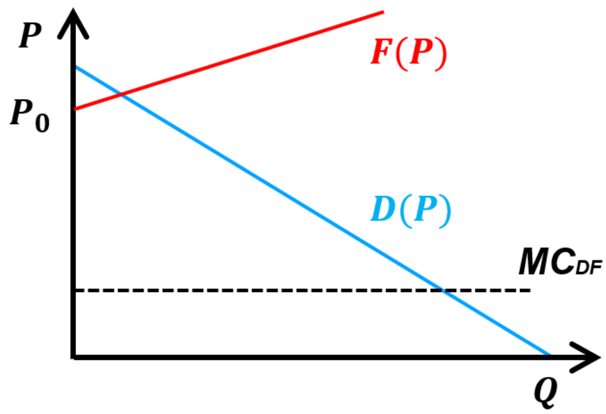
Industrial Organization

Midterm Spring 2024 – Solution Topics

1. True.

Even if there are some quantities for which the fringe supply curve, $F(P)$, lies below the demand curve, $D(P)$ – i.e., the values of Q to the left of the intersection between $F(P)$ and $D(P)$, for which the resulting market price would allow the competitive fringe to sell some units – there is still the **possibility that the dominant firm's optimal choice involves a price *below* the fringe supply curve** (i.e., $MR = MC \rightarrow P^M < P_0$). Hence, the fringe would be unable to compete, and the dominant firm would act like a monopolist.



2. False.

The Instability Index is a measure of volatility given by the formula: $I = \frac{1}{2}\sum_{i=1}^{N}\left|s_{i,t} - s_{i,t-1}\right|$. A low value of the Instability Index implies a small variation in the individual market shares of each firm, this does not necessarily imply that there is a lack of technological progress. Say we have a duopoly of symmetric firms competing à la Cournot, with marginal cost equal to average cost, implying an equal market share of 50% each. If a technological progress takes place, i.e. reduction in marginal cost, however, it is common knowledge and shared among both firms, the Instability Index will remain unchanged hence the statement is false.

3.

(i)

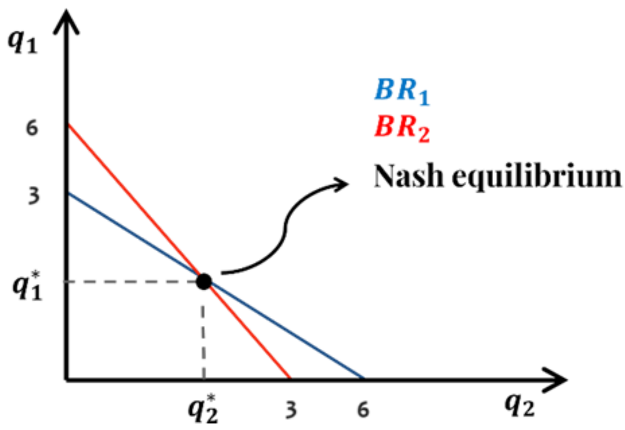
Cournot Model.

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, $\boldsymbol{q_2^* = 3 - \frac{q_1}{2}}$



(ii)

Since $\boldsymbol{q_1^* = 3 - \frac{q_2}{2}}$ and $\boldsymbol{q_2^* = 3 - \frac{q_1}{2}}$ then, in the Cournot-Nash equilibrium, $\boldsymbol{q_1^* = q_2^*}$.

In equilibrium:

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

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

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

(iii)

Firm 1's new profit-maximization problem:

$$\max_{q_1} \pi_1 = P(q_1, q_2) q_1 - \mathbf{2} q_1$$

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

In equilibrium:

$$\begin{cases} q_1^* = 4 - \dfrac{q_2}{2} \\ q_2^* = 3 - \dfrac{q_1}{2} \end{cases} \leftrightarrow \begin{cases} - \\ q_2^* = 3 - 2 + \dfrac{q_2}{4} \end{cases} \leftrightarrow \begin{cases} - \\ \dfrac{3}{4} q_2^* = 1 \end{cases} \leftrightarrow \begin{cases} \boldsymbol{q_1^* = \dfrac{10}{3}} \\ \boldsymbol{q_2^* = \dfrac{4}{3}} \end{cases}$$

$$P = 10 - \left(\frac{10}{3} + \frac{4}{3}\right) = \frac{16}{3}$$

$$\pi_1 = \left(\frac{16}{3} - 2\right) * \frac{10}{3} = \frac{100}{9} = 11.(1); \; \pi_2 = \left(\frac{16}{3} - 4\right) * \frac{4}{3} = \frac{16}{9} = 1.(7)$$

$$\boldsymbol{Value = 11.(1) - 4 = 7.(1)}$$

(iv)

$$q_1^*(q_2 = 2) = 4 - \frac{2}{2} = 3 \rightarrow P = 10 - 3 - 2 = 5 \rightarrow \pi_1 = (5 - 2) * 3 = 9$$

$$\boldsymbol{Direct\ Effect = 9 - 4 = 5}$$

The decrease in firm 1's marginal cost has a direct effect on its profit level, even without considering firm 2's response to the change in firm 1's quantity (and its effects on firm 1's profits).

