Partial cross ownership and tacit collusion under cost asymmetries

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Background

- Multilateral passive investments among rivals common:
  - Japanese and the U.S. automobile industries
  - Global airline industry
  - Dutch Financial Sector
  - Nordic power market
  - Global steel industry
  - Global Potash market

Legal treatment

- Many decisions have granted it de facto exemption:
  - E.g., Gillette (Gilo, 2000)
- Many cases unchallenged by antitrust agencies
  - E.g., MS-Apple, Potash, etc.
- Question: is this lenient approach justified?

Symmetric vs. Asymmetric case

- Gilo, Moshe, and Spiegel, (RJE 2006):
  - An increase in firm r's stake in rival s:
    - Always facilitates tacit collusion except when:
      - The industry maverick does not have a direct or an indirect stake in firm r
      - Firm s is the industry maverick
- RAND paper: symmetric marginal costs
- Current paper: asymmetric marginal costs

Related literature

- Unilateral effects of PCO:
  - Reynolds and Snapp (*IJIO*, 1986)
  - Bolle and Güth (*JITE*, 1992)
  - Dietzenbacher et al (*IJIO,* 2000)
  - Flath (*IJIO,* 1991, *MDE*, 1992)
  - Reitman (*JIE*, 1994)

- Some-ignore the multiplier effect of PCO

- Coordinated effects of PCO:
  - Malueg (*IJIO*, 1992) – symmetric firms, no multiplier effect
  - Gilo, Moshe, and Spiegel (RJE, 2006)

The model

- Infinitely repeated Bertrand model with n ≥ 2 price-setting firms
- Firms have constant marginal costs:

$$c_1 < c_2 < \ldots < c_n$$

- Firm i's profit:

$$y_i(p) = Q(p)(p - c_i)$$

- Assumptions:
  - yi(p) has a unique global maximizer, p_i^m (firm i's "monopoly price")

$$p_1^m < p_2^m < \ldots < p_n^m$$

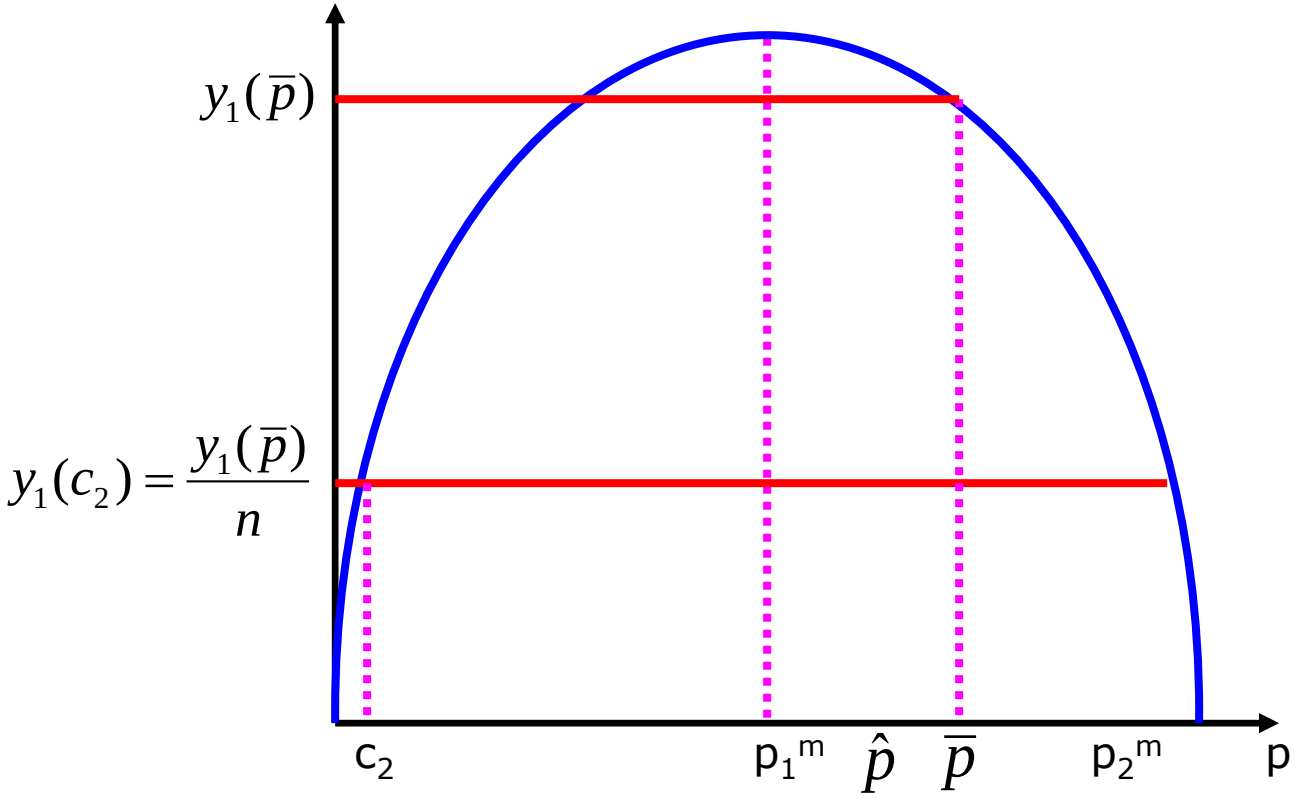
  - $p_1^m > c_n$ (all firms are effective competitors)
  - $y_1(c_2) > y_1(c_j)/(j-1)$ for all j = 3,...,n (absent collusion, firm 1 will prefer to monopolize the market by charging a price slightly below c_2 rather than share the market with more rivals)

