they share similar characteristics, have similar occasion of use and are sold in the same area.

b)

A larger market definition lowers the concentration measure and makes approval more likely. According to the market definitions, one may expect: (i) no objection; (ii) likely to disapprove; (iii) more likely to approve.

#### 1.B

a)

$$C4 = \sum_{i=1}^4 s_i \text{ (for the largest four firms)}$$

$$HHI = \sum_{i=1}^N s_i^2$$

C4 does not capture changes among the Top4. HHI captures asymmetries. Both are simplistic measures but can be complementary.

b)

C4 → Household refrigerator & home freezer manufacturing looks more concentrated.

HHI → Automobile manufacturing looks more concentrated.

Both C4 are  $\approx 80\%$  => very concentrated

Both HHI are  $> 1800$  => very concentrated

Not necessarily a contradiction. Differences in C4 are very small; automobile industry seems to have more asymmetries; not necessarily a link to degree of price competition.

You may give some real world intuition.

**Exercise 2**

a)

No. A promotion campaign by one of the firms increases the gross profits of both firms, but only implies a cost to the firm actually launching the campaign.

Firms benefit from the promotion campaigns of the rival firm due to the termination rates. There is a strong free riding effect.

b)

|                 |                         | <b>Tugacom</b>     |                       |                         |
|-----------------|-------------------------|--------------------|-----------------------|-------------------------|
|                 |                         | <i>no campaign</i> | <i>voice call</i>     | <i>voice call + SMS</i> |
| <b>Bodafone</b> | <i>no campaign</i>      | <u>6</u><br>6      | <u>7.5</u><br>$7 - c$ | <u>8.5</u><br>$8 - 2c$  |
|                 | <i>voice call</i>       | $7 - c$<br>7.5     | $8 - c$<br>$8 - c$    | $9 - c$<br>$9 - 2c$     |
|                 | <i>voice call + SMS</i> | $8 - 2c$<br>8.5    | $9 - 2c$<br>$9 - c$   | $10 - 2c$<br>$10 - 2c$  |

There is a Nash equilibrium in dominant strategies (*no campaign, no campaign*), with a payoff (6,6).

c)

|                 |                         | <b>Tugacom</b>     |                   |                         |
|-----------------|-------------------------|--------------------|-------------------|-------------------------|
|                 |                         | <i>no campaign</i> | <i>voice call</i> | <i>voice call + SMS</i> |
| <b>Bodafone</b> | <i>no campaign</i>      | <u>6</u><br>6      | <u>7.5</u><br>5.5 | <u>8.5</u><br>5         |
|                 | <i>voice call</i>       | 5.5<br>7.5         | 6.5<br>6.5        | 7.5<br>6                |
|                 | <i>voice call + SMS</i> | 5<br>8.5           | 6<br>7.5          | 7<br>7                  |

There is a Nash equilibrium in dominant strategies (*no campaign, no campaign*), with a payoff (6,6).

d)

(i) Collusion in 'voice call' 
$$6.5 + \frac{6.5}{i} \geq 7.5 + \frac{6}{i} \Rightarrow i \leq 50\%$$

(ii) Collusion in 'voice call + SMS' 
$$7 + \frac{7}{i} \geq 8.5 + \frac{6}{i} \Rightarrow i \leq \frac{2}{3} = 66.(6)\%$$

It is more likely for firms to collude with a price scheme that includes both voice calls and SMS (bigger range for discount rates and higher payoff in the collusive equilibrium).

### Exercise 3

a)

To avoid price competition firms move to the extremes (here 1 and 3); principle of maximum differentiation.

b)

Indifferent consumer: 
$$P_T + 3(1-x)^2 = P_B + 3(3-x)^2 \Leftrightarrow x = \frac{P_B - P_T + 24}{12}$$

Tugacom (profits in million euros):

$$\text{Max}_{P_T} \pi_T = P_T[x-0] \cdot 2.5 - 1 = P_T \left[ \frac{P_B - P_T + 24}{12} \right] \cdot 2.5 - 1$$

$$\text{FOC: } \frac{\partial \pi_T}{\partial P_T} = 0 \Leftrightarrow P_T = \frac{P_B + 24}{2}$$

Bodafone (profits in million euros):

$$\text{Max}_{P_B} \pi_B = P_B[4-x] \cdot 2.5 - 1 = P_B \left[ \frac{P_T - P_B + 24}{12} \right] \cdot 2.5 - 1$$

$$\text{FOC: } \frac{\partial \pi_B}{\partial P_B} = 0 \Leftrightarrow P_B = \frac{P_T + 24}{2}$$

Equilibrium

$$\begin{cases} P_T = \frac{P_B + 24}{2} \\ P_B = \frac{P_T + 24}{2} \end{cases} \Rightarrow P_T = P_B = 24 \Rightarrow \pi_T = \pi_B = 24 \cdot 2.5 - 1 = 119$$

Market shares are equal to 50% for both firms.

