IM 7011: Information Economics (Fall 2014)

Channel Selection under Competition

Ling-Chieh Kung

Department of Information Management
National Taiwan University

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Road map

- **Introduction**.
- Model.
- Analysis: pricing.
- Analysis: channel selection.
- Intuitions and implications.

Introduction

- In this lecture, we will see how game-theoretic modeling may be applied to a marketing problem.
  - This is a **channel selection** problem: How to reach your consumers?
  - McGuire and Staelin (1983).[1]
- As always, we focus on **incentive** and **efficiency** issues in decentralized systems.
- We want to demonstrate that economic modeling may deliver **nontrivial insights**.

[1] McGuire, T. W., R. Staelin. 1983. An industry equilibrium analysis of downstream vertical integration. *Marketing Science* **2**(1) 115–130.

Channel structure

- The selection of a **distribution channel** is one of the most fundamental marketing problems.
  - A brand owner (e.g., manufacturer) decides how to deliver products to **end consumers**.
- What are the options for a manufacturer to reach end consumers?
  - It may sell through independent retailers.
  - It may sell through franchises.
  - It may operate its own retail store.
  - It may operate its own outlet.
  - It may operate a online store.
- In general, a channel is either **direct** or **indirect**.
  - For the above five channels, which are direct and which are indirect?
  - A direct channel is **integrated**; an indirect channel is **decentralized**.
- One may even **mix** different distribution channels.

Direct and indirect channels

- What are the benefits of adopting a direct channel?
  - To understand end consumers.
  - In principle, controlling everything (complete **integration**) is optimal.
- Why indirect channels are so common?
- Sometimes you have no choice...
- Let the **professionals** do it!
  - A retailer may have a better reputation.
  - A retailer may do better marketing.
  - A retailer may attract more consumers by offering more choices.
  - A retailer may better forecast demands.
  - A retailer may provide better services.
- There must be some trade-offs between direct and indirect channels.

Interesting channel structure problems

- Suppose I write a paper to consider a very complicated channel and eventually show that a direct channel is better than an indirect one.
  - Is it interesting?
  - It is **trivial**: Complete integration is optimal.
- What if I show that a franchise store (i.e., an indirect channel) outperforms a self-owned store (i.e., a direct channel)?
  - Whether your result is interesting depends on the underlying reason.
  - If it is because the franchise store is capable to do be better selling business, it is again trivial.
  - Integrating a weak person may be worse than working with a strong one.
- What is interesting?
- If (1) the manufacturer is as strong as the retailer and (2) integration is not optimal, the result is interesting (or at least nontrivial).

When is vertical integration suboptimal?

- McGuire and Staelin (1983) show that it is possible!
- They study the key question in distribution channel selection: The number of levels of **intermediary** to distribute products.
  - Selling through a **company store**: zero level; integration.
  - Selling through a **franchise store**: one level; decentralization.
- The intermediary is assumed to be **equally good** as the manufacturer in the sales business.
- Then a reason for inserting one level of intermediary is provided.

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Research scope

- The environment studied is one with **exclusive** retail stores.
  - A retail store sells products only from **one** manufacturer.
  - We are comparing **company stores** and **franchise stores**.
- When do we see this?
  - Gasoline.
  - New automobiles.
  - Fast food restaurants.
  - And more.
- The paper searches for conditions under which the **industry equilibrium** has zero level of intermediary.
  - The level of intermediary is **not fixed**; it is chosen by firms (in a decentralized manner) to maximize their profits.

Industry structure

- There are two manufacturers in the industry.
- They sell different but **substitutable** products.
  - It is assumed that they are price setters and the demand of each product depends on both prices.
  - If both of them choose no intermediary, they play the **Bertrand game**.
- Each of them may independently decides whether to **delegate to a retailer** (insert one level of intermediary).
  - In this case, the manufacturer sets a wholesale price and the retailer sets a retail price.
  - The two players in the channel play the **channel pricing** game.[2]
- Each of them decides whether to **downwards vertically integrate**.

[2] In previous lectures, we call this the supply chain pricing game.

Industry structure

- There are three possible industry structures:
  - Pure integration (II: Integration–Integration).
  - Pure decentralization (DD: Decentralization–Decentralization).
  - Mixture (ID: Integration–Decentralization or DI).

- This is a dynamic game with embedded static games!

Model

- Two manufacturers.
- Each manufacturer has a downstream retail store (retailer).
- The retail store is either a company store (under integration) or a franchise store (under decentralization).
- The demands facing retail stores 1 and 2, respectively, are[3]

$$q_1 = 1 - p_1 + \theta p_2 \text{ and}$$
$$q_2 = 1 - p_2 + \theta p_1.$$

  - The industry demand is normalized to 2 when both prices are zero.
  - $\theta \in [0, 1)$ measures the **substitutability** between the two products.[4]

[3] The paper shows how a more general model reduces to this simple form.

