**Industrial Organization**

**Resit Exam Fall 2022 – Solution Topics**

**1.** <u>True.</u>

Firms may tacitly collude at any price above marginal cost. Suppose that, before the input's cost increased, the collusion price was already above the *new* marginal cost faced by all the firms that produce this good. Then, firms may prefer to keep charging the same price so as to not upset the collusive "arrangement." Therefore, in this situation, the (pre-)existence of tacit collusion would *unintentionally benefit* consumers, in the sense that the input cost increase would *not* be transmitted to consumers through a corresponding increase in the good's price.

**2.** <u>True.</u>

If consumers are not active searchers (for the lowest possible price), then it is as if each firm has *its own consumers*, and therefore *its own demand*. Naturally, this would give firms the ability to maximize profits with respect to *their own demand* and charge the profit-maximizing (monopoly) price, $P^M$. Hence, *dumb consumers* that do not search for lower prices would be a great source of revenue for firms.

[While not required in order to answer correctly, thinking of the monopolistic competition model could be useful to guide your reasoning.]

**3.**

**(i)** First, let us ignore the quantity constraint:

$$\max_{\{q_E\}} \pi_E = (10 - q_I - q_E)q_E - 4q_E$$

$$FOC\colon \frac{\partial \pi_E}{\partial q_E} = 0 \Leftrightarrow 10 - q_I - 2q_E - 4 = 0 \Leftrightarrow \boldsymbol{q_E = 3 - \frac{q_I}{2}}$$

Recall that, due to the capacity constraint, $q_E \leq 2$. We know that $3 - \frac{q_I}{2} \leq 2 \Leftrightarrow q_I \geq 2$. This implies that, for values of $q_I < 2$, firm E would like to produce more than 2 units (i.e., exceed the capacity constraint, which is impossible). Therefore, **if $\boldsymbol{q_I < 2, q_E^{BR} = 2}$**.

Moreover, we know that **firm E's best response to $\boldsymbol{q_I \geq 6}$ is to stay out of the market** (notice that $3 - \frac{6}{2} = 0$).

Therefore, **firm E's best-reply function** is given by:

$$\boldsymbol{q_E^{BR} = \begin{cases} 2, if\ q_I < 2 \\ 3 - \dfrac{q_I}{2}, if\ 2 \leq q_I < 6 \\ 0, if\ q_I \geq 6 \end{cases}}$$

**(ii)** "Accommodate" means that firm E will actually enter the market (i.e., $q_E > 0$).

**Focusing on the first "branch" of $q_E^{BR}$:**

Firm I's problem:

$$\max_{\{q_I\}}(10 - 2 - q_I)q_I - 2q_I$$

$$FOC: \frac{\partial \pi_I}{\partial q_I} = 0 \Leftrightarrow 8 - 2q_I - 2 = 0 \Leftrightarrow \boldsymbol{q_I = 3}$$

However, notice that the interval of the domain that corresponds to the first "branch" of this function is $[0; 2[$. Therefore, this cannot be the correct solution to this part of the exercise.

**Focusing on the second "branch" of $q_E^{BR}$**:

Firm I's problem:

$$\max_{\substack{\{q_I\} \\ s.t.\ q_E = 3 - \frac{q_I}{2}}} \pi_I = (10 - q_I - q_E)q_I - 2q_I \Leftrightarrow \max_{\{q_I\}}\left(10 - q_I - \left(3 - \frac{q_I}{2}\right)\right)q_I - 2q_I$$

$FOC$: $\frac{\partial \pi_I}{\partial q_I} = 0 \Leftrightarrow 10 - 2q_I - 3 + q_I - 2 = 0 \Leftrightarrow \boldsymbol{q_I = 5}$, and thus $\boldsymbol{q_E = 3 - \frac{5}{2} = 0.5}$

Hence, the market price would be $P = 10 - 5 - 0.5 = 4.5$ and $\boldsymbol{\pi_I = (4.5 - 2) * 5 = 12.5}$. Firm E's profits would be equal to $(4.5 - 4) * 0.5 = 0.25$.

