

IM 7011: Information Economics (Fall 2014)

Signaling Quality through Specialization

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Road map

- ▶ **Introduction.**
- ▶ Model.
- ▶ Signaling by prices.
- ▶ Signaling by prices and specialization.

Specialization

- ▶ We see **specialization** for some firms.
 - ▶ “Paint and wallpaper specialists” vs. “carpentry, paint, and landscaping services providers”.
 - ▶ “We do it all” vs. “brake people”.
- ▶ By specializing rather than providing a **product mix**, some potential profits go away.
 - ▶ When there is a synergy among multiple products/services.
 - ▶ Economies of scale.
 - ▶ Complementarity among products/services.
- ▶ Why?
 - ▶ Sometimes they have no choice: technology or capacity constraints.
 - ▶ Sometimes specialization enhances quality or reduces costs.
 - ▶ Any other reason?

Specialization as a signaling device

- ▶ Kalra and Li (2008) shows that a firm may **signal its hidden quality** through **specialization**.¹
- ▶ This is especially true for **effort-intensive** areas.
 - ▶ Specialization enhances quality or reduces costs.
 - ▶ Quality varies a lot for different services.
 - ▶ Consumers are quite uncertain about the quality.
- ▶ It may be beneficial to specialize.
 - ▶ In the **secondary category**, I lose some profit.
 - ▶ However, I also save some costs.
 - ▶ Moreover, I earn more in the **primary category** because consumers know that my quality is high.

¹Karla, A. and S. Li, 2008, “Signaling quality through specialization,” *Marketing Science* **27**(2), 168–184.

Key intuitions

- ▶ Is a separation really possible?
- ▶ Suppose there are two firms, one's quality is high and one's is low.
- ▶ Consumers cannot tell whose quality is high. They pay an average price for both services.
 - ▶ The high-quality firm tries to signal to win higher payments.
 - ▶ Why the low-quality firm chooses not to **mimic** the high-type one?
- ▶ Offering a low-quality service incurs a **low service cost**.
 - ▶ The **cost reduction** from specialization is low.
 - ▶ The **opportunity cost** of giving up a category is high.
- ▶ The **cost of specialization** is higher for the low-quality firm. It is **too costly** for a low-quality firm to specialize.

Pricing and specialization

- ▶ No matter a firm specializes or not, it has the **pricing decision**.
- ▶ A firm may **signal through prices** only.
 - ▶ The high-quality firm charges higher prices.
- ▶ A firm may at the same time **signal through specialization**.
 - ▶ Specialization serves as a **complement** to the price signal.
 - ▶ It helps the high-quality firm to further differentiate itself.
- ▶ Other signaling devices (not discussed here):
 - ▶ Advertising, umbrella branding, retailer reputation, money back guarantees, slotting allowance, warranties, salesforce compensation, etc.

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Firms

- ▶ There is a firm facing two **categories**, categories 1 and 2.
 - ▶ The firm is able to enter both categories at the same time.
 - ▶ It may also **specialize** in only category 1.
 - ▶ The demands for the two categories are **independent**.
- ▶ The firm's quality may be either **high or low** (label: h or l).
 - ▶ **High in both** categories or **low in both** categories.

Costs and prices

- ▶ Serving multiple markets (label: m) or specializing in one market (label: s) require different **unit service costs**.
- ▶ If multiple services are offered:
 - ▶ C_{im}^j = unit cost of service $i \in \{1, 2\}$ if the quality is $j \in \{l, h\}$.
 - ▶ $C_{im}^h > C_{im}^l$ for $i = 1, 2$.
- ▶ If a single service is offered:
 - ▶ C_{1s}^j is the unit cost for category 1 if the quality is j .
- ▶ $C_{1m}^j = \alpha C_{1s}^j$ where $\alpha > 1$: There is a **cost reduction** for specialization.
- ▶ **Unit prices** for the two categories are chosen by the firm.
 - ▶ P_{im}^j = price of service $i \in \{1, 2\}$ offered by the firm of type $j \in \{l, h\}$.
 - ▶ P_{1s}^j = price of service 1 offered by the specializing firm of type $j \in \{l, h\}$.

Demands

- ▶ The consumer's willingness-to-pay of service i is θ_i , $i \in \{1, 2\}$.
 - ▶ $\theta_1 \sim \text{Uni}(0, 1)$ and $\theta_2 \sim \text{Uni}(0, \delta)$.
 - ▶ δ may be greater than, equal to, or less than 1.
- ▶ The consumer's utility is $U_i^j = \theta_i q_i^j - P_i^j$ for buying service i from a type- j firm.
 - ▶ This can be evaluated if the quality is **public** or the two types of firm play a **separating equilibrium**.
 - ▶ If the consumer cannot tell the quality, he buys the product if the expected utility $\theta_i[\lambda q_i^h + (1 - \lambda)q_i^l] - P_i \geq 0$. λ is the **prior belief**.
- ▶ Given a price P for a service, the **demand** is $D = 1 - \frac{P}{Q}$,² where Q is the quality (under a separation) or expected quality (under pooling).
- ▶ The **profit** in that category is $\Pi = D(P - C)$.³
- ▶ The firm can always make money in either category.

