Hub and Spoke Collusion by Embargo

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Antitrust authorities recently have dealt with a number of cases where collusion between downstream firms was induced or facilitated by a common supplier.

Although this involves some vertical agreement between the supplier (the “hub”) and his buyers (the “spokes”) the legal doctrine that emerged from handling these cases was also influential for the view the EC holds on horizontal agreements.

Economic analysis has shown the difficulties in implementing a collusive (horizontal) agreement, see Osborne (1986). The possible role that a common upstream supplier could play in the reach of a collusive outcome however remains relatively unexplored.
The question therefore is:

- What “contribution” to cartel stability could the hub make (beyond what is in reach of the spokes when acting on their own)?
- When will the hub be willing to provide this support for the downstream cartel?

Both questions are answered in the affirmative for a strategy where the hub $U$ cuts the deviating downstream firm from its supply chain.

By refusing to further supply a downstream deviator (removing the spoke), the cartel becomes more stable compared to a cartel that has to rely on a price war on the rim for punishing deviation.

The supplier prefers to take up short the downstream deviator because price wars lead to renegotiations that reduce the intermediate or “transfer” price at which the upstream player sells to the downstream firms.
The model (i)

One upstream manufacturer \((U)\) and two downstream retailers \((D_1\) and \(D_2)\) play the following infinitely repeated three stage game:

1. \(U\) indicates which retailers he is willing to trade with (conditional on reaching an agreement)

\[\begin{align*}
\text{Bilateral negotiations (Nash bargaining) take place between } U \text{ and } \text{chosen partners to determine intermediate prices } (g_1, g_2). \\
\text{Relative retailer bargaining power is denoted by } \gamma \in [0, 1]. \\
\text{Retailers set prices } (p_1, p_2). \\
\text{Retailer } D_i \text{'s inverse demand is given by: } p_i = \frac{1}{\theta} q_i - \theta \sum_{j=1, j \neq i}^{2} q_j, \quad \theta \in [0, 1]. \\
\text{where } \theta \text{ measures the degree of substitutability. } \\
\theta = 0: \text{independent retailers; } \\
\theta \neq 1: \text{perfect substitutes.}
\end{align*}\]
The model (i)

One upstream manufacturer \((U)\) and two downstream retailers \((D_1\) and \(D_2)\) play the following infinitely repeated three stage game:

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2. Bilateral negotiations (Nash bargaining) take place between \(U\) and chosen partners to determine intermediate prices \((g_1, g_2)\). Relative retailer bargaining power is denoted by \(\gamma \in [0, 1)\).

\[ p_i = \frac{1}{\theta} q_i \theta \sum_{j \neq i} q_j, \quad \theta \in [0, 1) \]

\(\theta = 0: \) independent retailers; \(\theta = 1: \) perfect substitutes
One upstream manufacturer ($U$) and two downstream retailers ($D_1$ and $D_2$) play the following infinitely repeated three stage game:

1. $U$ indicates which retailers he is willing to trade with (conditional on reaching an agreement)

2. Bilateral negotiations (Nash bargaining) take place between $U$ and chosen partners to determine intermediate prices $(g_1, g_2)$. Relative retailer bargaining power is denoted by $\gamma \in [0, 1)$.

3. Retailers set prices $(p_1, p_2)$. Retailer $D_i$’s inverse demand is given by:

$$p_i = 1 - q_i - \theta \sum_{j \neq i} q_j, \quad \theta \in [0, 1)$$

where $\theta$ measures the degree of substitutability. [$\theta = 0$: independent retailers; $\theta \to 1$: perfect substitutes]
The model (ii)

Two crucial elements:

- **(Downstream) product differentiation**: Under a “price war”, each $D_i$ would still earn positive profits.
  - Role for $U$ to play by admitting more severe punishment
The model (ii)

Two crucial elements:

- **(Downstream) product differentiation**: Under a “price war”, each $D_i$ would still earn positive profits.
  → Role for $U$ to play by admitting more severe punishment

- **(Bilateral) bargaining over transfer prices**: $U$ cannot set $g$ freely: function of (relative) bargaining power and downstream fundamentals (# of retailers, degree of differentiation, conduct).
  → $U$ might allow for build-up of downstream market power if this yields higher transfer price.
### Stage game outcomes

<table>
<thead>
<tr>
<th>Downstream market:</th>
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<th>retail price</th>
<th>sales</th>
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<tr>
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<td>high</td>
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Retailer preferences:

\[
\pi^{M*}_{Di} > \pi^{C*}_{Di} > \pi^{NC*}_{Di}
\]

Supplier preferences depend on \((\theta, \gamma)\):
## Stage game outcomes

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Retailer preferences:

- \( \pi_M^* > \pi_C^* > \pi_{NC}^* \)

Supplier preferences depend on \((\theta, \gamma)\):

1. \( \pi_U^M < \pi_U^C < \pi_U^{NC} \) if \( \theta < \theta_C^* (\gamma) \)
Stage game outcomes

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Retailer preferences:

\[ \pi^{M*}_{D_i} > \pi^{C*}_{D_i} > \pi^{NC*}_{D_i} \]

Supplier preferences depend on \((\theta, \gamma)\):