Collusion without PCO

- Which price would firms coordinate on?
- With side payments, firm 1 will serve the entire market at a price p_1^m and firms will share y_1^m
- Assume side payments are not feasible, and consider instead a collusive scheme led by firm 1:
  - Firm 1 sets a price $\hat{p}$ which maximizes its profits
  - All firms adopt $\hat{p}$
  - Consumers randomize between the firms so each firm gets a market share 1/n
- How large can $\hat{p}$ be?

How large can $\hat{p}$ be?

- Firm 1 can always get $y_1(c_2)$
- Hence we must have $\hat{y}_1/n > y_1(c_2)$



- Implication: if firm i = 2,…,n deviates it charges $\hat{p}$
- If firm 1 deviates it charges p_1^m

The conditions for collusion absent PCO

- Firm i = 2,…,n will collude if

$$\underbrace{\frac{\hat{y}_i}{n(1-\delta)}}_{\text{Collude forever}} \geq \underbrace{\hat{y}_i}_{\text{Deviate}} \quad \Rightarrow \quad \delta \geq 1 - \frac{1}{n}$$

- Firm 1 will collude if

$$\underbrace{\frac{\hat{y}_1}{n(1-\delta)}}_{\text{Collude forever}} \geq \underbrace{y_1^{\,m} + \frac{y_1(c_2)}{1-\delta}}_{\text{Deviate}} \quad \Rightarrow \quad \delta \geq \hat{\delta}_1 \equiv \frac{y_1^{\,m} - \frac{\hat{y}_1}{n}}{y_1^{\,m} - y_1(c_2)}$$

- Firm 1 is the industry maverick:

$$\hat{\delta}_1 > \frac{y_1^{\,m} - \frac{\hat{y}_1}{n}}{y_1^{\,m}} > \frac{y_1^{\,m} - \frac{y_1^{\,m}}{n}}{y_1^{\,m}} = 1 - \frac{1}{n}$$

Unilateral PCO by firm 1

- Firm 1 will collude if

$$\underbrace{\frac{\hat{y}_1 + \sum_{i \neq 1} \alpha_{1i} \hat{y}_i}{n(1-\delta)}}_{\text{Collude forever}} \geq \underbrace{y_1^{\ m} + \frac{\delta y_1(c_2)}{1-\delta}}_{\text{Deviate}} \quad \Rightarrow \quad \delta \geq \hat{\delta}_1^{PO} \equiv \frac{y_1^{\ m} - \dfrac{\hat{y}_1 + \sum_{i \neq 1} \alpha_{1i} \hat{y}_i}{n}}{y_1^{\ m} - y_1(c_2)}$$

- $\hat{\delta}_1^{PO}$ decreases with each α_{1i}: collusion is facilitated
- $\hat{\delta}_1^{PO}$ decreases more when firm 1 invests in an efficient rival (because $\hat{y}_2 > \hat{y}_3 > \ldots > \hat{y}_n$)
- Assume that firm 1 remains the industry maverick (o/w it will not invest in rivals)

