Asymmetric Passive Cross-Ownership and Tacit Collusion

Rupayan Pal[1] and Emmanuel Petrakis[2]

1 Indira Gandi Institute of Development Research (IGIDR)

2 University of Crete and Universidad Carlos III de Madrid

Motivation (1)

- **Passive cross ownership among rival firms** is a widely observed phenomenon in many industries (banking and finance, information technology, natural resources, automobile, consumer goods, and other manufacturing)
- Its pattern is very often **asymmetric**
- For example, in the automobile industry:

  Toyota bought a 4.94% stake in Suzuki, while Suzuki bought 48-billion-yen worth of shares in Toyota in 2019.

  In 2018, Renault owned 43% of Nissan, while Nissan had a 15% share in Renault.

  From 2011 to 2015, VW and Suzuki held shares in each other 19.89% and 2.5%, respectively.

Motivation (2)

- It is well argued that passive cross ownership (PCO) **softens product market competition.**
- Ownership of a rival's share by a firm induces it to consider the implications of its market strategy, not only on its own profit, but also on the rival's profit.
- Softening of competition may occur independently whether the pattern of PCO is symmetric or asymmetric.
- It also **facilitates tacit collusion** among rival firms when PCO structure is **symmetric**.

Motivation (3)

- But what if the pattern of passive cross ownership is **asymmetric**?
- This crucially depends on how collusive profits are divided between firms with ex-ante asymmetric objectives.
- This issue has been ignored so far in the existing literature.
- We undertake this task in a stylized Cournot duopoly model

Related Literature

- Reynolds and Snapp (1986) – pricing effects of asymmetric PCO, no tacit collusion.
- Malueg (1992) – symmetric PCO.
- Gilo et al (2006) - asymmetric PCO aligns firms' interests and facilitates collusion.
- Gilo et al (2013) – cost asymmetries, symmetric PCO.
- Yang and Zheng (2021) – cost asymmetries, symmetric PCO.
- De Haas and Paha (2021) – asymmetric PCO, yet equal division of collusive profits.

The Model (1)

- Cournot homogenous good duopoly.
- Identical production technologies, with MC = c.
- Linear demand $p = a - q_1 - q_2$, $c < a$.
- Firm i owns $s_i \in [0, \frac{1}{2})$ of firm j's passive shares.
- Hence, firm i's objective is given by

$$\Gamma_i(q_i, q_j) = (1 - s_j)\pi_i(q_i, q_j) + s_i\pi_j(q_i, q_j)$$

$$\Rightarrow \Gamma_i(q_i, q_j) = (\alpha - q_i - q_j - c)[(1 - s_j)q_i + s_i q_j]$$

- Infinitely repeated game, t =1,2,…….
- Discount factor for both firms $\delta \in (0,1)$

Stage game: Cournot Competition

- Firm i maximizes $\Gamma_i(q_i, q_j)$ leading to reaction function $R_i(q_j) = \frac{1}{2}[\alpha - c - q_j(1 + \frac{s_i}{1-s_j})]$.
- The ownership of rival's passive shares induces a firm to compete less aggressively in the market.

- In the Cournot equilibrium we get:

- $\frac{\partial q_{iN}}{\partial s_i} < 0 < \frac{\partial q_{iN}}{\partial s_j}$, $\frac{\partial \Gamma_{iN}}{\partial s_j} < 0 < \frac{\partial \Gamma_{iN}}{\partial s_i}$
- $\frac{\partial CS_N}{\partial s_i} = \frac{\partial CS_N}{\partial s_j} < 0$, $\frac{\partial SW_N}{\partial s_i} = \frac{\partial SW_N}{\partial s_j} < 0$.

