ANNALS OF ECONOMICS AND FINANCE **9-2**, 315–343 (2008)

Retailers' Incentive to Sell through a New Selling Channel and Pricing Behavior in a Multi-channel Environment*

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We consider a duopoly market in which two retailers with different reputation compete in prices and one of the retailers is considering selling through a new channel. Consumers are reputation sensitive and averse to the new channel. In addition, the reputation sensitivity and new channel aversion are heterogeneous across consumers. In such a setting, we find that, there must be some cost reduction for the good reputation retailer to have an incentive to sell through a new channel unless consumers are sufficiently averse to the new channel. The good reputation retailer may keep or withdraw its old channel and may coexist with the bad reputation retailer or drive it out of the market, depending on the combination of cost reduction and the degree of consumers' aversion to the new channel. On the contrary, even if cost increases by a small amount, the bad reputation retailer also has an incentive to sell through the new channel. The bad reputation retailer always withdraws the old channel, and it may coexist with the good reputation retailer or drive it out of the market, depending on the cost difference between its two channels.

Key Words: Multi-channel market; Risk aversion; Sequential game; Market entry; Channel choice; Bertrand competition; Subgame perfect; Nash equilibrium.
JEL Classification Numbers: L13, C72, D80.

* This work was supported by a grant (No. R-122-000-074-112) from the National University of Singapore and a grant from the Research Grants Council of the Hong Kong Special Administrative Region, China (Project No. CUHK4310/02H).

1529-7373/2008

1. INTRODUCTION

Few things have dramatically and immediately impacted our lives and the way many businesses operate more than the development of the Internet. Consumers can easily get the information about goods' prices and digital attributes[1] from the Internet, and compare products and prices across retailers.

Internet provides a new channel for retailers to sell their goods. Though the new channel has some advantages, for example, consumers can make purchase any time and any where, some consumers are averse to the new channel, especially when it is not mature. It is very difficult for one to inspect goods' non-digital attributes.[2] There are also uncertainties and inconveniencies associated with the payment method and delivery, privacy and system security concerns. Some consumers may be concerned about the security of entering their credit card numbers online and the length of the time waiting for delivery. In addition, many e-Commerce websites collect customer information for future marketing purposes and some sites sell the information to other companies that are looking for ways to generate new business. Because of this kind of aversion to the new channel, a consumer's willingness to pay for an identical product when purchasing online is expected to be lower than the reservation price when purchasing at a conventional store.[3] This kind of aversion is expected to be heterogeneous across consumers since their familiarity to the new channel is different.

Brand matters in consumers' choice. Empirical studies have found that customers are willing to pay higher prices to shop in stores that they are familiar with (Monroe 1976, Brynjolfsson and Smith 2000, Brynjolfsson and Smith 2001, etc.). For example, Monroe (1976) examined the effects of price and brand familiarity on brand preferences using a complex experimental design and showed that when a buyer has had previous purchase-use experience with a product or brand, the experience is likely to be a dominant factor in choice behavior. Brynjolfsson and Smith (2000) concluded that while there is lower friction in many dimensions of Internet competition, branding awareness, and trust remain important sources of heterogeneity among Internet retailers. Brynjolfsson and Smith (2001) analyzed the electronic market for books and their empirical result showed

[1]Here, we use the definition of digital attributes and non-digital attributes in Lal and Sarvary (1999). Digital attributes are defined as all product attributes that can be communicated through the Internet. The majority of digital attributes are those that can be assessed through visual inspection and that traditionally have been evaluated by consumers in the store. Non-digital attributes are those that can only be evaluated through physical inspection of the products. (Lal and Sarvary 1999, p. 487-488)

[2]One may find some consumers' comments. However, they are hard to verify.

[3]It is possible that some consumers love the new channel and thus the willingness to pay is even higher. This is left for future research.

that brand is an important determinant of consumer choice. Consumers prefer the stores and brand with which they are familiar and this is also applicable to the channel with which they are familiar when the new channel is not mature.

Reputation matters in consumers' choice. A retailer's reputation is also an important factor when consumers choose a retailer from which to buy goods. Theoretical models have typically generated a positive relationship between the reputation of the seller and the resulting price of the transaction, in large part because the seller's reputation is a proxy for quality characteristics that are unobserved prior to the completion of the transaction (Klein and Leffler, 1981; Shapiro, 1983; Allen, 1984; Houser and Wooders, 2006). Many empirical studies have got results consistent with the theoretical expectation of buyers paying more to sellers who have better reputations (Houser and Wooders, 2006, Melnik and Alm, 2002, Lucking-Reiley et al., 2006, etc.).[4] There are also experimental findings which tend to support the theoretical results. For example, Resnick, Zeckhauser, Swanson, and Lockwood (2006) conducted the first randomized controlled field experiment of an Internet reputation mechanism and in the experiment, a high-reputation, established eBay dealer sold matched pairs of lots — batches of vintage postcards — under his regular identity and under new seller identities (also operated by him). The experiment showed that the established identity fared better and the difference in buyers' willingness-to-pay was 8.1% of the selling price.

In this paper, we consider a duopoly retail market in which one retailer has better reputation than the other and one of the retailers is considering selling through a new selling channel to which consumers are averse. The framework is as follows: Two retailers with different reputation are selling a physically homogenous product. Initially, both of them are operating at a conventional market. Consumers prefer the retailer with better reputation if the prices are the same and have higher willingness to pay to the retailer with better reputation in the conventional market, which is called "reputation sensitivity". The reputation sensitivity is heterogeneous across consumers. One of the retailers is considering whether to sell through a new selling channel to which consumers are averse. The aversion to the new channel is heterogeneous across consumers and proportional to reputation sensitivity. The number of consumers is constant.[5] If a retailer has an incentive to sell through the new channel, then it will determine whether to keep or withdraw its old channel and whether to coexist with the other retailer or drive it out of the market by pricing aggressively. Both of the two retailers set prices simultaneously and compete in prices.

[4]See Houser and Wooders (2006) for a review of more empirical studies.

[5]In many cases, a product will reach more consumers after a new selling channel is introduced. This is also left for future research.

Some theoretical models in the literature have analyzed price competition in the Internet markets and in multi-channel markets, coordination of selling channels for multi-channel retailers, and consumer's shopping channel choices. For example, Bakos (1997) examines the effects of lower search cost on equilibrium prices in electronic markets and shows that low search cost may drive Internet prices for homogeneous goods toward the Bertrand marginal cost pricing pattern. Unfortunately, Harrington (2001) finds that the two critical results in Bakos (1997) are either mathematically wrong (Harrington proved that there is no symmetric pure-strategy equilibrium in which consumers search), or based on an implicit assumption that is unreasonable (Harrington 2001 p. 1731). The Harrington critique has thus left the profession without positive results along this line. From another perspective, Balasubramanian (1998) models competition in a multi-channel market. In his model, an increase in transportation cost means a more differentiated market where consumers are less sensitive to price changes. He finds that an increase in transportation cost benefits both direct marketer and conventional retailers by allowing them to charge higher prices. But increasing transportation cost will reduce conventional share and add to direct share. Lal and Sarvary (1999) classify product attributes into "digital" attributes (which can be easily communicated online) and "non-digital" attributes (which need physical inspection), and show that the impact of the Internet on competition will be radically different depending on the relative importance of parameters describing the relevant shopping and distribution context. Zettelmeyer (2000) shows how firms' pricing and communications strategies may be affected by the size of the Internet, and demonstrates that firms can use information strategically on multiple channels to achieve finer consumer segmentation. Cattani, Gilland, and Swaminathan (2002) explore the issue of coordinating Internet and traditional channels for a monopoly and find the optimal prices under different degrees of autonomy for the Internet operations. They also find that it is not always a good strategy to price the Internet channel below the traditional channel. Iyer and Pazgal (2003) examine the impact of Internet shopping agents on market competition, proposing that the equilibrium insider pricing is such that the average price charged can increase or decrease when more retailers join, depending on whether or not the reach of Internet shopping agents is independent of the number of joining retailers.