The collusive price under unilateral PCO by firm 1

- Firm 1 will choose the collusive price to maximize its collusive profit:

$$\frac{\hat{y}_1 + \sum_{i \neq 1} \alpha_{1i} \hat{y}_i}{n(1-\delta)}$$

- It is a weighted average of the profits of the n firms:
  - Collusive price is above p_1^m
  - and increases with α_{1i}

- Firm 1 will prefer to invest first in firm 2
  - It leads to a larger reduction in $\hat{\delta}_1^{PO}$
  - + collusive price closer to p_1^m

Multilateral PCO

- The PCO matrix:

$$A = \begin{pmatrix} 0 & \alpha_{12} & \cdots & \alpha_{1n} \\ \alpha_{21} & 0 & \cdots & \alpha_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \alpha_{n1} & \alpha_{n2} & \cdots & 0 \end{pmatrix}$$

The inverse Leontief matrix

- Let

$$B \equiv (I - A)^{-1} = \begin{pmatrix} b_{11} & b_{12} & \cdots & b_{1n} \\ b_{21} & b_{22} & \cdots & b_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ b_{n1} & b_{n2} & \cdots & b_{nn} \end{pmatrix}$$

- b_{ij} = the "imputed share" of a real shareholder of firm i in the profit of firm j
  - Taking into account direct and indirect ownership stakes
  - A shareholder with a stake α in firm i has $\alpha \times b_{ij}$ in firm j
- $b_{ii} \geq 1$ and $b_{ii} > b_{ij} \geq 0$
- $b_{ij} = 0$ iff firm i has no direct or indirect stake in firm j
- $b_{ii} > 1$ iff firm i has an indirect stake in itself

Multilateral PCO –profits

- The collusive profits:

$$\pi_i(\hat{p}; A) = \frac{1}{n}\sum_{j=1}^{n} b_{ij}\hat{y}_j$$

- The profits following deviation:

$$\pi_1^{d_1}(\hat{p}; A) = b_{11}y_1^{m} \qquad \pi_i^{d_i}(\hat{p}; A) = b_{ii}\hat{y}_i$$

- The profits once collusion breaks down:

$$\pi_1^{f}(c_2; A) = b_{11}y_1(c_2) \qquad \pi_i^{f}(c_2; A) = b_{i1}y_1(c_2)$$

Collusion with multilateral PCO

- Firm i = 2,…,n will collude if

$$\delta \geq \hat{\delta}_i(A) \equiv \frac{\pi_i^{d_i}(\hat{p};A) - \pi_i(\hat{p};A)}{\pi_i^{d_i}(\hat{p};A) - \pi_i^{f}(c_2;A)} = \frac{b_{ii}\hat{y}_i - \frac{1}{n}\sum_{j=1}^{n} b_{ij}\hat{y}_j}{b_{ii}\hat{y}_i - b_{i1}y_1(c_2)} \equiv \frac{\hat{y}_i - \frac{1}{n}\sum_{j=1}^{n}\overbrace{\left(\frac{b_{ij}}{b_{ii}}\right)}^{z_{ij}}\hat{y}_j}{\hat{y}_i - \underbrace{\left(\frac{b_{i1}}{b_{ii}}\right)}_{z_{i1}} y_1(c_2)}$$

- z_{ij} = firm i's shareholders' stake in firm j relative to their stake in firm i:
  - $z_{ii} = 1$
  - $z_{ij} < 1$

Collusion with multilateral PCO

- Firm 1 will collude if

$$\delta \geq \hat{\delta}_1(A) \equiv \frac{\pi_1^{d_1}(\hat{p};A) - \pi_1(\hat{p};A)}{\pi_1^{d_1}(\hat{p};A) - \pi_1^{f}(c_2;A)} = \frac{b_{11}y_1^{m} - \frac{1}{n}\sum_{j=1}^{n} b_{1j}\hat{y}_j}{b_{11}y_1^{m} - b_{11}y_1(c_2)} = \frac{y_1^{m} - \frac{1}{n}\sum_{j=1}^{n}\overbrace{\left(\frac{b_{1j}}{b_{11}}\right)}^{z_{1j}}\hat{y}_j}{y_1^{m} - y_1(c_2)}$$

The effect of $\alpha_{rs}\uparrow$ by ω

- We break the analysis into two steps:
  - Step 1: how does ω affect z_{ij}?
  - Step 2: how does z_{ij} affect $\hat{\delta}_i(A)$?