Stage game: Collusion (1)

- Collusive quantity and profits: $Q_C = \frac{\alpha - c}{2}, \Pi_C = \frac{(\alpha - c)^2}{4}$.
- Firms divide those profits via bargaining without side payments, i.e., by properly adjusting their quantities $q_{iC}^*, i = 1,2$ such that $q_{1C}^* + q_{2C}^* = Q_C$.
- Let $y_1 + y_2 = \Pi_C$. Then $\omega_{ic} = (1 - s_j)y_i + s_i y_j$.
- Let $(\gamma, 1 - \gamma), \gamma \in [0,1]$ the bargaining power distribution.
- The generalized Nash bargaining problem is

$$\max_{y_1, y_2} Z = (\omega_{1c}(y_1, y_2) - \Gamma_{1N})^{\gamma} (\omega_{2c}(y_1, y_2) - \Gamma_{2N})^{1-\gamma}$$

$$\text{s.t. } y_1 + y_2 \leq \Pi_C, y_1 \geq 0 \text{ and } y_2 \geq 0$$

- $\omega_{1c}^* = \Gamma_{1N} + \gamma(\Pi_C - \Gamma_{1N} - \Gamma_{2N})$ and
- $\omega_{2c}^* = \Gamma_{2N} + (1 - \gamma)(\Pi_C - \Gamma_{1N} - \Gamma_{2N})$

Stage game: Collusion (2)

- Since $y_{iC}^{*} = \frac{\omega_{ic}^{*} - s_i(\omega_{1c}^{*} + \omega_{2c}^{*})}{1 - s_1 - s_2}$, we get $y_{iC}^{*}(s_i, s_j)$. Then
- $q_{1C}^{*} = \frac{(\alpha - c)\left((1 - s_1)(4 + \gamma - s_1) - (\gamma - s_1)s_2\right)}{2(3 - s_1 - s_2)^2}$
- $q_{2C}^{*} = \frac{(\alpha - c)\left((1 - s_2)(5 - \gamma - s_2) - (1 - \gamma - s_2)s_1\right)}{2(3 - s_1 - s_2)^2}$
- Note that if $\gamma = \frac{1}{2}$, this corresponds to the solution under Nash bargaining a la Harrington (1984)
- While if $\gamma = \frac{1 - s_2}{2 - s_1 - s_2}$, it corresponds to the solution under market sharing arrangement a la Fershtman and Gandal (1994)

Stage game: Deviation in period t

- Suppose that firm 1 deviates, while firm 2 sticks to its collusive output q_{2C}^*.
- Then firm 1's best response is given by $q_{1D} = R_1(q_{2C}^*)$.
- And firm 1's deviation net profits are $\Gamma_{1D}(q_{1D}, q_{2C}^*) > \omega_{1c}^*$.

Stability of Tacit Collusion (1)

- **Trigger strategy**:

  In t=1, set $q_i = q_{iC}^*$.

  In any t >1, if $(q_i, q_j) = (q_{iC}^*, q_{jC}^*)$ for all $t = 1,2,..t-1$, set $q_i = q_{iC}^*$

  Otherwise, set $q_i = q_{iN}^*$ forever

- Then collusion is stable as long as
- $\delta > \hat{\delta}(s_1, s_2; \gamma) = \max\left[\hat{\delta}_1(s_1, s_2; \gamma), \hat{\delta}_2(s_1, s_2; \gamma)\right]$, with
- $\hat{\delta}_i(s_1, s_2; \gamma) = \frac{\Gamma_{iD} - \omega_{ic}^*}{\Gamma_{iD} - \Gamma_{iN}}$, $i = 1,2.$
- A lower value of $\hat{\delta}(s_1, s_2; \gamma)$ implies that collusion is more stable.

Stability of Tacit Collusion (2)

- Suppose that $s_1 \leq s_2$. Let $\bar{s} \in (0, \frac{1}{2})$ and $2\Delta = s_2 - s_1$ denote the mean and the spread of PCOs. Then $s_1 = \bar{s} - \Delta$ and $s_2 = \bar{s} + \Delta$.
- **Proposition 1**: Under symmetric PCO ($\Delta = 0$), tacit collusion becomes more stable as $\bar{s}$ increases, i.e., $\frac{\partial \hat{\delta}}{\partial \bar{s}} < 0 \; \forall \; \gamma \in [0,1]$.
- This confirms that the main finding in the received literature (Malueg, 1992) does not depend on how collusive profits are divided between rival firms in a duopoly.