None of these papers discusses retailers' incentive to sell through a new channel. They either assume each retailer is selling through only one channel and thus no multi-channel retailer in their models or assume one retailer is selling through two channels but ignore the retailer's incentive to be a multi-channel seller.

However, in the literature on the introduction of new products, Siebert (2003) analyzed the optimal provision of goods in a market characterized by vertical product differentiation. He considered a duopoly model in which incumbents may introduce a new product with certain quality and demonstrated that the innovator always withdraws the existing product from the market in order to reduce price competition and to avoid cannibalizing its new product demand. His model is actually similar to the one in this paper in the sense that both consider whether a firm (retailer) wants to keep or withdraw its old product (channel) after introducing a new product (selling channel). The differences are as follows: (1) Siebert (2003) assumed the innovator's marginal costs of producing the new product and the old one are the same while we allow them to be different since it seems to be the case; (2) Siebert (2003) did not consider whether the innovator wants to drive the other firm out of the market by pricing aggressively, which is just because the innovator cannot do so given Siebert (2003) assumed marginal costs are identical across firms and products; (3) Firm's incentive problem is ignored in Siebert (2003) while it is one of our focuses.

We demonstrate that retailers' incentive to sell through a new channel depends on the combination of consumers' aversion to the new channel and cost difference between the old channel and the new channel. We also analyze retailers' behavior after selling through a new channel. We find that, there must be some cost reduction for the good reputation retailer to have an incentive to sell through a new channel unless consumers are sufficiently averse to the new channel. After selling through a new channel, the good reputation retailer may keep or withdraw its old channel and may coexist with the bad reputation retailer or drive it out of the market, depending on the combination of cost reduction and the degree of consumers' aversion to the new channel. On the contrary, even if cost increases by a small amount, the bad reputation retailer also has an incentive to sell through the new channel. After selling through a new channel, the bad reputation retailer always withdraws the old channel, and it may coexist with the good reputation retailer or drive it out of the market, depending on the cost difference between its two channels.

The remainder of the paper is organized as follows. We make some assumptions of the model in Section 2, solve retailers' equilibrium prices before selling through a new channel in Section 3, and then investigate retailers' incentive to sell through a new channel and behavior after selling through the new channel in Sections 4 and 5. Section 6 is concluding remarks.

2. THE MODEL

We will deal with the issue of retailers' incentive to sell through a new channel and their pricing behavior in a multi-channel environment after one retailer sells through the new channel.

On the supply side, there are two retailers selling a physically homogenous product. One is with better reputation and the other retailer's reputation is relatively bad. Initially, the retailers are operating in a conventional market. The retailers compete in prices to maximize their profits. We will let Retailer 1 and Retailer 2 denote the retailer with better reputation and the other retailer with relatively bad reputation respectively. We consider retailers' incentive to sell through a new channel to which consumers are averse.

On the demand side, a consumer's utility function is given by

$$U(\mu,\sigma)=\begin{cases}\mu-p_1, & \text{if purchasing from Retailer 1's conventional store,}\\ \mu-\gamma\sigma_1-p_{1n}, & \text{if purchasing through Retailer 1's new channel,}\\ \mu-\gamma-p_2, & \text{if purchasing from Retailer 2's conventional store,}\\ \mu-\gamma\sigma_2-p_{2n}, & \text{if purchasing through Retailer 2's new channel,}\end{cases} \tag{1}$$

where, μ is the gross utility consumers get from consumption of a unit of the product purchased from Retailer 1's conventional store, $p_1(p_2)$ and $p_{1n}(p_{2n})$ are prices charged by Retailer 1's (Retailer 2's) conventional store and new channel,[6],[7] γ is the measure of consumers' reputation sensitivity which captures a consumer's more willingness to pay for a unit of product at Retailer 1's conventional store than at Retailer 2's store, and $\gamma\sigma_1(\gamma\sigma_2)$ denotes consumers' aversion to Retailer 1's (Retailer 2's) new channel. Consumers will maximize their utility when making purchase decision. With respect to μ, γ, σ_1 and σ_2, we have the following assumptions:

ASSUMPTION 1. *μ is large enough so that any consumer will buy one and only one unit of the good if prices are not too high.*

ASSUMPTION 2. *The reputation sensitivity is heterogeneous across consumers and γ is uniformly distributed in $[0, 1]$. The bigger γ, the more reputation sensitive is a consumer.*

ASSUMPTION 3. *$\sigma_2 > 1$, but both $\sigma_1 > 1$ and $0 < \sigma_1 < 1$ are possible.*

Assumption 2, together with Assumption 3, implies that all consumers are averse to the new selling channel. Some consumers might love the new channel, but we do not consider that case. So our model is more applicable to a new immature channel.

[6]Once again, note that only one retailer is considering selling through a new channel in our model.

[7]The subscript "n" denotes the new channel.

The retailers' marginal costs to sell a good through the old channels are c_1 and c_2 respectively, and their marginal costs to sell through the new channels are c_{1n} and c_{2n} respectively. To simplify the calculations, we make the following assumption:

ASSUMPTION 4. *The two retailers' marginal costs of selling one unit of product through the old channel are identical, that is,* $c_1 = c_2 = c_0$.

Finally, we make an assumption on the size of the market.

ASSUMPTION 5. *The total number of consumers is normalized to 1 and does not change after the new channel is introduced.*

This assumption is restrictive since a new channel often makes a product reach more customers. But it should be reasonable when the new channel is immature.

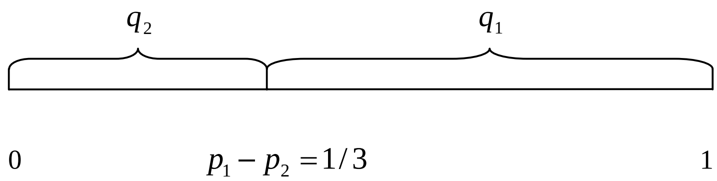
We consider a two-stage game. The game structure is as follows: Initially, Retailer 1 and Retailer 2 are operating in a conventional market. They compete in prices to maximize their profits. In stage 1, one retailer (Retailer 1 or Retailer 2) is considering selling its products through a new channel to which consumers are averse. If it does not sell its products through a new channel, then it becomes a multichannel retailer. It competes with the other retailer in prices in stage 2. It can sell through both the old channel and the new one; alternatively, it can withdraw the old channel and sell only through the new channel. It can also coexist with the rival retailer or drive the rival retailer out of the market by pricing aggressively. Thus, the innovator (the retailer with two possible selling channels) has four types of strategies. We shall solve for the subgame perfect Nash equilibrium of this game.

3. RETAILERS' PRICING BEHAVIOR BEFORE THE INTRODUCTION OF A NEW CHANNEL

First, we consider retailers' pricing behavior before the introduction of a new channel. Since all consumers prefer Retailer 1 when the prices charged by both retailers are identical, for Retailer 2 to earn profits, p_2 should be less than p_1, otherwise all consumers will buy from Retailer 1. Consumers who are more reputation sensitive will buy from Retailer 1 and consumers who are less reputation sensitive will buy from Retailer 2.

