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① Firm 1 ;

$$\pi_1 = TR_1 - TC_1$$

$$\pi_1 = (a - bq_1 - bq_2 - bq_3)q_1 - C_1$$

$$\frac{\partial \pi_1}{\partial q_1} = a - 2bq_1 - bq_2 - bq_3 = 0$$

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

$$q_1 = \frac{a - bq_2 - bq_3}{2b}$$

sub ② $\rightarrow q_1 = \dfrac{a - \left(\frac{a - q_3 b}{3b}\right)b - q_3 b}{2b}$

$$q_1 = \frac{3a - a + q_3 b - 3q_3 b}{6b}$$

$$q_1 = \frac{a - q_3 b}{3b} \quad — ①$$

sub ③ $\rightarrow q_1 = \dfrac{a - \left(\frac{a}{4b}\right)b}{3b}$

$$q_1 = \frac{4a - a}{12b} = \frac{a}{4b}$$

Firm 2;

$$\pi_2 = TR_2 - TC_2$$

$$\pi_2 = (a - bq_1 - bq_2 - bq_3)q_2 - C_2$$

$$\frac{\partial \pi_2}{\partial q_2} = a - bq_1 - 2bq_2 - bq_3 = 0$$

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

$$\text{sub } ① \rightarrow 2q_2 b = a - \left(\frac{a - q_2 b - q_3 b}{2b}\right) b - q_3 b$$

$$2q_2 b = \frac{2a - a + q_2 b + q_3 b - 2q_3 b}{2}$$

$$4q_2 b = a + q_2 b - q_3 b$$

$$q_2 = \frac{a - q_3 b}{3b} \quad \text{— } ②$$

$$\text{sub } ③ \rightarrow q_2 = \frac{a - \left(\frac{a}{4b}\right) b}{3b}$$

$$q_2 = \frac{4a - a}{12b} = \frac{a}{4b}$$

Firm 3:

$$\pi_3 = TR_3 - TC_3$$

$$\pi_3 = (a - bq_1 - bq_2 - bq_3) q_3 - C_3$$

$$\frac{\partial \pi_3}{\partial q_3} = a - bq_1 - bq_2 - 2bq_3 = 0$$

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

$$q_3 = a - bq_1 - bq_2$$

$$\text{sub } ① \,\&\, ② \rightarrow q_3 = \frac{a - b\left(\frac{a - q_3 b}{3b}\right) - b\left(\frac{a - q_3 b}{3b}\right)}{2b}$$

$$q_3 = \frac{3a - a + q_3 b - a + q_3 b}{6b}$$

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

$$6bq_3 = a + 2q_3 b$$

$$4bq_3 = a + 2q_3 b$$

$$q_3 = \frac{a}{4b}$$

At equilibrium price; $p = a - bQ$

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

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

$$p = a - \left(\frac{3a}{4}\right) = \frac{a}{4} = 0.25a$$

$\therefore$ Firm 1; $\pi_1 = pQ - C_1$

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

$$\pi_1 = \frac{a^2}{16b} - C_1 \quad \#$$

Firm 2; $\pi_2 = PQ_2 - C_2$

$$= \left(0.25a \cdot \frac{a}{4b}\right) - C_2$$

$$\pi_2 = \frac{a^2}{16b} - C_2 \quad \#$$

Firm 3; $\pi_3 = PQ_3 - C_3$

$$= \left(0.25a \cdot \frac{a}{4b}\right) - C_3$$

$$\pi_3 = \frac{a^2}{16b} - C_3 \quad \#$$

② Assume: $q_1+q_2+\dots+q_n=A$

$p=a-b(q_1+q_2+\dots q_n)$

$p=a-bq_1-bq_2 \dots -bq_n$

$\pi_1=(a-bq_1-bq_2-\dots bq_n)\cdot q_1-c_1$

$\vdots$

$\pi_n=(a-bq_1-bq_2-\dots bq_n\cdot q_1-c_n$

$\frac{\partial \pi_1}{\partial q_1}=a-2bq_1-bq_2-\dots-bq_n=0$

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

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

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

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

$q_1=\frac{a}{b}-A$ — ①

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

$\vdots$

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

since $A=q_1+q_2+\dots q_n$

so, $A=n(\frac{a}{b}-A)$

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

$A+nA=n(\frac{a}{b})$

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

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

sub into ①; $q_1 = \frac{a}{(n+1)b}$

$\therefore q_i = \frac{a}{(n+1)b}$ #

equlibrium price; $p = a - b(A)$

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

$p = a - \left(\frac{n}{n+1}\right)a$

$p = \frac{a(n+1) - na}{n+1}$

$p = \frac{na + a - na}{n+1} = \frac{a}{n+1}$

$\pi_i = pq_i - c_i$

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

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

③

if $n \to \infty$;

$q_i = \frac{a}{(n+1)b}$; nearly zero and each firms will sell q at nearly zero unit.

$A = nq_i$; nearly zero. So, Q of each firms combinded will nearly ∞ unit.

$P = \frac{a}{n+1}$; nearly zero. When supply increases, price will decrease nearly zero.

$\pi_i = \frac{a^2}{(n+1)^2 b} - C_i$; each firm will lose the profit.

If $n = 1$;

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

$A = nq_i = Q$ Since $n = 1$, the firm will be monopoly.

$P = \frac{a}{n+1} = \frac{a}{2}$ sine $P_M = \frac{a}{2} > P = \frac{a}{n-1}$, monopoly firm will set the higher price.

$\pi_i = \frac{a^2}{(n+1)^2 b} - C_i = \frac{a^2}{4b} - C_i$ which higher than $\pi_i = \frac{a^2}{(n+1)^2 b}$

As a result, the monopoly will gain more profit.