[4] The general formulation disallow θ to be 1. You will see that allowing or disallowing $\theta = 1$ does not affect our results.

Model

- Under II, manufacturer i sets retail price p_i to solve

$$\pi_i^{\mathrm{I}} \equiv \max_{p_i} \ p_i q_i, \quad i = 1, 2,$$

  where π_i^{I} is the profit of channel i under II.
- Under DD:
  - First manufacturer i sets wholesale price w_i to solve

$$\pi_i^{\mathrm{M}} \equiv \max_{w_i} \ w_i q_i, \quad i = 1, 2.$$

  - Then retailer i sets retail price p_i to solve

$$\pi_i^{\mathrm{R}} \equiv \max_{p_i} \ (p_i - w_i) q_i, \quad i = 1, 2.$$

  - π_i^{M} and π_i^{R} are the profits of the manufacturer and retailer under DD.

Model

- Under ID:
  - First manufacturer 2 sets wholesale price w_2 to solve

$$\hat{\pi}_2^{\mathrm{M}} \equiv \max_{w_2} \ w_2 q_2.$$

  - Then manufacturer 1 and retailer 2 set retail prices p_1 and p_2 to solve

$$\hat{\pi}_1^{\mathrm{I}} \equiv \max_{p_1} \ p_1 q_1 \text{ and}$$
$$\hat{\pi}_2^{\mathrm{R}} \equiv \max_{p_2} \ (p_2 - w_2) q_2.$$

- DI is the opposite of ID.
- To complete our analysis, we apply **backward induction**:
  - Given any industry structure, find the equilibrium prices and profits.
  - Find the equilibrium industry structures.

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Illustrative analysis: the DD structure

- Suppose the two manufacturers have chosen to have franchise stores.
- This is the DD structure.
- Let $\pi_i^{\mathrm{R}}(p_i) = (p_i - w_i)q_i = (p_i - w_i)(1 - p_i + \theta p_{3-i})$, where w_is are announced by the manufacturers.
- The two retailers solve

$$\pi_i^{\mathrm{R}} \equiv \max_{p_i} \ \pi_i^{\mathrm{R}}(p_i), \quad i = 1, 2.$$

- If (p_1^*, p_2^*) is a Nash equilibrium, retailer i's price p_i^* satisfies

$$\frac{\partial}{\partial p_i}\pi_i^{\mathrm{R}}(p_i)\bigg|_{p_i = p_i^*} = 1 - 2p_i^* + \theta p_{3-i}^* + w_i = 0, \quad i = 1, 2.$$

- A unique Nash equilibrium is

$$p_i^* = \frac{1}{2-\theta} + \frac{2w_i + \theta w_{3-i}}{(2+\theta)(2-\theta)}, \quad i = 1, 2.$$

Intuitions behind the equilibrium retail prices

- Consider the equilibrium retail prices

$$p_i^* = \frac{1}{2-\theta} + \frac{2w_i + \theta w_{3-i}}{(2+\theta)(2-\theta)}, \quad i = 1, 2.$$

- Do they make sense?
  - p_i^* goes up when w_i goes up.
  - p_i^* goes up when w_{3-i} goes up.
  - w_i has a larger effect on p_i^* than w_{3-i} does.
  - When $\theta = 0$, does p_i^* degenerate to that in the channel pricing game?
- Given these prices, the equilibrium demands are

$$q_i^* = 1 - p_i^* + \theta p_{3-i}^* = \frac{1}{2-\theta} - \frac{(2-\theta^2)w_i - \theta w_{3-i}}{(2+\theta)(2-\theta)}, \quad i = 1, 2.$$

  Do they make sense?
- Let's continue to the manufacturers' problems.

The manufacturers' problems

- Let $\pi_i^{\mathrm{M}}(w_i) = w_i q_i^* = w_i \left[\frac{1}{2-\theta} - \frac{(2-\theta^2)w_i - \theta w_{3-i}}{(2+\theta)(2-\theta)} \right]$, the manufacturers solve

$$\pi_i^{\mathrm{M}} \equiv \max_{w_i} \ \pi_i^{\mathrm{M}}(w_i), \quad i = 1, 2.$$

- If (w_1^*, w_2^*) is a Nash equilibrium, manufacturer i's price w_i^* satisfies

$$\frac{\partial}{\partial w_i} \pi_i^M(w_i) \Big|_{w_i = w_i^*} = \frac{1}{2-\theta} - \frac{2(2-\theta^2)w_i^* - \theta w_{3-i}^*}{(2+\theta)(2-\theta)} = 0, \quad i = 1, 2.$$