²Or $\delta - \frac{P}{Q}$ for category 2.

³Proper indices are needed for $\Pi_{i,t}^j$, $j \in \{l, h\}$, $i \in \{1, 2\}$, $t \in \{s, m\}$.

Timing

- ▶ The sequence of events is as follows:
 - ▶ Nature selects the firm's quality according to the prior λ .
 - ▶ The firm decides whether to enter both categories or just category 1.
 - ▶ The firm determines the price(s).
 - ▶ The consumer observes the number of categories entered and the price(s).
 - ▶ He forms the posterior belief Λ on the quality.
 - ▶ He decides whether to buy.
- ▶ We look for **pure-strategy** equilibria.
 - ▶ We will only discuss **separating equilibria**.⁴

⁴Keep in mind that pooling equilibria are still possible in most cases.

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Benchmark: complete-information case

- ▶ Suppose the quality is **observable**.
- ▶ Because the firm is able to earn money in either category, under a mild condition (what?), the firm will serve both categories.
- ▶ In categories 1 and 2, the firm of quality j solves

$$\max_P \left(1 - \frac{P}{q_1^j}\right) (P - \alpha C_{1s}^j) \quad \text{and} \quad \max_P \left(\delta - \frac{P}{q_2^j}\right) (P - \alpha C_{2s}^j)$$

The **first-best prices** are

$$P_{1m}^{j*} = \frac{q_1^j + \alpha C_{1s}^j}{2} \quad \text{and} \quad P_{2m}^{j*} = \frac{\delta q_2^j + \alpha C_{2s}^j}{2}.$$

- ▶ The first-best profit is $\Pi_m^{j*} = \frac{(q_1^j + \alpha C_{1s}^j)^2}{4q_1^j} + \frac{(\delta q_2^j + \alpha C_{2s}^j)^2}{4q_2^j}$.

Signaling through prices only

- ▶ When qualities are unobservable, the first-best prices are suboptimal.
 - ▶ Fewer consumer will be willing to pay those amounts.
 - ▶ If the firm does not try to signal its quality, it should decrease the prices.
- ▶ Suppose the firm still wants to serve both categories.
- ▶ Can **prices along** signal the qualities?

Profit functions

- ▶ In a **separating** equilibrium, let

$$\Pi_{ma}^t(P_1^t, P_2^t) = \left(1 - \frac{P_1^t}{q_1^t}\right)(P_1^t - \alpha C_{1s}^t) + \left(\delta - \frac{P_2^t}{q_2^t}\right)(P_2^t - \alpha C_{2s}^t)$$

be the type- t firm's profit under prices P_1^t and P_2^t , $t \in \{l, h\}$.

- ▶ Denote $(P_{1ma}^{l*}, P_{2ma}^{l*})$ and $(P_{1ma}^{h*}, P_{2ma}^{h*})$ as the optimal prices for the low- and high-quality firms **under separation**, respectively.
 - ▶ Naturally, they cannot be identical.
- ▶ In a **pooling** equilibrium, let

$$\bar{\Pi}_{ma}^t(P_1, P_2) = \left(1 - \frac{P_1}{\bar{q}_1}\right)(P_1 - \alpha C_{1s}^t) + \left(\delta - \frac{P_2}{\bar{q}_2}\right)(P_2 - \alpha C_{2s}^t)$$

be the type- t firm's profit under prices P_1 and P_2 , $t \in \{l, h\}$.

- ▶ $\bar{q}_i = \lambda q_i^h + (1 - \lambda)q_i^l$ is the expected quality of service i , $i \in \{1, 2\}$.

Pricing problems

- ▶ Let $\Pi_{ma}^{l*} = \Pi_{ma}^l(P_{1ma}^{l*}, P_{2ma}^{l*})$ and $\Pi_{ma}^{h*} = \Pi_{ma}^h(P_{1ma}^{h*}, P_{2ma}^{h*})$.
- ▶ In a separating equilibrium, we have for the high-quality firm

$$\begin{aligned}
 (P_{1ma}^{h*}, P_{2ma}^{h*}) &= \operatorname{argmax}_{P_1, P_2} \Pi_{ma}^h(P_1, P_2) \\
 \text{s.t.} \quad &\bar{\Pi}_{ma}^l(P_1, P_2) \leq \Pi_{ma}^l(P_{1ma}^{l*}, P_{2ma}^{l*}) \\
 &\bar{\Pi}_{ma}^h(P_{1ma}^{l*}, P_{2ma}^{l*}) \leq \Pi_{ma}^{h*}.
 \end{aligned}$$

and for the low-quality firm

$$\begin{aligned}
 (P_{1ma}^{l*}, P_{2ma}^{l*}) &= \operatorname{argmax}_{P_1, P_2} \Pi_{ma}^l(P_1, P_2) \\
 \text{s.t.} \quad &\bar{\Pi}_{ma}^h(P_1, P_2) \leq \Pi_{ma}^h(P_{1ma}^{h*}, P_{2ma}^{h*}) \\
 &\bar{\Pi}_{ma}^l(P_{1ma}^{h*}, P_{2ma}^{h*}) \leq \Pi_{ma}^{l*}.
 \end{aligned}$$

Separating equilibrium

- ▶ The following lemma characterize the separating equilibrium.