(v)

$$\boldsymbol{Strategic\ Effect = 11.(1) - 9 = 2.(1)}$$

Since the decision variables of these firms are strategic substitutes, firm 2 will react to firm 1's increase in quantity by decreasing its own output. This has a positive effect on firm 1's profit level, adding to the direct effect calculated above.

(vi)

There are **two externalities** involved in this investment decision:

1. A **positive externality for consumers**, who benefit from the lower market price and higher quantity traded (i.e., enjoy a larger consumer surplus than in the absence of the investment).
2. A **negative externality for firm 2**, whose profits are reduced as a result of firm 1's decision to invest.

4.

(i)

To calculate the value of E's investment to its shareholders, we must calculate the total profits generated for firm E in the referenced time period (2024-2028), hence:

For 2024:

$$p_I = 5 - \varepsilon$$

$$q_E = 0$$

$$\boldsymbol{\pi_E^{2024} = 0}$$

For 2025:

$$p_I = p_E = 4$$

$$q_I = q_E = \frac{6}{2} = 3$$

$$\boldsymbol{\pi_E^{2025} = (4 - 4) * 3 = 0}$$

For 2026 (equal to 2027 and 2028):

$$p_E = 4 - \varepsilon$$

Assume ε will tend to 0 such that p_E will tend to 4 and q_E will tend to 6 such that:

$$\boldsymbol{\pi_E^{2026} = \pi_E^{2027} = \pi_E^{2028} = (4-3)*6 = 6}$$

Hence the value of E's investment to its shareholders will be $6*3 = 18$ (assuming no cost of technology).

(ii)

The value of E's entry to consumers will be the change in total consumer surplus after E's entry for the respective time period (2024-2028) such that:

Prior to E's entry in 2024 (equal to 2025, 2026, 2027 and 2028):

$$p_I = 7$$

$$q_I = 3$$

$$\boldsymbol{CS^{2024} = \frac{1}{2}*(10-7)*3 = 4.5}$$

After E's entry:

For 2024:

$$\boldsymbol{CS^{2024} = \frac{1}{2}*(10-5)*5 = 12.5}$$

For 2025 (equal to 2026, 2027 and 2028):

$$\boldsymbol{CS^{2025} = \frac{1}{2}*(10-4)*6 = 18}$$

Now we must subtract the difference between the 2 values:

$$\boldsymbol{CS^{Before} = 5*4.5 = 22.5}$$

$$\boldsymbol{CS^{After} = 12.5 + 4*18 = 84.5}$$

$$\boldsymbol{\Delta CS = CS^{After} - CS^{Before} = 84.5 - 22.5 = 62}$$

The value E's entry to consumers will be equal to 62.

(iii)

The value of E's entry to society will change in total surplus after E's entry for the respective time period (2024-2028).

The producer surplus for firm I prior to E's entry in 2024 (equal to 2025, 2026, 2027 and 2028):

$$\boldsymbol{PS_I^{2024} = (7-4)*3 = 9}$$

The producer surplus for firm I after E's entry in 2024:

$$\boldsymbol{PS_I^{2024} = (5-4)*5 = 5}$$

$$\Delta \boldsymbol{PS_I} = \boldsymbol{PS_I^{After}} - \boldsymbol{PS_I^{Before}} = \mathbf{5 - 9 * 5 = -40}$$

Assuming a cost of technology of c:

$$\Delta TS = \Delta CS + \Delta PS_I + \Delta PS_E$$

$$\Delta TS = 62 - 40 + 18 - c$$

$$\Delta TS = 40 - c$$

Hence the value of E's entry to society will be 40 – c.

(iv)

Firm I will choose not to reverse engineer E's technology in 2028. This is because under this scenario the expected profits for Firm I will be 0 - c, where c is the cost of copying the technology, which is below its expected profit in 2028 of 0 assuming Firm E is aware of this.

(v)

To evaluate whether this decision is socially desirable we must calculate the change in total surplus with the copying of the technology.

As explained previously:

$$\Delta PS_I = -c$$

For Firm E:

$$p_E = p_I = 3$$

$$PS_E^{Before} = 6$$

$$\boldsymbol{PS_E^{After}} = \mathbf{(3 - 3) * 3.5 = 0}$$

$$\Delta \boldsymbol{PS_E} = \boldsymbol{PS_E^{After}} - \boldsymbol{PS_E^{Before}} = \mathbf{0 - 6 = -6}$$

Finally, for consumers:

$$CS^{Before} = 18$$

$$\boldsymbol{CS^{After}} = \frac{\mathbf{1}}{\mathbf{2}} * \mathbf{(10 - 3) * 7 = 24.5}$$

$$\Delta \boldsymbol{CS} = \boldsymbol{CS^{After}} - \boldsymbol{CS^{Before}} = \mathbf{24.5 - 18 = 6.5}$$

Therefore, the change in total surplus for society would be:

$$\Delta TS = \Delta CS + \Delta PS_I + \Delta PS_E$$

$$\Delta TS = 6.5 - c - 6$$

$$\Delta \boldsymbol{TS} = \mathbf{0.5} - \boldsymbol{c}$$

Hence this decision would not be desirable for society if c is less than 0.5. For values above 0.5 it would be socially desirable and for c equal to 0.5 it would be indifferent.