A consumer, with parameter $\hat{\gamma} \in (0, 1)$, is indifferent between buying from Retailer 1 and Retailer 2 if and only if $p_1 = \hat{\gamma} + p_2$. Solving the equation gives us $\hat{\gamma} = p_1 - p_2$. It follows that the demand configuration is as follows: $q_1(p_1, p_2) = 1 - (p_1 - p_2)$ and $q_2(p_1, p_2) = p_1 - p_2$, and retailers'

FIG. 1. Demand Configuration in Basic Case (case 0)



profit functions are given by

$$\pi_1(p_1, p_2) = (p_1 - c_0)[1 - (p_1 - p_2)], \tag{2}$$
$$\pi_2(p_1, p_2) = (p_2 - c_0)(p_1 - p_2). \tag{3}$$

Solving profit-maximizing problems gives us the equilibrium prices, quantities and profits: $p_1 = c_0 + 2/3$, $p_2 = c_0 + 1/3$, $q_1 = 2/3$, $q_2 = 1/3$, $\pi_1 = 4/9$ and $\pi_2 = 1/9$.[8] Figure 1 gives the demand configuration before a new channel is introduced.

To be convenient, we call this basic case "case 0". In the two sections that follow, we will investigate Retailer 1's and Retailer 2's incentive to sell through a new selling channel and retailers' pricing behavior in a multichannel market.

4. GOOD REPUTATION RETAILER'S INCENTIVE TO SELL THROUGH A NEW CHANNEL

Retailer 1's marginal costs of selling a unit of product through a new channel are assumed to be constant and denoted by c_{1n}. If Retailer 1 sells through the new channel, then according to our assumption, there are two possibilities: $\sigma_1 > 1$ and $0 < \sigma_1 < 1$. After selling through the new channel, Retailer 1 can sell through both the old channel and the new one; alternatively, it can withdraw the old channel and sell only through the new channel. It can also coexist with Retailer 2 or drive Retailer 2 out of the market by pricing aggressively. Thus, there are four possible market configurations to consider. We summarize these four configurations (cases) in Table 1.

We will obtain Retailer 1's profits in these four cases and then compare them with 4/9, its profit in case 0. If its profit in at least one case is higher than 4/9, then Retailer 1 will have an incentive to sell through the new channel. If its profits in more than one case are higher than 4/9, then

[8]This is a standard result in the literature of vertical differentiation. See Section 7.5.1 of Tirole (1988). We include it for the sake of completeness.

TABLE 1.

Four cases after Retailer 1 selling through a new channel

Case	Coexist with Retailer 2 or drive it out of the market	Keep or withdraw the old channel	Market configuration
1	Coexist	Keep	Retailer 1: two channels, Retailer 2: old channel
2	Drive out	Keep	Retailer 1: two channels
3	Coexist	Withdraw	Retailer 1: new channel, Retailer 2: old channel
4	Drive out	Withdraw	Retailer 1: new channel

we will compare its profits in these cases and determine its behavior after selling through the new channel. If its profits in all the four cases are lower than 4/9, then we will conclude that it has no incentive to sell through a new channel.

We examine the first possibility ($\sigma_1 > 1$) in Section 4.1 and the second one ($0 < \sigma_1 < 1$) in Section 4.2. In the analysis of each possibility, we first obtain Retailer 1's profits in each of the four cases, then compare them with 4/9, and finally draw conclusions on its incentive to sell through the new channel and pricing behavior in a multi-channel environment if it does have an incentive to sell through the new channel.

4.1. The first possibility: $\sigma_1 > 1$

4.1.1. Four cases

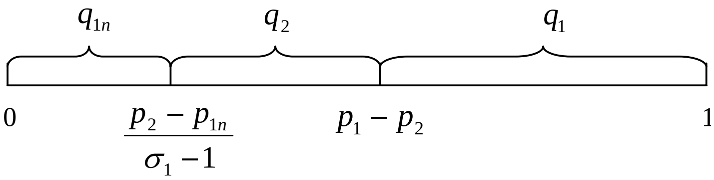
Case 1: Retailer 1 coexists with Retailer 2 and keeps its old channel

In this case Retailer 1 will set p_1 and p_{1n} to maximize its profit and Retailer 2 will set p_2. They choose prices simultaneously. Consumers will determine to buy from which retailer and through which channel. In equilibrium, consumers who are sufficiently high reputation sensitive will buy through Retailer 1's old channel; consumers who are sufficiently low reputation sensitive will buy through Retailer 1's new channel; and other consumers will buy through Retailer 2's old channel.

A consumer, with parameter $\hat{\gamma} = p_1 - p_2$, is indifferent between buying through Retailer 1's old channel and Retailer 2's old channel. Similarly, a consumer, with parameter $\hat{\gamma}_2 = (p_2 - p_{1n})/(\sigma_1 - 1)$, is indifferent between buying through Retailer 2's old channel and Retailer 1's new channel. Figure 2 gives the demand configuration in this case.

Thus, the demand configuration is as follows: $q_1(p_1, p_2, p_{1n}) = 1 - (p_1 - p_2)$, $q_{1n}(p_1, p_2, p_{1n}) = (p_2 - p_{1n})/(\sigma_1 - 1)$ and $q_2(p_1, p_2, p_{1n}) = (p_1 - p_2) -$

FIG. 2. Demand Configuration in Case 1 (Retailer 1 sells through a new channel and $\sigma_1 > 1$)



$(p_2 - p_{1n})/(\sigma_1 - 1)$. And retailers' profit functions are:

$$\pi_1(p_1, p_2, p_{1n}) = (p_1 - c_0)[1 - (p_1 - p_2)] + (p_{1n} - c_{1n})\frac{p_2 - p_{1n}}{\sigma_1 - 1}, \quad (4)$$

$$\pi_2(p_1, p_2, p_{1n}) = (p_2 - c_0)\left[(p_1 - p_2) - \frac{p_2 - p_{1n}}{\sigma_1 - 1}\right]. \quad (5)$$

Solving profit-maximization problems gives us the equilibrium prices and Retailer 1's profit:

$$p_1 = c_0 + (c_{1n} - c_0 + 4\sigma_1 - 1)/(6\sigma_1), \quad (6)$$

$$p_2 = c_0 + (c_{1n} - c_0 + \sigma_1 - 1)/(3\sigma_1), \quad (7)$$

$$p_{1n} = (c_0 + c_{1n})/2 + (c_{1n} - c_0 + \sigma_1 - 1)/(6\sigma_1). \quad (8)$$

$$\pi_1 = \frac{1}{36\sigma_1}\left[\frac{9\sigma_1 - 5}{\sigma_1 - 1}(c_0 - c_{1n})^2 - 2(c_0 - c_{1n}) + 16\sigma_1 - 7\right]. \quad (9)$$

To ensure Retailer 1's old channel and new channel and Retailer 2's old channel have a positive demand, we require that $0 < (p_2 - p_{1n})/(\sigma_1 - 1) < p_1 - p_2 < 1$. Using (6), (7) and (8), we get the following condition:

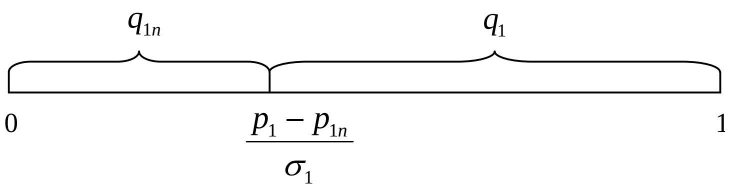
$$(1 - \sigma_1)/(3\sigma_1 - 1) < c_0 - c_{1n} < \sigma_1 - 1. \quad (10)$$

So if (10) does not hold, case 1 is never going to happen in equilibrium. However, it does not mean this case is optimal for Retailer 1 when (10) holds. For this case to be optimal for Retailer 1, its profit must be higher than 4/9 and also higher than in each of the following three cases.