- The equilibrium wholesale prices are

$$w_1^* = w_2^* = \frac{2+\theta}{4-\theta-2\theta^2}.$$

The complete equilibrium

- The equilibrium wholesale prices are $w_1^* = w_2^* = \frac{2+\theta}{4-\theta-2\theta^2}$.
- The equilibrium retail prices are

$$p_1^* = p_2^* = \frac{2(3-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)}.$$

- The equilibrium demands are

$$q_1^* = q_2^* = \frac{2-\theta^2}{(2-\theta)(4-\theta-2\theta^2)}.$$

- The manufacturers' equilibrium profits are

$$\pi_1^{\mathrm{M}} = \pi_2^{\mathrm{M}} = \frac{(2+\theta)(2-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)^2}.$$

- The retailers' equilibrium profits and the equilibrium channel profits can also be found.

Other industry structures

- For other industry structures, i.e., ID, DI, and II, we may find all the equilibrium outcomes.
- In particular, the manufacturers' equilibrium profits (the channel profit under integration) can be found.
- The four pairs of the manufacturers' equilibrium profits will be the basis for solving the stage-1 **channel structure game**.

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The channel structure game

- The "real" problems of the two manufacturers are the selection of channel structures.
- In the channel structure game:
  - There are two players.
  - They make decisions simultaneously.
  - Each of them has two options: integration of decentralization.
  - The payoff matrix can be constructed by solving the four pricing games.

The channel structure game

- The payoff matrix:

M1 \ M2	I	D
I	$\frac{1}{(2-\theta)^2}$, $\frac{1}{(2-\theta)^2}$	$\frac{2+\theta}{4(2-\theta)(2-\theta^2)}$, $\left[\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}\right]^2$
D	$\left[\frac{4+\theta-2\theta^2}{2(2-\theta)(2-\theta^2)}\right]^2$, $\frac{2+\theta}{4(2-\theta)(2-\theta^2)}$	$\frac{(2+\theta)(2-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)^2}$, $\frac{(2+\theta)(2-\theta^2)}{(2-\theta)(4-\theta-2\theta^2)^2}$

- Is there any pure-strategy Nash equilibrium?
  - Why not mixed-strategy Nash equilibria?

Equilibrium channel structures: polar cases

- Find all the pure-strategy Nash equilibria for the two polar cases:

$(\theta = 0)$

M1 \ M2	I	D
I	$\frac{1}{4}, \frac{1}{4}$	$\frac{1}{4}, \frac{1}{8}$
D	$\frac{1}{8}, \frac{1}{4}$	$\frac{1}{8}, \frac{1}{8}$

