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1 firm 1 : $\Pi_1 = TR_1 - TC_1$

$$\Pi_1 = (a - bq_1 - bq_2 - bq_3)q_1 - C_1$$

$$\frac{\partial \Pi_1}{\partial q_1} = a - 2bq_1 - bq_2 - bq_3 = 0$$

$$a - bq_2 - bq_3 = 2bq_1$$

$$q_1 = \frac{a - bq_2 - bq_3}{2b} \quad \text{—— (1)}$$

firm 2 : $\Pi_2 = TR_2 - TC_2$

$$\Pi_2 = (a - bq_1 - bq_2 - bq_3)q_2 - C_2$$

$$\frac{\partial \Pi_2}{\partial q_2} = a - bq_1 - 2bq_2 - bq_3 = 0$$

$$a - bq_1 - bq_3 = 2bq_2$$

$$q_2 = \frac{a - bq_1 - bq_3}{2b} \quad \text{—— (2)}$$

substitute (1) to (2) ; $q_2 = \dfrac{a - b\left(\frac{a - bq_2 - bq_3}{2b}\right) - bq_3}{2b}$

$$q_2 = \frac{a - bq_3}{3b} \quad \text{—— (3)}$$

substitute (2) to (1) ; $q_1 = \dfrac{a - b\left(\frac{a - bq_3}{3b}\right) - bq_3}{2b}$

$$q_1 = \frac{a - bq_3}{3b} \quad \text{—— (4)}$$

firm 3 : $\Pi_3 = TR_3 - TC_3$

$$\Pi_3 = (a - bq_1 - bq_2 - bq_3)q_3 - C_3$$

$$\frac{\partial \Pi_3}{\partial q_3} = a - bq_1 - bq_2 - 2bq_3 = 0$$

$$a - bq_1 - bq_2 = 2bq_3$$

$$q_3 = \frac{a - bq_1 - bq_2}{2b} \quad \text{—— (5)}$$

substitute (3) & (4) to (5) ; $q_3 = \dfrac{a - b\left(\frac{a - bq_3}{3b}\right) - b\left(\frac{a - bq_3}{3b}\right)}{2b}$

$$q_3 = \frac{a + 2bq_3}{6b}$$

$$q_3 = \frac{a}{4b} \quad \text{—— (6)}$$

substitute (6) to (3) ; $q_1 = \dfrac{a - b\left(\frac{a}{4b}\right)}{3b}$

$$q_1 = \frac{a}{4b}$$

substitute (6) to (4) ; $q_2 = \dfrac{a - b\left(\frac{a}{4b}\right)}{3b}$

$$q_2 = \frac{a}{4b}$$

Equilibrium price ; $P = a - bQ$

$$P = a - b(q_1 + q_2 + q_3)$$

$$P = a - b\left(\frac{a}{4b} + \frac{a}{4b} + \frac{a}{4b}\right)$$

$$P = a - \left(\frac{3a}{4}\right)$$

$$P = \frac{a}{4} = 0.25a$$

firm 1 ; $\Pi_1 = P \cdot Q - C_1$

$$= 0.25a\left(\frac{a}{4b}\right) - C_1$$

$$= \frac{a^2}{16b} - C_1$$

firm 1 ; $\Pi_2 = \dfrac{a^2}{16b} - C_2$

firm 1 ; $\Pi_3 = \dfrac{a^2}{16b} - C_3$

② assume : $q_1 + q_2 + q_3 + q_n = A$

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$$P = a - b(q_1 + q_2 + q_3 + \dots + q_n)$$
$$P = a - bq_1 - bq_2 - bq_3 - \dots - bq_n$$

$$\Pi_1 = (a - bq_1 - bq_2 - bq_3 - \dots - bq_n)q_1 - C_1$$
$$\Pi_n = (a - bq_1 - bq_2 - bq_3 - \dots - bq_n)q_n - C_n$$

$$\frac{\partial \Pi_1}{\partial q_1} ; \quad a - 2bq_1 - bq_2 - bq_3 - \dots - bq_n = 0$$
$$q_1 = \frac{a}{2b} - 0.5(q_2 + q_3 + \dots + q_n)$$

$$q_n = \frac{a}{2b} - 0.5(q_1 + q_2 + q_3 + \dots + q_{n-1})$$

$$\therefore \quad q_1 - 0.5q_1 = \frac{a}{2b} - 0.5(q_1 + q_2 + q_3 + \dots + q_n)$$

$$0.5q_1 = \frac{a}{2b} - 0.5A$$

$$q_1 = \frac{a}{b} - A \quad \text{—— ①}$$

$$q_2 = \frac{a}{b} - A$$

$$q_3 = \frac{a}{b} - A$$
$$\vdots$$
$$q_n = \frac{a}{b} - A$$

since $A = q_1 + q_2 + q_3 + \dots + q_n$, $A = n\left(\frac{a}{b} - A\right)$

$$A = n \cdot \frac{a}{b} - nA$$

$$A = \frac{na}{(n+1)b}$$

substitute into ① ; $q_i = \frac{a}{(n+1)b}$

<u>Equilibrium price</u> ; $P = a - b(A)$

$$P = a - b\left(\frac{na}{(n+1)b}\right)$$

$$P = \frac{a}{n+1}$$

$$\Pi_i = P \cdot q_i - c_i$$
$$\Pi_i = \left(\frac{a}{n+1}\right)\left(\frac{a}{(n+1)b}\right) - c_i$$

$$\Pi_i = \frac{a^2}{(n+1)^2 b} - c_i$$

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(3) If $n \to \alpha$, it will make $q_i = \frac{a}{(n+1)b}$ $\Rightarrow$ nearly zero and each firms will sell at q is nearly zero unit

it will make $A = nq_i$ $\Rightarrow$ nearly zero. Q of every firms combined will be nearly α unit

it will make $P = \frac{a}{n+1}$ $\Rightarrow$ nearly zero. When supply increases, price decreases nearly zero

it will make $\pi_i = \frac{a^2}{(n+1)^2 b} - c_i$ $\Rightarrow$ Each firm will lose the profit.

If $n = 1$, it will make $q_i = \frac{a}{(n+1)b} = \frac{a}{2b}$. Since $Q = \frac{a}{2b} < Q = \frac{na}{(n+1)b}$, monopoly will sell less quantity.

it will make $A = nq_i = Q$. Since $n = 1$, firm will be a monopoly.

it will make $P = \frac{a}{n+1} = \frac{a}{2}$. Since $P_M = \frac{a}{2} > P = \frac{a}{n+1}$, monopoly will set higher price.

it will make $\pi_i = \frac{a^2}{(n+1)^2 b} - c_i = \frac{a^2}{4b} - c_i$, which higher than $\pi_i = \frac{a^2}{(n+1)^2 b}$. Monopoly will get higher profit.