Case 2: Retailer 1 drives Retailer 2 out of the market and keeps its old channel

In this case, similarly, we can find the indifferent consumer. Then the demand configuration is $q_1(p_1, p_{1n}) = 1 - (p_1 - p_{1n})/\sigma_1$ and $q_{1n}(p_1, p_{1n}) = (p_1 - p_{1n})/\sigma_1$, as shown in Figure 3. Retailer 1's profit function is $\pi_1 = (p_1 - c_0)(1 - (p_1 - p_{1n})/\sigma_1) + (p_{1n} - c_{1n})(p_1 - p_{1n})/\sigma_1$.

FIG. 3. Demand Configuration in Case 2 (Retailer 1 sells through a new channel and $\sigma_1 > 1$)



Note that in this case, Retailer 1 has to restrict its prices such that Retailer 2 has no demand even when $p_2 = c_0$. Specifically, this constraint is as follows: $p_1 \leq c_0 + \gamma$ for $\gamma \geq (p_1 - p_{1n})/\sigma_1$ and $p_{1n} + \gamma\sigma_1 \leq c_0 + \gamma$ for $\gamma \leq (p_1 - p_{1n})/\sigma_1$. It turns out that the constraint can be rewritten as $p_1 \leq (p_1 - p_{1n})/\sigma_1 + c_0$. So Retailer 1 will choose p_1 and p_{1n} to maximize its profit subject to this constraint. Using Kuhn-Tucker Theorem, we solve the profit-maximizing problem and get equilibrium prices. And the equilibrium prices and Retailer 1's profit are as follows:

$$p_1 = c_0 + (c_0 - c_{1n} + 1)/(2\sigma_1), \tag{11}$$
$$p_{1n} = c_0 - (c_0 - c_{1n} + 1)(\sigma_1 - 1)/(2\sigma_1), \tag{12}$$
$$\pi_1 = (c_0 - c_{1n} + 1)^2/(4\sigma_1). \tag{13}$$

To ensure Retailer 1's old channel and new channel have a positive demand, we require $0 < (p_1 - p_{1n})/\sigma_1 < 1$. Using (11) and (12), we get the following condition:

$$-1 < c_0 - c_{1n} < 2\sigma_1 - 1. \tag{14}$$

(14) is a necessary condition for case 2 to happen in equilibrium.

Case 3: Retailer 1 coexists with Retailer 2 and withdraws its old channel

In this case, the demand configuration is $q_2(p_2, p_{1n}) = 1 - (p_2 - p_{1n})/(\sigma_1 - 1)$ and $q_{1n}(p_2, p_{1n}) = (p_2 - p_{1n})/(\sigma_1 - 1)$, as shown in Figure 4. Retailers' profit functions are $\pi_1 = (p_{1n} - c_{1n})(p_2 - p_{1n})/(\sigma_1 - 1)$ and $\pi_2 = (p_2 - c_0)(1 - (p_2 - p_{1n})/(\sigma_1 - 1))$.

FIG. 4. Demand Configuration in Case 3 (Retailer 1 sells through a new channel and $\sigma_1 > 1$)

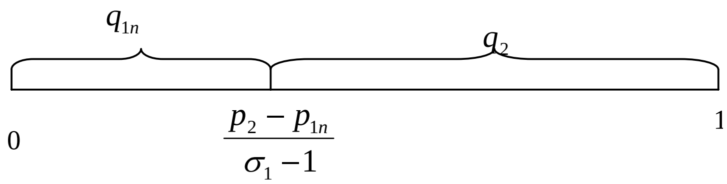
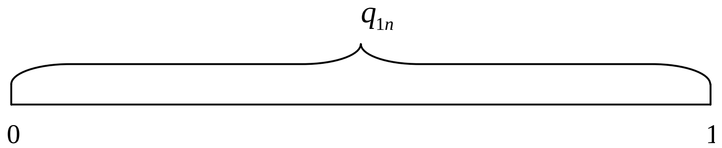


FIG. 5. Demand Configuration in Case 4 (Retailer 1 sells through a new channel and $\sigma_1 > 1$)



First order conditions imply the following equilibrium prices and Retailer 1's profit:

$$
\begin{aligned}
p_2 &= [2c_0 + c_{1n} + 2(\sigma_1 - 1)]/3, &(15)\\
p_{1n} &= [c_0 + 2c_{1n} + (\sigma_1 - 1)]/3, &(16)\\
\pi_1 &= [(c_0 - c_{1n}) + (\sigma_1 - 1)]^2/[9(\sigma_1 - 1)]. &(17)
\end{aligned}
$$

And the condition which ensures $q_2 > 0$ and $q_{1n} > 0$ is

$$1 - \sigma_1 < c_0 - c_{1n} < 2(\sigma_1 - 1). \tag{18}$$

Case 4: Retailer 1 drives Retailer 2 out of the market and withdraws its old channel

In this case, Retailer 1 captures the entire demand, as shown in Figure 5. Retailer 1 has to restrict its price p_{1n} such that Retailer 2 has no demand even when $p_2 = c_0$. Specifically, this constraint is as follows: $p_{1n} + \gamma\sigma_1 \leq c_0 + \gamma$ for $\gamma \in [0, 1]$, which can be rewritten as $p_{1n} \leq c_0 - (\sigma_1 - 1)$. So Retailer 1 will choose p_{1n} to maximize its profit $\pi_{1n} = p_{1n} - c_{1n}$ subject to this constraint. Clearly, the optimal price and the resulting profit are as follows:

$$p_{1n} = c_0 - (\sigma_1 - 1), \tag{19}$$

$$\pi_1 = (c_0 - c_{1n}) - (\sigma_1 - 1). \tag{20}$$

4.1.2. Profit comparison

As pointed out before, Retailer 1 has an incentive to sell through a new channel if and only if its profit in at least one of the four cases is higher than 4/9, its profit when selling through the old channel only (case 0). So we compare Retailer 1's profit in each of these four cases with 4/9 and derive the condition under which Retailer 1's profit in each case is higher than 4/9.

