Industrial Organization

Midterm Fall 2023 – Solution Topics

1. False.

The concentration ratio is defined as the sum of the market shares of the *k* biggest firms in a given industry. This measure of concentration is not (strictly) negatively related to the number of firms, *n*. Consider the following counterexample:

Market #1: $s_1 = 0.5; s_2 = 0.3; s_3 = 0.2$

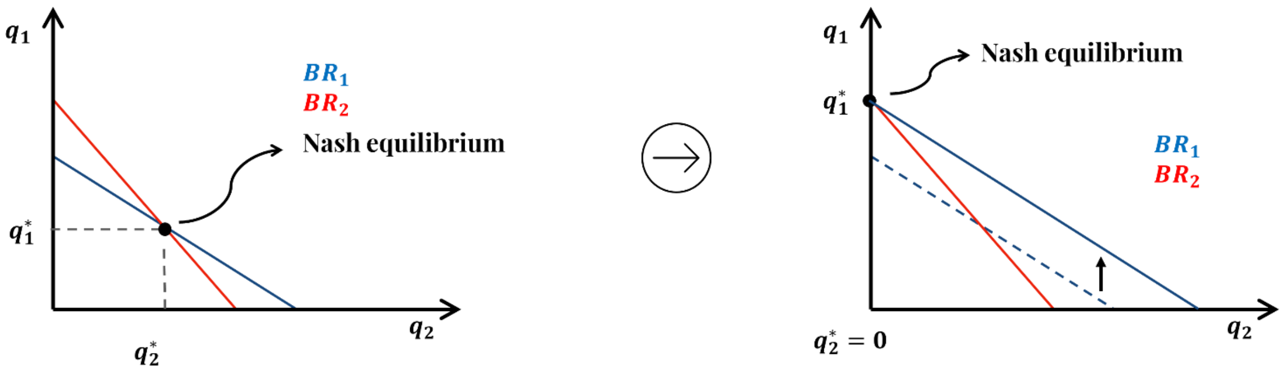
Market #2: $s_1 = 0.5; s_2 = 0.3; s_3 = 0.1; s_4 = 0.1$

Then, $C_2 = 0.5 + 0.3 = 0.8$ in both scenarios, even though *n* is higher in Market #2, thereby disproving the statement.

2. True.

A decrease in a firm's marginal cost triggers an outwards shift in its best response function.

Under this context, a proprietary technological improvement has the potential to reduce a firm's marginal cost to a point where the intersection of both firms' best response functions, i.e., the Nash Cournot equilibrium, results in the least efficient firm producing zero units of output, effectively transforming the market into a monopoly.



3.

(i)

Cournot Model.

Firm 1's profit-maximization problem:

$$\max_{q_1} \pi_1 = P(q_1, q_2)q_1 - 4q_1$$

$$FOC: \frac{d\pi_1}{dq_1} = 0 \Leftrightarrow 10 - 2q_1 - q_2 - 4 = 0 \Leftrightarrow \boldsymbol{q_1^* = 3 - \frac{q_2}{2}}$$

Firms 1 and 2 face the same demand and have identical cost structures (in particular, equal MC). Hence, $\boldsymbol{q_2^* = 3 - \frac{q_1}{2}}$ and thus, in the Cournot-Nash equilibrium, $\boldsymbol{q_1^* = q_2^*}$.

In equilibrium:

$$\begin{cases} q_1^* = 3 - \frac{q_2}{2} \\ q_1^* = q_2^* \end{cases} \leftrightarrow \begin{cases} q_1^* = 3 - \frac{q_1}{2} \\ - \end{cases} \leftrightarrow \begin{cases} \frac{3}{2} q_1^* = 3 \\ \boldsymbol{q_1^* = q_2^* = 2} \end{cases}$$

$$P = 10 - (2 + 2) = 6$$

$$\boldsymbol{\pi_1 = \pi_2 = (6 - 4) * 2 = 4}$$

(ii)

Suppose that **at least one firm** pays for the advertising campaign. Firm 1's profit-maximization problem:

$$\max_{q_1} \pi_1 = P(q_1, q_2)q_1 - 4q_1[-c] = (\mathbf{16} - q_1 - q_2)q_1 - 4q_1[-c]$$ [1]

$$FOC: \frac{d\pi_1}{dq_1} = 0 \Leftrightarrow \mathbf{16} - 2q_1 - q_2 - 4 = 0 \Leftrightarrow \boldsymbol{q_1^* = 6 - \frac{q_2}{2}}$$

Firms 1 and 2 would face the same demand, $q = 16 - p$, **regardless of which firm (or firms) pays for the advertising campaign**. *(Notice the demand function: the product is clearly still homogeneous!)* Besides, these firms have identical cost structures (in particular, equal MC). Hence, $\boldsymbol{q_2^* = 6 - \frac{q_1}{2}}$ and thus, in the Cournot-Nash equilibrium, $\boldsymbol{q_1^* = q_2^*}$.

