Strategic Information Management under Leakage in a Supply Chain

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The case of Newbury Comics
Newbury Comics: a trendsetting retailer

• Trendy store

• **Information is key**: A key competitive advantage for retailers like Newbury is *knowing* what will sell..

• **So is Exclusivity**.. and then selling aggressively and *exclusively*. 
The Supply Chain for the Music Industry

Music Labels

Distributors

Retailers

Some distributors also act as *Rackjobbers* managing the shelf inventory of retailers like Wal-Mart

**Demand Information**
- 'Hit and Miss' Nature

**Material Flow**

**Information Flow**

**Promotional Support**

**‘Large Retail Chains’**

**‘Trendy Outlets’**
Information Leakage through SoundScan

Some distributors also act as Rackjobbers managing the shelf inventory of retailers like Wal-Mart.

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Some distributors also act as Rackjobbers managing the shelf inventory of retailers like Wal-Mart.

Large Retail Chains

Trendy Outlets

Demand Information ‘Hit and Miss’ Nature
Information Leakage

“We lost control of our data..I am talking about a region and its specific taste (Information that mainstream competitors could never compile on their own)….and letting Best Buy and Wal-Mart and people like that just come in and scoop your customers.”

- Mike Dreese (CEO, Newbury Comics)

• Benefits of information sharing have been well touted.

• Information leakage, the dark side of information sharing
Information leakage is pervasive

• Automotive sector: greater than 28% of firms had their intellectual property leaked by at least one Detroit automaker.
  (Ward’s Survey)

• Information leakage through suppliers
  – 64% of supply chain managers identified this as the most significant threat to their supply chain operations.
    (survey by supplychainaccess.com)
  – “key deterrent to sharing information in supply chains”.
    Lee and Whang (2000)
Information leakage is hard to prevent..

..even by well-intentioned companies.

“..compromising supplier’s intellectual property will not be tolerated”. (GM)

“..it is very, very hard for us to make sure no one else is dipping into their technology.”

(Chief of Purchasing of GM).
..even the threat of leakage is a problem!
A common theme

One firm is privy to a second firm’s private information as a result of a special (vertical) relationship,

and then leaks this information to a horizontally competing firm which has an information disadvantage.
Building the Model

- Special (vertical) relationship
- Privy to private information
- Leakage to a horizontal firm, at an informational disadvantage
Components of information flow

Demand Information

Information Acquisition?

Information Dissemination?

Information Revelation?

Information Leakage?

Supplier

Incumbent

Entrant

Material Flow

Information Flow

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Demand Model

\[ P(Q) = \widetilde{A} - Q, \text{ where } Q = q_i + q_e \]

\[ \widetilde{A} = A_H \text{ with probability } p \]
\[ \widetilde{A} = A_L \text{ with probability } (1 - p) \]
\[ A_H > A_L \]
The Event Horizon

Order can convey information

Incumbent decides on Information Acquisition

Incumbent places order with supplier

Supplier decides whether to leak

Entrant places order with supplier

Quantities released in the market; prices/profits determined

Time

Information and Material Flows are intertwined

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Information Dissemination Game (IDG)

Signaling Game (order qty)

Incumbent has demand information

Incumbent places order with supplier

Supplier decides whether to leak

Entrant places order with supplier

Quantities released in the market; prices/profit determined

Time
The Separating Equilibrium

**Proposition 1** A separating PBNE exists for all \( \theta \), and is as follows:

(i) The incumbent orders:

\[
q_{iH}^* = \begin{cases} 
(A_H/2), & \text{if demand is high, and} \\
\frac{(A_L/2),}{2A_H - A_L - \sqrt{3A_H^2 - 4A_H A_L + A_L^2}} & \text{if demand is low and } \theta \geq 3; \\
\frac{2A_H - A_L - \sqrt{3A_H^2 - 4A_H A_L + A_L^2}}{2} & \text{if demand is low and } \theta < 3.
\end{cases}
\]

(ii) The supplier always leaks.