First, we compare Retailer 1's profit in case 1 with 4/9 and get

$$\pi_1(\text{case } 1) - \frac{4}{9} = \frac{1}{36\sigma_1}\left[\frac{9\sigma_1 - 5}{\sigma_1 - 1}(c_0 - c_{1n})^2 - 2(c_0 - c_{1n}) - 7\right]. \tag{21}$$

Simple algebra implies that $\pi_1(\text{case } 1) > 4/9$ if and only if

$$\begin{aligned} c_0 - c_{1n} &> \frac{\sigma_1 - 1 + 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5} \\ \text{or} \\ c_0 - c_{1n} &< \frac{\sigma_1 - 1 - 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5}. \end{aligned} \tag{22}$$

Recall (10) is the necessary condition for case 1 to happen in equilibrium. So $\pi_1(\text{case } 1) > 4/9$ holds only when both (10) and (22) are fulfilled. The intersection of (10) and (22) is $\frac{\sigma_1 - 1 + 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5} < c_0 - c_{1n} < \sigma_1 - 1$ when $\sigma_1 > 16/9$ and empty when $1 < \sigma_1 < 16/9$. Thus, we have

$\pi_1(\text{case } 1) > 4/9$, if and only if $\dfrac{\sigma_1 - 1 + 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5} < c_0 - c_{1n} < \sigma_1 - 1$ and $\sigma_1 > 16/9$. (23)

Next, we compare Retailer 1's profit in case 2 with 4/9 and get, $\pi_1(\text{case } 2) - \frac{4}{9} = \frac{1}{4\sigma_1}\left[(c_0 - c_{1n} + 1)^2 - \frac{16}{9}\sigma_1\right]$, which is positive if and only if

$$c_0 - c_{1n} > \frac{4}{3}(\sigma_1)^{1/2} - 1 \text{ or } c_0 - c_1 < -\frac{4}{3}(\sigma_1)^{1/2} - 1. \tag{24}$$

Recall (14) is the necessary condition for case 2 to happen in equilibrium. So $\pi_1(\text{case } 2) > 4/9$ holds only when both (14) and (24) are fulfilled. The intersection of (14) and (24) is $4(\sigma_1)^{1/2}/3-1 < c_0 - c_{1n} < 2\sigma_1 - 1$. Thus,

$$\pi_1(\text{case 2}) > 4/9, \text{ if and only if } 4(\sigma_1)^{1/2}/3-1 < c_0 - c_{1n} < 2\sigma_1 - 1. \quad (25)$$

Similarly, we can get the following conditions (26) and (27) under which Retailer 1's profit in case 3 and case 4 is higher than 4/9, respectively.

$\pi_1(\text{case 3}) > 4/9$, if and only if $1-\sigma_1+2(\sigma_1-1)^{1/2} < c_0-c_{1n} < 2(\sigma_1-1)$ and $\sigma_1 > 13/9$.[9] (26)

$$\pi_1(\text{case 4}) > 4/9, \text{ if and only if } c_0 - c_{1n} > \sigma_1 - 5/9. \quad (27)$$

After we get these conditions, we need to know the ranges of $c_0 - c_{1n}$ under which Retailer 1's profits in more than one case are higher than 4/9. Then we compare Retailer 1's profits in those cases to determine in which case Retailer 1's profit is the highest.

Alternatively, we can compare Retailer 1's profits in every possible pair of cases. By "possible", we mean the intersection of the sets of $c_0 - c_{1n}$ in the pair of cases is not empty. For example, the intersection of the sets of $c_0 - c_{1n}$ in case 1 and case 2 is $4(\sigma_1)^{1/2}/3-1 < c_0-c_{1n} < \sigma_1-1$ when $\sigma_1 > 16/9$; for case 1 and case 3, it is $1-\sigma_1+2(\sigma_1-1)^{1/2} < c_0-c_{1n} < \sigma_1-1$ when $2 < \sigma_1 < 2.7980$ and $\dfrac{\sigma_1-1+2[(\sigma_1-1)(16\sigma_1-9)]^{1/2}}{9\sigma_1-5} < c_0-c_{1n} < \sigma_1-1$ when $\sigma_1 > 2.7980$; for case 1 and case 4, it is empty. Comparing $\pi_1(\text{case 1})$ with $\pi_1(\text{case 2})$, we find that the former is always higher; comparing $\pi_1(\text{case 1})$ with $\pi_1(\text{case 3})$, we find that $\pi_1(\text{case 1}) > \pi_1(\text{case 3})$ when $2 < \sigma_1 < 16/7$; $\pi_1(\text{case 1} > \pi_1(\text{case 3})$ when $1-\sigma_1+2(\sigma_1-1)^{1/2} < c_0-c_{1n} < \left(1+4\sigma_1-2\sqrt{9\sigma_1^2-23\sigma_1+9}\right)/5$ and $16/7 < \sigma_1 < 2.7980$; $\pi_1(\text{case 1}) < \pi_1(\text{case 3})$ when $\left(1+4\sigma_1-2\sqrt{9\sigma_1^2-23\sigma_1+9}\right)/5 < c_0-c_{1n} < \sigma_1-1$ and $16/7 < \sigma_1 < 2.7980$; $\pi_1(\text{case 1}) < \pi_1(\text{case 3})$ when $\sigma_1 > 2.7980$.

So case 1 is optimal for Retailer 1 when (i) $\frac{\sigma_1-1+2[(\sigma_1-1)(16\sigma_1-9)]^{1/2}}{9\sigma_1-5} < c_0-c_{1n} < \sigma_1-1$ and $16/9 < \sigma_1 < 16/7$,[10] or (ii) $1-\sigma_1+2(\sigma_1-1)^{1/2} < c_0-c_{1n} < \left(1+4\sigma_1-2\sqrt{9\sigma_1^2-23\sigma_1+9}\right)/5$ and $16/7 < \sigma_1 < 2.7980$.

Now consider when case 2 is optimal for Retailer 1. The intersection of the sets of c_0-c_{1n} in case 1 and case 2 is given above; for case 2 and case 3, it is $1-\sigma_1+2(\sigma_1-1)^{1/2} < c_0-c_{1n} < 2(\sigma_1-1)$ when $13/9 < \sigma_1 < 2.2245$ and $4(\sigma_1)^{1/2}/3-1 < c_0-c_{1n} < 2(\sigma_1-1)$ when

[9]When $1 < \sigma_1 < 13/9$, it is impossible for Retailer 1's profit in case 3 to be higher than 4/9.

[10]In this range, either only case 1 is relevant or Retailer 1's profit is the highest.

$\sigma_1 > 2.2245$; for case 2 and case 4, it is $\sigma_1 - 5/9 < c_0 - c_{1n} < 2\sigma_1 - 1$. We have mentioned that π_1(case 2) is always lower than π_1(case 1) in the intersection. Comparing π_1(case 2) with π_1(case 4), we find that the former is always higher; comparing π_1(case 2) with π_1(case 3), we find that π_1(case 2) $>$ π_1(case 3) when $13/9 < \sigma_1 < 2.2245$; π_1(case 2) $>$ π_1(case 3) when

$$\frac{(4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}}{5\sigma_1 - 9} < c_0 - c_{1n} < 2(\sigma_1 - 1)$$

and $\sigma_1 > 2.2245$; π_1(case 2) $<$ π_1(case 3) when $4(\sigma_1)^{1/2}/3 - 1 < c_0 - c_1 < \left((4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}\right)/(5\sigma_1 - 9)$ and $\sigma_1 > 2.2245$.

So case 2 is optimal for Retailer 1 when (i) $4(\sigma_1)^{1/2}/3 - 1 < c_0 - c_{1n} < 2\sigma_1 - 1$ and $1 < \sigma_1 < 16/9$[11], (ii) $\sigma_1 - 1 < c_0 - c_{1n} < 2\sigma_1 - 1$ and $16/9 < \sigma_1 < 16/7$,[12] or (iii) $\left((4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}\right)/(5\sigma_1 - 9) < c_0 - c_{1n} < 2(\sigma_1 - 1)$ and $\sigma_1 > 16/7$.

Next consider when case 3 is optimal for Retailer 1. The intersections of the sets of $c_0 - c_{1n}$ in case 1 and case 3 and in case 2 and case 3 are given above; for case 3 and case 4, it is $\sigma_1 - 5/9 < c_0 - c_{1n} < 2(\sigma_1 - 1)$ when $\sigma_1 > 13/9$. We have mentioned the relationship between π_1(case 1) and π_1(case 3), π_1(case 2) and π_1(case 3). Comparing π_1(case 3) with π_1(case 4), we find that the former is always higher.