Lemma 1

Suppose the firm must enter both categories. In the separating equilibrium, the high-quality firm distorts prices upwards in both categories. The low-quality firm, on the other hand, chooses its first-best prices.

- ▶ Prices alone can signal quality.
 - ▶ This conclusion is made due to the existence of a separating equilibrium.
- ▶ **Price distortions** are required.
 - ▶ Why is there a distortion?
 - ▶ Why is it an upward distortion?

Intuitions for signaling through prices

- ▶ If the high-quality firm charges the first-best prices, the low-quality firm will mimic it by charging the same prices.
- ▶ Therefore, the high-quality firm **upwards distorts** its prices.
 - ▶ This decreases the demands both for the high-quality firm and the low-quality firm mimicking the high-quality one.
- ▶ However, the low-quality firm is **hurt more** due to its **lower costs**.
 - ▶ When the prices are high enough, the low-quality firm will give up.
 - ▶ It will **admit its low quality** and charge its first-best prices. This is optimal for it (even if the low quality is revealed).

Impacts of signaling through prices

- ▶ If we look at this game from outside:
 - ▶ There is **just one** firm!
 - ▶ Under complete information, the firm charges some prices.
 - ▶ Under incomplete information, the **prices may become higher**.
 - ▶ “My quality (and cost) is high, otherwise I will not charge such a high price.”
 - ▶ Information asymmetry causes **inefficiency**.
- ▶ It is still possible for the prices to eventually become lower (in pooling equilibria).

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Signaling also through specialization

- ▶ Is it possible to also signal through **specialization**?
 - ▶ “Also”: There is still the pricing decision.
- ▶ In a separating equilibrium, we will see:
 - ▶ The high-quality firm **specializes** in category 1.
 - ▶ The low-quality firm serves both categories.
- ▶ Let

$$\Pi_s^h(P) = \left(1 - \frac{P}{q_1^h}\right)(P - C_{1s}^h)$$

be the type- h firm's profit under price P in a **separating** equilibrium.

- ▶ Let

$$\bar{\Pi}_s^l(P) = \left(1 - \frac{P}{\bar{q}_1}\right)(P - C_{1s}^l)$$

be the type- l firm's profit under price P in a **pooling** equilibrium.

- ▶ Let Π_s^{h*} and Π_s^{l*} be the type- h and type- l firms' equilibrium profits under separation.

Signaling also through specialization

- ▶ In a separating equilibrium, we have for the high-quality firm

$$\begin{aligned}\Pi_s^{h*} &= \operatorname{argmax}_P \Pi_s^h(P) \\ \text{s.t.} \quad &\bar{\Pi}_s^l(P) \leq \Pi_m^{l*} \\ &\Pi_{ma}^{h*} \leq \Pi_s^{h*} .\end{aligned}$$

- ▶ The low-type firm finds it suboptimal to **mimic** the high-type one.
- ▶ The high-type firm finds it suboptimal to **serve two categories** and earn Π_{ma}^{h*} under signaling **with prices alone**.
- ▶ The problem of the low-quality firm is omitted.
- ▶ Note that due to the second constraint, the firm **earns more** by using specialization as another signaling device.
 - ▶ Be careful! The firm is better off in “this separating equilibrium” than in “that separating equilibrium”.
 - ▶ If we include **pooling** equilibria, specialization may be suboptimal.

Separating equilibrium

- ▶ The following proposition characterize the separating equilibrium.

Lemma 2

There exists a separating equilibrium in which the high-quality firm specializes and upwards distorts the price. The upward distortion is less than that when signaling only through prices. The low-quality firm enters both categories and chooses its first-best prices.

- ▶ Prices and specialization can **together** signal quality.
- ▶ **An upward price distortion** is still required.
 - ▶ Why the distortion becomes **smaller**?

Intuitions for a smaller distortion

- ▶ Previously, upward price distortions are used to discourage the low-quality firm from mimicking the high-quality one.
 - ▶ This is possible because the low-quality firm **hates high prices**.
- ▶ Now, the high-quality firm specializes.
 - ▶ The low-quality firm also **hates specialization**: It must give up the profit in category 2.
 - ▶ The upward price distortion needs not to be that much.
- ▶ When will we see specialization?
 - ▶ When the market of the second category is small (i.e., δ is small).
 - ▶ When price sensitivity is high (so large price distortions are harmful).
 - ▶ When consumers are not confident about the quality (i.e., λ is small).