(iii) The entrant orders

\[
q_{eH}^* = \begin{cases} 
\frac{A_H}{4}, & \text{if } \Pr_e (\tilde{A} = A_H | q_i) = 1, \text{ and}
\end{cases}
\]

\[
q_{eL}^* = \begin{cases} 
\frac{A_L/4}{3A_L - 2A_H + \sqrt{(A_H - A_L)(3A_H - A_L)}} & \text{if } \theta \geq 3 \text{ and } \Pr_e (\tilde{A} = A_H | q_i) = 0; \\
\frac{3A_L - 2A_H + \sqrt{(A_H - A_L)(3A_H - A_L)}}{4} & \text{if } \theta < 3 \text{ and } \Pr_e (\tilde{A} = A_H | q_i) = 0,
\end{cases}
\]

consistent with his beliefs that:

\[
\Pr_e (\tilde{A} = A_H | q_i) = \begin{cases} 
0 & \text{if the supplier leaks and } q_i \leq q_{iL}^*, \text{ OR the supplier does not leak;}
1, & \text{otherwise.}
\end{cases}
\]
Proposition 2 I. When \( \theta \leq \bar{\Theta}(p) = \frac{2 + 2p - p^2}{1 + 4p - p^2} \), a Pareto-dominant pooling equilibrium exists and is as follows:

(i) The incumbent orders \( q_i^* = A_L - \frac{\mu}{2} \).

(ii) The supplier always leaks.

(iii) The entrant orders \( q_p^* = \frac{3\mu - 2A_L}{4} \), consistent with his beliefs that:

\[
Pr(e = A_H | q_i) = \begin{cases} 
0, & \text{if the supplier leaks and } q_i < q_p, \text{ OR the supplier does not leak;} \\
p, & \text{if the supplier leaks and } q_p \leq q_i \leq q_p^*; \\
1, & \text{otherwise.}
\end{cases}
\] (2)

where \( q_p = \left( A_H - \frac{\mu}{2} - \frac{1}{2} \sqrt{(A_H - \mu)(3A_H - \mu)} \right). \)
Results (1):
Information Dissemination

• Supplier always leaks.

• Information is revealed and disseminated (separating equilibrium is played) whenever:
  – Demand variability is high enough
  – The result is in contrast to much of the existing literature (Raith 1996, Li 2002, etc.), that argues that demand information is not shared under similar conditions.

• Information is concealed (pooling equilibrium is played) only when demand variability is low.
Information Acquisition Game

- **Incumbent** decides on Information Acquisition
- Incumbent places order with supplier
- Supplier decides whether to leak
- Entrant places order with supplier
- Quantities released in the market; prices/profit determined

**Information Dissemination Game (IDG)**

**Information Acquisition Game (IAG)**

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Results (2): Information Acquisition

- There is no information asymmetry in equilibrium (contrast with Raith (1996), Li (1985, 2002), etc.)

- Either all parties share the true demand information (under high demand variance),

  OR

No information is acquired and shared in the supply chain (under low demand variance), even when such information acquisition is costless.

- Tension between the
  - internal informational imperative (maximizing one’s own information endowment) and,
  - external informational imperative (desire to control the information endowment of the environment).
Summary

• The endogeneity of information endowment of a supply chain is the fundamental thesis of the paper.

• Our research underscores the importance of ‘Strategic Information Management’
  – Explicitly model information flow and incentives: Information may be acquired, shared, inferred or even leaked.
  – We demonstrate that it is equally important for a firm to manage both information and material flows.
  – Our abstraction of ‘information’ in our model captures all kinds of information, from hard data to more ‘nebulous’ knowledge of local tastes and conditions.
Results (3): Endogenous wholesale price and Exclusive sourcing strategies

- The obvious impact of wholesale price on material flows through the well known double marginalization effect
- Wholesale price also impact the material flows through information flows.
- We develop a simple example to compare these two effects.
  - the impact of $w$ on material flows through information flows is twice that through double marginalization

- The incumbent can employ exclusive suppliers to prevent leakage.
  - Key factor: level of demand uncertainty