Profits are equal to 119 million € for each firm.

c)

Disabling Bodafone's former antenna:

$$P_T + 3(4-1)^2 = 30 \Rightarrow P_T = 3$$

$$\pi_T = 3 \cdot 10 - 1 = 29$$

Keeping Bodafone's former antenna and practicing collusive prices:

$$P_T + 3(2-1)^2 = 30 \Rightarrow P_T = 27$$

$$\pi_T = 27 \cdot 10 - 1 - 1 = 268$$



Disabling both antennas and building a new one in the middle:

$$P_T + 3(2 - 0)^2 = 30 \Rightarrow P_T = 18$$

$$\pi_T = 18 \cdot 10 - 2 - 1 = 177$$

Tugacom is willing to pay 149 million € (=268 - 119). It should not disable the other antenna.

d)

If Tugacom installs more antennas it may mitigate the problem of the transportation costs and will be able to charge higher prices and obtain larger profits.

However, this strategy will depend on the size of the maintenance and installment costs.

In this case, if Tugacom builds three additional antennas on locations 0, 2 and 4:

$$P_T + 3(1 - 0.5)^2 = 30 \Rightarrow P_T = 29.25 \quad \pi_T = 29.25 \cdot 10 - 3 \cdot 2 - 5 \cdot 1 = 281.5$$

Tugacom's economic reasons for its proposal are related to higher profits (281.5 > 268).

If Alfacom approves Tugacom's proposal, prices will increase from 27 to 29.25, which is harmful for consumers (ignoring the better quality of service).

#### Exercise 4

a)

Set the fixed fee equal to the consumer surplus of each type and the price equal to the marginal cost of 10. The fixed fee for light users is equal to  $F_L = (40 \cdot 40) \cdot 0.5 = 800$ .

For heavy users it is equal to  $F_H = (90 \cdot 90) \cdot 0.5 = 4050$ .

The profit will be equal to (*Inv* is the cost of investment):

$$\pi_B = [\beta \cdot 800 + (1 - \beta) \cdot 4050] \cdot N - Inv$$

b)

Bodafone needs to choose between practicing a low fee and selling to all consumers or practicing a higher fee and selling only to the heavy users.

#### Complete answer:

Only heavy users (Fee=4050):  $\pi_B = 4050(1 - \beta) \cdot N - Inv$

All consumers (it may practice a price larger than MC):

$$\pi_B = \underbrace{0.5 \cdot (50 - P)^2}_{\text{Fixed fee}} + \underbrace{(50 - P)(P - 10) \cdot \beta}_{\text{Light users}} + \underbrace{(100 - P)(P - 10)(1 - \beta)}_{\text{Heavy users}} - Inv$$

$$\text{FOC: } \frac{\partial \pi_B}{\partial P} = 0 \Leftrightarrow P = 60 - 50\beta$$

Substituting into the objective function:

$$\pi_B(P = 60 - 50\beta) > 4050(1 - \beta) \cdot N - Inv$$

$$\Leftrightarrow \beta > \frac{11\sqrt{41} - 31}{50} \approx 78.9\%$$

For  $\beta > 78.9\%$  Bodafone should sell to all consumers and practice  $P = 60 - 50\beta$ .

Alternative (incomplete) answer:

$$\text{All consumers (Fee=800):} \quad \pi_B = 800 \cdot N - Inv$$

$$\text{Only heavy users (Fee=4050):} \quad \pi_B = 4050(1 - \beta) \cdot N - Inv$$

Bodafone will decide to sell to all consumers if:

$$800 \cdot N > 4050(1 - \beta) \cdot N \Leftrightarrow \beta > \frac{3250}{4050} \approx 80.2\%$$

c)

Profits will be higher in a). The firm will be able to extract the entire consumer surplus of both types of consumers. In b) it can only accomplish this for one consumer type at most.

### Exercise 5

A. Excess capacity as a credible entry barrier

B. product proliferation in the soft drink market to difficult entry