So case 3 is optimal for Retailer 1 when (i)

$$\begin{aligned} \frac{1 + 4\sigma_1 - 2\sqrt{9\sigma_1^2 - 23\sigma_1 + 9}}{5} &< c_0 - c_{1n} \\ &< \frac{(4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}}{5\sigma_1 - 9} \end{aligned}$$

and $16/7 < \sigma_1 < 2.7980$, or (ii) $1 - \sigma_1 + 2(\sigma_1 - 1)^{1/2} < c_0 - c_{1n} < \left((4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}\right)/(5\sigma_1 - 9)$ and $\sigma_1 > 2.7980$.

Finally, we determine under what conditions case 4 is optimal for Retailer 1. We have mentioned that Retailer 1's profit in case 4 is the lowest when there are at least another case in which Retailer 1's profit is higher than

[11] In this range, only case 2 and case 4 are relevant but Retailer 1's profit is higher in case 2 than in case 4.

[12] Since $\left((4\sigma_1 - 9)(\sigma_1 - 1) + 6(\sigma_1 - 2)\sqrt{\sigma_1(\sigma_1 - 1)}\right)/(5\sigma_1 - 9) < \sigma_1 - 1$ when $2.2245 < \sigma_1 < 16/7$ and Retailer 1's profit in case 2 is lower than in case 1, the lower bound of the set of $c_0 - c_{1n}$ in which case 2 is optimal for Retailer 2 becomes $\sigma_1 - 1$ and the upper bound of the set of σ_1 becomes $16/7$.

4/9. So case 4 is optimal only when it is the unique such case. Examining (23), (25), (26) and (27), we find that when $c_0 - c_{1n} > 2\sigma_1 - 1$, case 4 is optimal for Retailer 1.

Clearly, in all the other situations, Retailer 1 has no incentive to sell through a new channel.

4.1.3. Results

Now we can determine whether Retailer 1 will sell through a new channel and its pricing behavior after selling through the new channel. The results are summarized into Table 2. We draw Figure 6 to describe Retailer 1's decision on selling through a new channel and its behavior after doing so.

From Table 2 and Figure 6, we can draw the following conclusions:

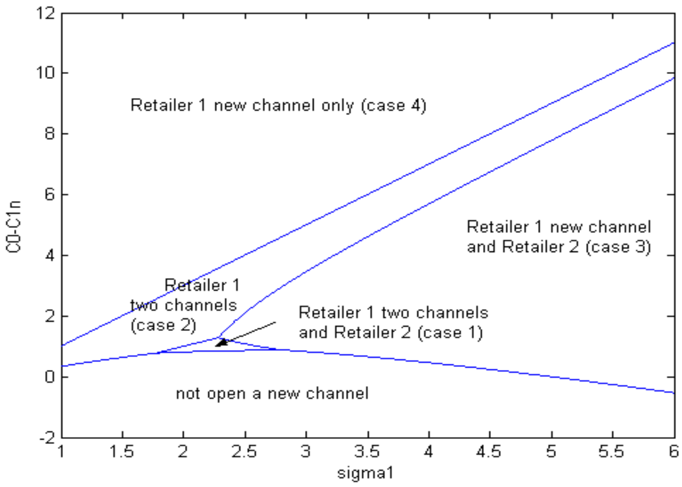
(1) Case 1 is the equilibrium outcome when consumers are moderately averse to the new channel ($16/9 < \sigma_1 < 2.7980$) and the cost reduction is medium.

TABLE 2.
The condition under which Retailer 1 sells through a new channel and equilibrium ($\sigma_1 > 1$)

σ_1	$c_0 - c_{1n}$	Equilibrium
$1 < \sigma_1 < 16/9$	$(-1 + 4\sigma_1^{1/2}/3, 2\sigma_1 - 1)$	Case 2
	$c_0 - c_{1n} > 2\sigma_1 - 1$	Case 4
$16/9 < \sigma_1 < 16/7$	$\left(\frac{\sigma_1 - 1 + 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5}, \sigma_1 - 1\right)$	Case 1
	$(\sigma_1 - 1, 2\sigma_1 - 1)$	Case 2
	$c_0 - c_{1n} > 2\sigma_1 - 1$	Case 4
$16/7 < \sigma_1 < 2.7980$	$\left(\frac{\sigma_1 - 1 + 2[(\sigma_1 - 1)(16\sigma_1 - 9)]^{1/2}}{9\sigma_1 - 5}, [1 + 4\sigma_1 - 2(9\sigma_1^2 - 23\sigma_1 + 9)^{1/2}]/5\right)$	Case 1
	$\left([1 + 4\sigma_1 - 2(9\sigma_1^2 - 23\sigma_1 + 9)^{1/2}]/5, \frac{(4\sigma_1-9)(\sigma_1-1)+6(\sigma_1-2)[\sigma_1(\sigma_1-1)]^{1/2}}{5\sigma_1-9}\right)$	Case 3
	$\left(\frac{(4\sigma_1-9)(\sigma_1-1)+6(\sigma_1-2)[\sigma_1(\sigma_1-1)]^{1/2}}{5\sigma_1-9}, 2\sigma_1 - 1\right)$	Case 2
	$c_0 - c_{1n} > 2\sigma_1 - 1$	Case 4
$\sigma_3 > 2.7980$	$\left(1 - \sigma_1 + 2(\sigma_1 - 1)^{1/2}, \frac{(4\sigma_1-9)(\sigma_1-1)+6(\sigma_1-2)[\sigma_1(\sigma_1-1)]^{1/2}}{5\sigma_1-9}\right)$	Case 3
	$\left(\frac{(4\sigma_1-9)(\sigma_1-1)+6(\sigma_1-2)[\sigma_1(\sigma_1-1)]^{1/2}}{5\sigma_1-9}, 2\sigma_1 - 1\right)$	Case 2
	$c_0 - c_{1n} > 2\sigma_1 - 1$	Case 4

(2) When the cost reduction is sufficiently large and/or the more willingness to pay for a unit of product sold by Retailer 2 than for a unit of product sold through Retailer 1's new channel is small ($1 < \sigma_1 < 16/9$), Retailer 1 drives Retailer 2 out of the market (Case 2 & Case 4).

FIG. 6. Retailer 1's decision on selling through a new channel and the equilibrium in the multi-channel environment ($\sigma_1 > 1$)



(3) If Retailer 1 sells through the new channel, then it coexists with Retailer 2 (Case 1 & Case 3) when consumers are moderately or sufficiently averse to the new channel and the cost reduction is not sufficiently large.

(4) Retailer 1 will sell through the new channel when there is some cost reduction. It also has an incentive to do so when cost increases if consumers are very averse to the new channel ($\sigma_1 > 5$) and if this is the case it withdraws the old channel and coexists with Retailer 2.

Summarizing these results and conclusions, we have the following proposition:

PROPOSITION 1. *In the case of $\sigma_1 > 1$, given that Retailer 2 (the bad reputation retailer) does not sell through a new channel,*

(i) There must be some cost reduction for Retailer 1 (the good reputation retailer) to have an incentive to sell through a new channel unless consumers are sufficiently averse to the new channel ($\sigma_1 > 5$);

(ii) Retailer 1 has an incentive to do so even if cost increases by a little amount when consumers are sufficiently averse to the new channel ($\sigma_1 > 5$) and if this is the case it withdraws the old channel and coexists with Retailer 2;

(iii) After beginning to sell through the new channel, Retailer 1 may keep or withdraw its old channel, and may coexist with Retailer 2 or drive Retailer 2 out of the market. The equilibrium outcome depends on the

combination of cost reduction and the degree of consumers' aversion to the new channel.