I. \[ \pi^{M*}_{U} < \pi^{C*}_{U} < \pi^{NC*}_{U} \text{ if } \theta < \theta^{*}_C (\gamma) \]

II. \[ \pi^{M*}_{U} < \pi^{NC*}_{U} < \pi^{C*}_{U} \text{ if } \theta \in [\theta^{*}_C (\gamma), \theta^{*}_M (\gamma)] \]
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Retailer preferences:

- \( \pi_{D_i}^M > \pi_{D_i}^C > \pi_{D_i}^{NC} \)

Supplier preferences depend on \((\theta, \gamma)\):

1. \( \pi_U^M < \pi_U^C < \pi_U^{NC} \) if \( \theta < \theta_C^* (\gamma) \)
2. \( \pi_U^M < \pi_U^{NC} < \pi_U^C \) if \( \theta \in [\theta_C^* (\gamma), \theta_M^* (\gamma)] \)
3. \( \pi_U^{NC} < \pi_U^M < \pi_U^C \) if \( \theta > \theta_M^* (\gamma) \)
Stage game outcomes

\[ \begin{array}{c|cccc}
 & I & II & III & \theta^*(\gamma) \\
\hline
C & 0.633 & 0.736 & 1 & \\
M & 0.736 & 0.633 & 1 & \\
\end{array} \]
Region II + III: Cartel is desirable for $U$
Stage game outcomes

- Region II + III: Cartel is desirable for $U$
- Region III: In case of a “price war”, $U$ will refuse to supply one of the retailers.
The repeated game
Trigger-like strategies

Retailers:

- Start by charging the collusive price

Manufacturer:
Retailers:

- Start by charging the collusive price
- Permanently revert to non-cooperative pricing in case of price deviation

Manufacturer:
The repeated game
Trigger-like strategies

Retailers:

- Start by charging the collusive price
- Permanently revert to non-cooperative pricing in case of price deviation
- Act as a monopolist whenever only firm in the market

Manufacturer:
The repeated game
Trigger-like strategies

Retailers:
- Start by charging the collusive price
- Permanently revert to non-cooperative pricing in case of price deviation
- Act as a monopolist whenever only firm in the market

Manufacturer:
- Start by supplying both retailers
The repeated game
Trigger-like strategies

Retailers:
- Start by charging the collusive price
- Permanently revert to non-cooperative pricing in case of price deviation
- Act as a monopolist whenever only firm in the market

Manufacturer:
- Start by supplying both retailers
- Permanently refuse to supply retailer that deviates (first)
The repeated game
Equilibrium conditions

Proposition

Necessary and sufficient conditions for the existence of tacit collusion enforced by embargo in an hub and spokes environment require that the following set of conditions is satisfied:

\[ \delta \geq \delta_{EM} \quad (C.1) \]
\[ 0 < \gamma < 1 \quad (C.2) \]
\[ \theta > \theta^*_M (\gamma) \quad (C.3) \]

- Limited scope for hub and spoke collusion by embargo
Corollary

Cartel stability is guaranteed for a larger set of discount rates when the manufacturer is willing to impose an embargo. Or discount rates too low for ensuring cartel stability between retailers if left on their own still can be sufficiently high when the manufacturer is willing to impose an embargo.
The repeated game
Comparative statics (i)

Corollary

The critical discount factor \( \delta^*_E \) is increasing is (i) independent of \( \gamma \) and (ii) increasing in \( \theta \), approaching one as the downstream market becomes undifferentiated (i.e. \( \theta \to 1 \)).

Corollary

The critical discount factor \( \delta^*_N \) is non-monotonic in \( \gamma \) and \( \theta \), approaching one as the downstream market becomes undifferentiated (i.e. \( \theta \to 1 \)).
The repeated game

Comparative statics (ii)

\[ \delta_{EM}(\theta, \gamma) \]

\[ \delta_{NC}(\theta) \]

\( \gamma = 0.5 \)

\( \gamma = 0.1 \)

\( \gamma = 0.9 \)

\( \gamma = 0; \gamma \to 1 \)
Conclusions

Downstream cartel can be desirable for $U$ when competition is detrimental for transfer prices.
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  - Limited manufacturer bargaining power
  - Low degree of differentiation
Conclusions

- Downstream cartel can be desirable for $U$ when competition is detrimental for transfer prices.
- $U$ can guarantee a more stable downstream cartel by threat of embargo.
- Scope of embargo scheme is limited. Requires:
  - Limited manufacturer bargaining power
  - Low degree of differentiation
- Antitrust authorities should be careful when presuming the existence of such agreements.
Appendix
Generalized Nash bargaining

Monopoly ($M$):

$$g^M* = \arg \max_g V = [\pi_D^M(g) - 0]^\gamma [\pi_U^M(g) - 0]^{1-\gamma}$$

$$= \frac{1-\gamma}{2}$$

Non-cooperative duopoly ($NC$):

$$g_i^{NC*} = \arg \max_{g_i} V_i = \left[\pi_{Di}^{NC}(g_i, g_j) - 0\right]^\gamma \left[\pi_{Ui}^{NC}(g_i, g_j) - \pi_U^M(g_j)\right]^{1-\gamma}$$

$$= \frac{(1-\gamma)(2-\theta(1+\theta))}{4-\theta(1+\theta)(2-\gamma\theta(2-\theta))} \leq g^M*$$

Cartel ($C$):

$$g^C* = \arg \max_g V^C(g) = [2\pi_D^C(g) - 0]^\gamma [\pi_U^C(g) - 0]^{1-\gamma}$$

$$= \frac{1-\gamma}{2}$$