- Step 1: $\frac{\partial \hat{\delta}_1(A)}{\partial z_{1j}} < 0, \quad \frac{\partial \hat{\delta}_i(A)}{\partial z_{i1}} < 0, \quad \frac{\partial \hat{\delta}_i(A)}{\partial z_{ij}} < 0.$

- An increase in z_{ij} boosts the incentives to collude

Step 2: The effect of ω on the matrix Z

- Lemma A1 in Gilo, Moshe, and Spiegel (2006):

$$z_{ij}^{\omega} = \frac{b_{ij} + \varepsilon_i b_{sj}}{b_{ii} + \varepsilon_i b_{si}} \qquad \varepsilon_i = \frac{\omega b_{ir}}{1 - \omega b_{sr}}$$

- Differentiation: $$\frac{\partial z_{ij}^{\omega}}{\partial \omega} = \frac{b_{ii} b_{sj} - b_{si} b_{ij}}{\left(b_{ii} + \varepsilon_i b_{si}\right)^2} \times \frac{b_{ir}}{\left(1 - \omega b_{sr}\right)^2}$$

- Zeng (*Econ. Systems Research*, 2000) proves that $b_{sj} b_{ii} \geq b_{si} b_{ij}$

The main result

- $\hat{\delta}_i\left(A^{\omega}\right) \leq \hat{\delta}_i\left(A\right)$ for all i with equality only if:
  - i = s (the maverick is firm s)
  - b_{ir} = 0 (the maverick has no direct or indirect stake in firm r)

- Same as symmetric case
  - Even though firm i's stake in firm 1 goes up
  - Intuition: firm 1's collusive profits are larger than its price war profits

Firm r buys a stake ϕ in firm s from firm k

- In 2002, Luxembourg-based Arcelor increased its stake in Brazilian steelmaker CST by buying shares from Acesita, another Brazilian steelmaker

- What's the effect of such an ownership change on tacit collusion?
  - Firm r buys a stake in firm s from firm k

The effect of ϕ on the matrix z

- By equation (2) in Zeng (2000):

$$z_{ij}^{\phi} = \frac{b_{ij} + \varepsilon_i^{\phi} b_{sj}}{b_{ii} + \varepsilon_i^{\phi} b_{si}} \qquad \varepsilon_i^{\phi} = \frac{\phi(b_{ir} - b_{ik})}{1 - \phi(b_{sr} - b_{sk})}$$

- Differentiation:

$$\frac{\partial z_{ij}^{\phi}}{\partial \phi} = \frac{b_{ii} b_{sj} - b_{si} b_{ij}}{\left(b_{ii} + \varepsilon_i^{\phi} b_{si}\right)^2} \times \frac{b_{ir} - b_{ik}}{\left(1 - \phi(b_{sr} - b_{sk})\right)^2}$$

- $\hat{\delta}_s\left(A^{\phi}\right) = \hat{\delta}_s(A)$
- $\hat{\delta}_i\left(A^{\phi}\right) = \hat{\delta}_i(A)$ if $b_{ir} = b_{ik}$ (firm i has the same stake in firms r and k)
- $\hat{\delta}_i\left(A^{\phi}\right) \leq (\geq) \hat{\delta}_i(A)$ as $b_{ir} > (<) b_{ik}$

Extensions

- When does firm 2 become the maverick?
- Does investment in a more efficient firm facilitate collusion more?
- How does investment affect the collusive price?
  - When firm 1's stake in less/more efficient rivals is affected
  - Even investment in firm 1 as a maverick could lower the collusive price

Conclusion

- Passive investments in rivals may facilitate collusion also with cost asymmetries
- Agencies seem to lenient toward passive investments in rivals
- Passive investment has no effect on stability of collusion if:
  - The investment is in the maverick
  - The maverick has no stakes (direct or indirect) in the acquirer
- It matters who invests in who:
  - How efficient is the target firm