4.2. The second possibility: $0 < \sigma_1 < 1$

We leave the technical details in Appendix 1. The results are summarized into Table 3. We also draw Figure 7 to describe Retailer 1's decision on selling through a new channel and its behavior after doing so.

From Table 3 and Figure 7, we can draw the following conclusions:

(1) Case 1 is the equilibrium outcome when consumers are moderately averse to the new channel ($0 < \sigma_1 < 9/16$) and the cost reduction is medium.

(2) When the cost reduction is sufficiently large and/or the more willingness to pay for a unit of product sold through Retailer 1's new channel than for a unit of product sold by Retailer 2 is small ($9/16 < \sigma_1 < 1$), Retailer 1 drives Retailer 2 out of the market (Case 2 & Case 4).

(3) If Retailer 1 sells through the new channel, then it coexists with Retailer 2 (Case 1 & Case 3) when consumers are moderately or slightly averse to the new channel and the cost reduction is not sufficiently large.

(4) Retailer 1 will sell through the new channel when there is some cost reduction. It has no incentive to do so when cost increases.

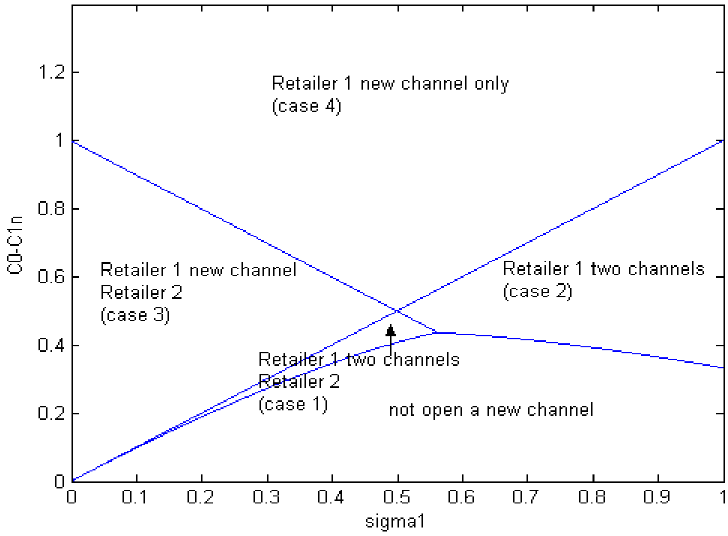
TABLE 3.
The condition under which Retailer 1 sells through a new channel and equilibrium ($0 < \sigma_1 < 1$)

σ_1	$c_0 - c_{1n}$	Equilibrium
$0 < \sigma_1 < 1/2$	$\left(\frac{(1-\sigma_1)+2[(1-\sigma_1)(16-9\sigma_1)]^{1/2}}{9-5\sigma_1}\sigma_1, \sigma_1\right)$	Case 1
	$(\sigma_1, 1-\sigma_1)$	Case 3
	$c_0 - c_{1n} > 1 - \sigma_1$	Case 4
$1/2 < \sigma_1 < 9/16$	$\left(\frac{(1-\sigma_1)+2[(1-\sigma_1)(16-9\sigma_1)]^{1/2}}{9-5\sigma_1}\sigma_1, 1-\sigma_1\right)$	Case 1
	$(\sigma_1, 1-\sigma_1)$	Case 2
	$c_0 - c_{1n} > 1 - \sigma_1$	Case 4
$\sigma_1 > 9/16$	$\left(-\sigma_1 + 4\sigma_1^{1/2}/3, \sigma_1\right)$	Case 2
	$c_0 - c_{1n} > 1 - \sigma_1$	Case 4

Summarizing these results and conclusions, we have the following proposition:

PROPOSITION 2. *In the case of* $0 < \sigma_1 < 1$, *given that Retailer 2 (the bad reputation retailer) does not sell through a new channel,*

FIG. 7. Retailer 1's decision on selling through a new channel and the equilibrium in the multi-channel environment ($0 < \sigma_1 < 1$)



(i) There must be some cost reduction for Retailer 1 (the good reputation retailer) to have an incentive to sell through a new channel. It has no incentive to do so if cost increases;

(ii) After selling through the new channel, Retailer 1 may keep or withdraw its old channel, and may coexist with Retailer 2 or drive Retailer 2 out of the market. The equilibrium outcome depends on the combination of cost reduction and the degree of consumers' aversion to the new channel.

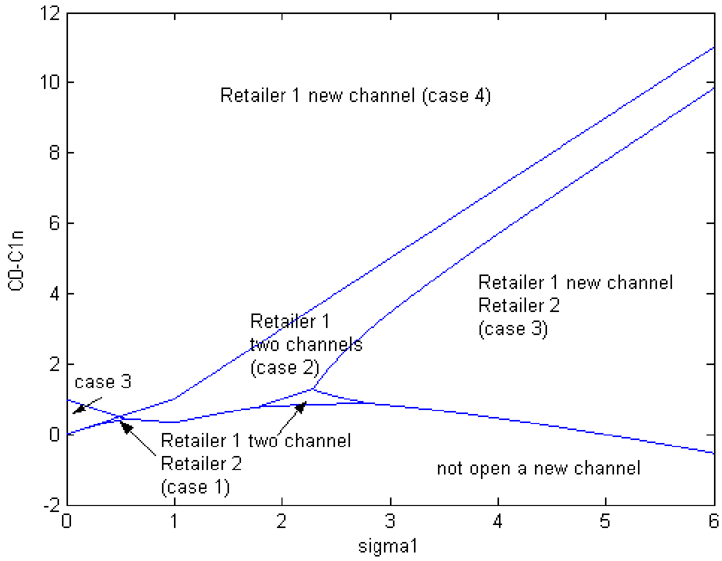
4.3. Summary: good reputation retailer's incentive to sell through a new channel

We can draw Figure 8 to describe Retailer 1's decision on selling through a new channel and equilibrium outcome after it does so. Examining Figure 8, we have the following proposition.[13]

PROPOSITION 3. *Given that Retailer 2 (the bad reputation retailer) does not sell through a new channel,*

[13]From the figure, we can see that, when the marginal costs of selling a unit of product through the new and old channels are equal, Retailer 1 either has no incentive to sell through the new channel or withdraws the old channel if it has the incentive. This is consistent with the result in Siebert (2003).

FIG. 8. Retailer 1's decision on selling through a new channel and the equilibrium in the multi-channel environment



(i) There must be some cost reduction for Retailer 1 (the good reputation retailer) to have an incentive to sell through a new channel unless consumers are sufficiently averse to the new channel ($\sigma_1 > 5$*);*

(ii) Retailer 1 has an incentive to do so even if cost increases by a little amount when consumers are sufficiently averse to the new channel ($\sigma_1 > 5$*) and if this is the case it withdraws the old channel and coexists with Retailer 2;*

(iii) After beginning to sell through the new channel, Retailer 1 may keep or withdraw its old channel, and may coexist with Retailer 2 or drive Retailer 2 out of the market. The equilibrium outcome depends on the combination of cost reduction and the degree of consumers' aversion to the new channel.