Stability of Tacit Collusion (3)

Lemma 1: Let $0 \leq s_1 < s_2 < \frac{1}{2}, 2\Delta = s_2 - s_1, \gamma_l(\bar{s}, \Delta) \equiv \frac{1}{2} - \frac{\Delta}{2(1-\bar{s})}$ and $\gamma_u(\bar{s}, \Delta) \equiv \frac{1}{2} + \Delta - \frac{(3-2\bar{s})^2(1-2\bar{s})}{2(5-4\bar{s}^2+8\Delta)}$. Then:

- (a) $\hat{\delta}_1(\bar{s} - \Delta, \bar{s} + \Delta, \gamma) > \hat{\delta}_2(\bar{s} - \Delta, \bar{s} + \Delta, \gamma)$ if and only if $0 \leq \gamma < \gamma_l(\bar{s}, \Delta)$

- (b) $\frac{\partial \hat{\delta}_1}{\partial \bar{s}} < 0$ if $\hat{\delta}_1(.) > \hat{\delta}_2(.)$; and $\frac{\partial \hat{\delta}_2}{\partial \bar{s}} > 0$ if $\hat{\delta}_1(.) < \hat{\delta}_2(.)$ and $\gamma_l(\bar{s}, \Delta) < \gamma < \gamma_u(\bar{s}, \Delta)$, otherwise $\frac{\partial \hat{\delta}_2}{\partial \bar{s}} < 0$.

- (c) $\frac{\partial \hat{\delta}_1}{\partial \Delta} < 0$ and $\frac{\partial \hat{\delta}_2}{\partial \Delta} > 0$ for all $\gamma \in [0, 1]$

Stability of Tacit Collusion (4)

Proposition 2: If passive cross-ownership is asymmetric, $0 < s_1 = \bar{s} - \Delta < s_2 = \bar{s} + \Delta < \frac{1}{2}$, then

- As the average cross-ownership **$\bar{s}$ increases, tacit collusion becomes less stable** when the asymmetry in cross ownership is high, and the bargaining power is neither too high nor too low, $\gamma_l(\bar{s}, \Delta) < \gamma < \gamma_u(\bar{s}, \Delta)$.

- **As cross-ownership becomes more asymmetric** (higher Δ), **collusion becomes less stable** if and only if the bargaining power of the firm that owns less shares of its rival is high enough, $\gamma > \gamma_l(\bar{s}, \Delta)$.

Stability of Tacit Collusion (5)

- Let $\gamma = \frac{1-s_2}{2-s_1-s_2}$ and $1-\gamma = \frac{1-s_1}{2-s_1-s_2}$, i.e., the bargaining power distribution is such that the ratio of firms' collusive profits is the same as under Cournot competition (Fershtman and Gandal, 1994).
- Then $\hat{\delta}_1 = \hat{\delta}_2 = \hat{\delta}$ for all (s_1, s_2), with $\frac{\partial \hat{\delta}}{\partial \bar{s}} < 0$ and $\frac{\partial \hat{\delta}}{\partial \Delta} = 0$.
- **Proposition 3**: (a) A 'mean-increasing spread-preserving' shift in the distribution of cross-ownership makes tacit collusion more stable.

  (b) The stability of tacit collusion remains unchanged due to 'mean-preserving spread-increasing' shift in the distribution of cross-ownership.

Forfeiting bargaining power

- Suppose that a firm can forfeit part of its bargaining power (Marx and Shaffer, 2010).
- This can be materialized e.g. by delegating bargaining to a weaker in the negotiation table agent.
- Does a firm have incentives to do so to enhance collusion stability?
- Let $\gamma > \frac{1-s_2}{2-s_1-s_2}$ such that firm 1's discount factor $\delta < \hat{\delta}_2$, rendering thus collusion non-sustainable. Firm 1 has incentives to forfeit the least possible part of its bargaining power such that collusion can be sustained.

Concluding Remarks

- We challenge the maintained in the existing literature assumption that collusive profits are equally divided even if firms own asymmetric shares in their rivals.
- In contrast to the literature, we identify conditions under which an increase in the average number of rivals' shares destabilizes collusion.
- Our findings have important policy implications for antitrust authorities.
- Our analysis suggests that the negotiations over the surplus division under collusion leads to pro-competitive (instead of anti-competitive) outcomes under certain market conditions.
- Future research should delve into the investigation of those market conditions.