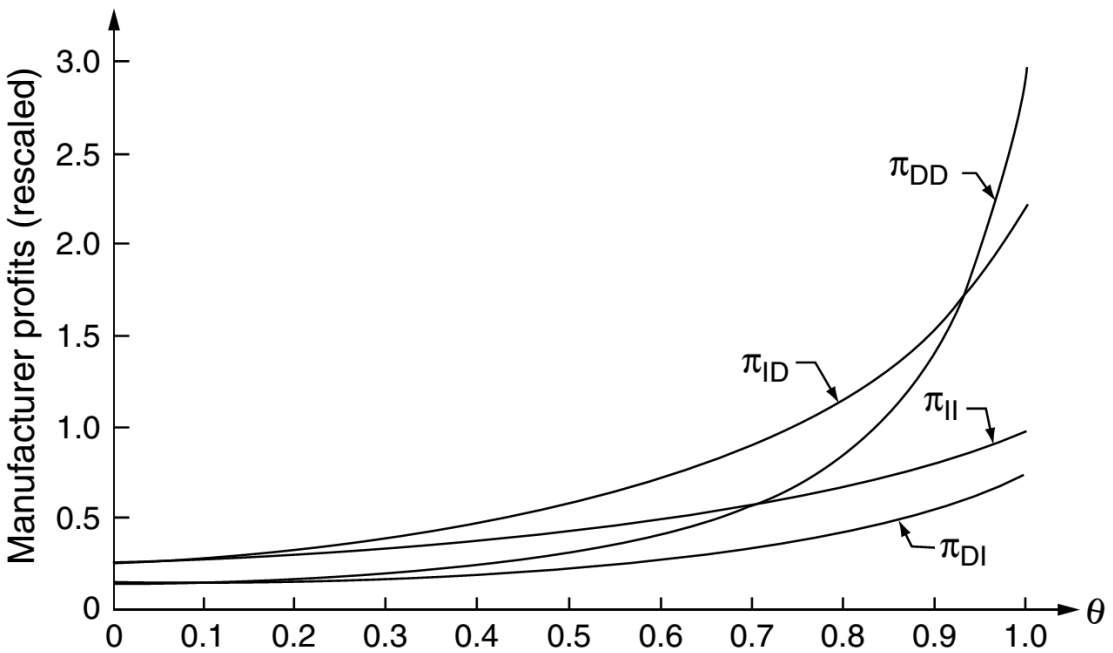
$(\theta = 1)$

M1 \ M2	I	D
I	$1, 1$	$\frac{9}{4}, \frac{3}{4}$
D	$\frac{3}{4}, \frac{9}{4}$	$3, 3$

- DD is an **equilibrium** when $\theta = 1$!
- As all functions are continuous in $\theta \in [0, 1]$, DD must be an equilibrium for **large enough** θ.
- Let's do the complete analysis.

Equilibrium channel structures: general cases

Figure 2 **Manufacturer's Profits as a Function of θ for Pure and Mixed Distribution Systems When Franchises Are Given Away**



(McGuire and Staelin, 1983)

- $\pi_{II} > \pi_{DI}$: Mixture is never an equilibrium. II is always an equilibrium.
- If $\theta < 0.931$, $\pi_{ID} > \pi_{DD}$: DD is not an equilibrium. II is the only equilibrium.
- If $\theta > 0.931$, $\pi_{DD} > \pi_{ID}$: II is still an equilibrium. DD is **another equilibrium**.
- $\pi_{DD} > \pi_{II}$ if $\theta > 0.708$: **prisoners' dilemma** for $\theta \in (0.708, 0.931)$.

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Incentives for decentralization

- Even though the retailer is not stronger than the manufacturer, a manufacturer may want do decentralization.
  - Note that the retailer extracts some profits!
  - What is the incentive for the manufacturer to do so?
- This happens when θ is high, i.e., the products are quite similar or the **competition is quite intense**.
- According to the paper:

  Manufacturers in a duopoly are better off if they can **shield** *themselves from this environment by inserting privately-owned profit maximizers between themselves and the ultimate retail market.*

- "The competition is so intense that I'd better find someone to **fight for me**. I'd better not to compete head-to-head directly."
- Is there an explanation from the perspective of efficiency?

Decentralization can be more efficient

- If the manufacturers are better off by doing pure decentralization, pure decentralization must generating a higher system profit.
- Why does DD outperform II?
- Suppose currently it is II.
  - The two manufacturers play the Bertrand game and consequently the equilibrium **prices are too low**.
- If they change to DD, each channel now has one additional layer of intermediary and the **price goes up**.
- Decentralization makes the prices **closer to the efficient level**.
- The pie becomes larger!

Decentralization provides credibility

- Under pure integration, the prices are too low and the two manufacturers are trapped in a prisoners' dilemma.
  - They know this. They know that together raising prices is win-win.
  - However, the promise to raise a price is **non-credible**.
  - They must somehow show that "I am (we are) forced to raise the price."
  - Having one additional layer provides **credibility**.
- Doing decentralization provides **incentives** for the competitor to raise its price (because it knows that I will raise my price).

Integration vs. decentralization

- Why integration fails? You told me integration is always optimal!
- The fact is **complete integration** is always optimal.
  - If the four firms are all integrated, the system is efficient.
  - But when complete integration is impossible (because no manufacturer can integrate the other), **partial integration** may be worse than **no integration** (i.e., decentralization).
- This is the so-called "Principle of the second best".
  - When you can control everything, do it.
  - When you cannot control everything, it may be better to control nothing.

Extensions

- When the manufacturers act to maximize channel profits, DD is an equilibrium if $\theta > 0.771$.
  - A manufacturer may do so because it can extract all the channel profit through some coordinating contracts.
  - The region for DD to be an equilibrium is enlarged. Why?
- When the two manufacturers collude, they will downwards integrate.
- The qualitative result remains valid under other game structures.

Conclusions

- A scenario for a manufacturer to delegate to a retailer is provided.
  - A manufacturer may do so when the competition is intense.
  - Vertical integration may be suboptimal under horizontal competition.
  - The model is simple: It is a combination of price competition (Bertrand game) and pricing in a supply chain (Stackelberg game).
  - While in either game integration makes the firms better, mixing the two games generates new insights.
- The mathematical results generates managerial implications:
  - To hide from intense competition.
  - To drives the originally too-low prices up.
  - To incentivize the competitor to increase its price.
- The principal of the second best.