**(iii)** In order to prevent firm E's entry, firm I would have to produce 6 units **(third "branch" of $q_E^{BR}$)**. Therefore, the market price would be $P = 10 - 6 = 4$ and $\boldsymbol{\pi_I = (4 - 2) * 6 = 12}$.

**(iv)** Firm I will accommodate firm E's entry (compare firm I's profits in **(ii)** and **(iii)**).

**(v)** This is a more standard Stackelberg exercise. First, find I's best-reply function:

$$\max_{\{q_I\}} \pi_I = (10 - q_I - q_E)q_I - 2q_I$$

$$FOC: \frac{\partial \pi_I}{\partial q_I} = 0 \Leftrightarrow 10 - 2q_I - q_E - 2 = 0 \Leftrightarrow \boldsymbol{q_I = 4 - \frac{q_E}{2}}$$

Then, plug it into E's profit-maximization problem:

$$\max_{\substack{\{q_E\} \\ s.t.\ q_I = 4 - \frac{q_E}{2} \\ q_E \leq 2}} \pi_I = (10 - q_I - q_E)q_E - 4q_E \Leftrightarrow \max_{\substack{\{q_E\} \\ q_E \leq 2}}\left(10 - q_E - \left(4 - \frac{q_E}{2}\right)\right)q_E - 4q_E$$

$$FOC: \frac{\partial \pi_I}{\partial q_I} = 0 \Leftrightarrow 10 - 2q_E - 4 + q_E - 4 = 0 \Leftrightarrow \boldsymbol{q_E = 2}$$

**(vi)** Firm I will choose to produce $\boldsymbol{q_I = 4 - \frac{2}{2} = 3}$.

Thus, the market price will be $P = 10 - 2 - 3 = 5$ and $\boldsymbol{\pi_I = (5-2) * 3 = 9}$. Firm E's profits would be equal to $(5-4) * 2 = 2$.

**(vii)**[1]

Consumers are worse off (higher market price, lower quantity sold): the consumer surplus has clearly decreased.

Firm E is better off by becoming the leader – in fact, it is now able to "force" its entry into the market, earning higher profits than before. Simultaneously, firm I is worse off (lower profits than before).

**4.**[2]

**(i)** Yes, provided that... $\frac{\pi^M}{2} + \delta\frac{\pi^M}{2} + \delta^2\frac{\pi^M}{2} + \cdots \geq \pi^M \Leftrightarrow \cdots \Leftrightarrow \delta \geq \frac{1}{2}$

**(ii)** The ideal (optimal) collusive price would be **5**, i.e., the monopoly price:

$$\max_{\{P\}} \pi^M = P(6-P) - 4(6-P) = (P-4)(6-P) = -P^2 + 10P - 24$$

$$FOC\colon \frac{d\pi^M}{dQ} = 0 \Leftrightarrow -2P + 10 = 0 \Leftrightarrow \boldsymbol{P^M} = \mathbf{5}$$

**(iii)** No, these firms are unable to tacitly collude.

If firm C decides to undercut, charging $P = 4(-\varepsilon)$, it will earn a profit of $(4-2)(6-4) = 4$ (i.e., the monopoly profit for a firm with $MC = 2$ that faces a demand given by $Q = 6 - P$).

On the other hand, if firm C decided to collude (getting 1/3 of the industry profit under collusion), it would only receive $(5-2)\frac{1}{3} = 1$.

Therefore, firm C would never choose to collude.

[1] We meant to ask you to compare the answers to questions **(ii)** and (vi). However, the conclusions you were meant to reach are exactly the same, and the question was graded "as written."

[2] You needed to show all the relevant steps in part **(i)**, not just jump from the initial inequality to the conclusion!