In equilibrium:

$$\begin{cases} q_1^* = 6 - \frac{q_2}{2} \\ q_1^* = q_2^* \end{cases} \leftrightarrow \begin{cases} q_1^* = 6 - \frac{q_1}{2} \\ - \end{cases} \leftrightarrow \begin{cases} \frac{3}{2} q_1^* = 6 \\ \boldsymbol{q_1^* = q_2^* = 4} \end{cases}$$

$$P = \mathbf{16} - (4 + 4) = 8$$

$\boldsymbol{\pi_1 = (8 - 4) * 4 - c = 16 - c}$, if Firm 1 orders the campaign; $\boldsymbol{\pi_1 = 16}$ if it does not.

Likewise, $\boldsymbol{\pi_2 = (8 - 4) * 4 - c = 16 - c}$, if Firm 2 orders the campaign; $\boldsymbol{\pi_2 = 16}$ if it does not.

Moreover, **if no firm pays** for the campaign, profits are just as calculated in the previous question.

Given that the choice each firm makes regarding the advertising campaign is simultaneous and independent, we can build a payoff matrix to represent that static game and thereby find the Nash equilibrium/equilibria: [A stands for *Advertise*, NA for *Not Advertise*.]

$\mathbf{1, 2}$	A	NA
A	$16 - c, 16 - c$	$16 - c, 16$
NA	$16, 16 - c$	$4, 4$

[1]Notice that c is a fixed cost!

The Nash equilibria depend on the value of c:

- If $c < 12$, $NE = \{(A, NA); (NA, A)\}$
- If $c = 12$, $NE = \{(A, NA); (NA, A); (NA, NA)\}$
- Finally, if $c > 12$, no firm would pay for the campaign: $NE = (NA, NA)$

(iii)

Private net[2] benefit for the firm that orders the advertising campaign: $\Delta\pi_A = 16 - c - 4 = 12 - c$.

(iv)

Private value of the campaign for the firm that does not order it: $\Delta\pi_{NA} = 16 - 4 = 12$.

(v)

Industry value of the campaign: $\Delta\pi_A + \Delta\pi_{NA} = 12 - c + 12 = 24 - c$.

(vi)

$$CS_{(i)} = \frac{(10 - 6) * 4}{2} = 8$$

$$CS_{(ii)} = \frac{(\mathbf{16} - 8) * 8}{2} = 32$$

$$\Delta CS = CS_{(ii)} - CS_{(i)} = 24$$

Social value of the advertising campaign: $\Delta CS + Industry\ Value = 24 + 24 - c = 48 - c$.

(vii)

Two positive externalities arise from one firm's decision to advertise. First, consumers benefit from the advertising campaign since the consumer surplus increases. Second, the other firm (i.e., the one which does not advertise) also benefits from the advertising campaign, as attested by its higher profits.

[2]We gave full points in parts **(iii) – (vi)** to those who chose to calculate the private, industry, and social values of the advertising campaign while omitting its cost, c.

4.

(i)

In stage (iii), Firm 1 will best respond to Firm 2.

Firm 1's profit-maximization problem:

$$\max_{q_1} P(q_1 + q_2)q_1 - 2q_1$$

$$FOC: \frac{d\pi_1}{dq_1} = 0 \Leftrightarrow 10 - 2q_1 - q_2 - 2 = 0 \Leftrightarrow \boldsymbol{q_1^* = 4 - \frac{q_2}{2}}$$

(ii)

Applying backward induction, in the second stage, Firm 2 will strategically maximize its profits considering Firm 1's best response function.

$$\max_{q_2} P(q_1 + q_2)q_2 - 2q_2 \Leftrightarrow P\left(4 - \frac{q_2}{2} + q_2\right)q_2 - 2q_2 \Leftrightarrow \left(6 + \frac{q_2}{2}\right)q_2 - 2q_2$$

$$FOC: \frac{d\pi_2}{dq_2} = 0 \Leftrightarrow 6 + q_2 - 2 = 0 \Leftrightarrow q_2 = 4$$

(iii)

In stage (iii), Firm 1 has the flexibility to adjust its initial choice upward or downward without incurring any costs. Consequently, Firm 1 will ultimately produce in accordance with its best response function, as calculated in question **(i)**. Therefore, Firm 2 should not consider Firm 1's provisional announcement in stage (i) as credible.

(iv)

Since its announcement is not credible, Firm 1 can announce any quantity: $q_1 \in \mathbb{R}_0^+$.