(iv) When the difference between consumers' willingness to pay for a unit sold through Retailer 1's new channel and sold by Retailer 2 is small ($9/16 < \sigma_1 < 16/9$*), then Retailer 1 will always drive Retailer 2 out of the market.*

These results can be explained intuitively. First of all, if the new channel does not have some cost advantage, it is not so attractive for Retailer 1 since consumers are averse to the new channel and have lower willingness to pay for a unit of product sold through its new channel than for a unit of product sold through its old channel and the new channel cannibalizes the demand of the old channel; second, however, if consumers are sufficiently averse to its new channel, the new channel is attractive for Retailer 1 even if the new channel has no cost advantage since the price competition between Retailer 1's new channel and Retailer 2 is moderate and moreover, in this case, Retailer 1 will withdraw the old channel to avoid channel cannibalization; third, the difference between consumers' willingness to pay for a unit of product sold by different retailers and different channels actually measures the degree of product differentiation and thus the intensity of price competition, so the equilibrium outcome also depends on the degree of consumers' aversion to the new channel; fourth, if the aforementioned degree of product differentiation is small, resulting in intense price competition, if cost reduction is significant, Retailer 1 will drive Retailer 2 out of the market to avoid intense price competition.

5. BAD REPUTATION RETAILER'S INCENTIVE TO SELL THROUGH A NEW CHANNEL

Retailer 2's marginal costs of selling a unit of product are assumed to be constant and denoted by c_{2n}. If Retailer 2 sells through the new channel, then according to our assumption, $\sigma_2 > 1$. Retailer 2 can sell through both the old channel and the new channel; alternatively, it can withdraw the old channel and sell only through the new channel. It can also coexist with Retailer 1 or drive Retailer 1 out of the market. Thus, there are four cases to consider. These four cases are the same as in Table 1 except that the two retailers' roles are exchanged.

We will obtain Retailer 2's profits in these four cases and then compare them with 1/9, its profit in case 0. If its profit in at least one case is higher than 1/9, then Retailer 2 will have an incentive to sell through the new channel. If its profits in more than one case are higher than 1/9, then we will compare its profits in these cases and determine its behavior after selling through the new channel. If its profits in all the four cases are lower than 1/9, then we will conclude that it has no incentive to sell through the new channel.

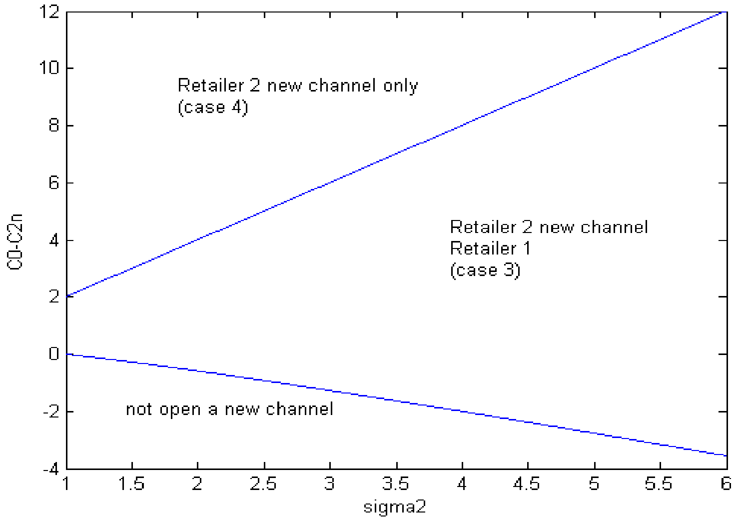
We leave the technical details in Appendix 2. The results are summarized into Table 4. We draw Figure 9 to describe Retailer 2's decision on selling through a new channel and its behavior after doing so.

TABLE 4.

The condition under which Retailer 2 sells through a new channel and equilibrium

σ_2	$c_0 - c_{2n}$	Equilibrium
$\sigma_2 > 1$	$-\sigma_2 + \sigma_2^{1/2} < c_0 - c_{2n} < 2\sigma_2$	Case 3
	$c_0 - c_{2n} > 2\sigma_2$	Case 4

FIG. 9. Retailer 2's decision on selling through a new channel and the equilibrium in the multi-channel environment



Examining Table 4 and Figure 9, we have the following proposition.[14]

Proposition 4. *Given that Retailer 1 does not sell through the new channel,*

(i) Retailer 2 always has an incentive to sell through the new channel if there is cost reduction and it also has an incentive even if cost increases by a small amount;

(ii) Retailer 2 always withdraws its old channel after beginning to sell through the new channel;

(iii) Retailer 2 coexists with Retailer 1 when the cost reduction is not significant and drives Retailer 1 out of the market otherwise.

[14] Again, Retailer 2 withdraws the old channel if the marginal costs of selling a unit of product through the new and old channels are equal. This is consistent with the result in Siebert (2003).

Intuitively, Retailer 2 will never keep its old channel after selling through the new channel because it has to set a very low price level so that its old channel has a positive demand. On the contrary, if it withdraws old channel, then it can set a high price because the degree of product differentiation between its new channel and Retailer 1 is big and as a result the price competition becomes moderate; moreover, it avoids channel cannibalization.

Whether Retailer 2 coexists with Retailer 1 or drives it out of the market depends on the extent of cost reduction, which is easy to understand. If Retailer 2 has more cost advantage, it will drive Retailer 1 out of the market and serve the entire market.

6. CONCLUDING REMARKS

In spite of some papers discussing retailers' pricing behavior in a multi-channel environment in the literature, the issue of retailers' incentive to sell through a new channel has not been investigated deeply. In this study, we fill in this gap.

We consider a duopoly market in which two retailers with different reputation compete in prices and one of the retailers is considering selling through a new channel. Consumers are reputation sensitive and averse to the new channel. In addition, the reputation sensitivity and new channel aversion are heterogeneous across consumers.

In such a setting, we find that, there must be some cost reduction for the good reputation retailer to have an incentive to sell through a new channel unless consumers are sufficiently averse to the new channel. The good reputation retailer may keep or withdraw its old channel and may coexist with the bad reputation retailer or drive it out of the market, depending on the combination of cost reduction and the degree of consumers' aversion to the new channel. On the contrary, even if cost increases by a small amount, the bad reputation retailer also has an incentive to sell through the new channel. The bad reputation retailer always withdraws the old channel, and it may coexist with the good reputation retailer or drive it out of the market, depending on the cost difference between its two channels.

In our model, we assume all consumers are averse to the new channel and the market size does not change after the introduction of the new channel. These two assumptions are restrictive and are limitations of our model. In reality, some consumers are averse to a new channel but probably some others love it. Normally, the demand increases after the introduction of a new channel. Further research should address these issues. However, these assumptions seem not so restrictive for an immature new channel.

Another limitation of our study is that the products sold by two retailers are physically homogenous. We do not consider products which are horizontally differentiated. If there is horizontal differentiation, then it will affect consumers' purchase decision. A situation with both horizontal differentiation and vertical differentiation is left for future research.

In our setting, only one retailer is considering selling through a new selling channel. One interesting direction for future research is that a retailer will also consider selling through the new channel after a new channel is introduced by its rival.

APPENDIX: THE SECOND POSSIBILITY FOR RETAILER 1

A.1.1. Four cases

Following the same procedure as the one in subsection 4.1, we obtain the equilibrium prices, Retailer 1's profit in each case and the necessary condition for each case to happen in equilibrium.

Case 1: Retailer 1 coexists with Retailer 2 and keeps its old channel

The equilibrium prices and Retailer 1's profit are as follows:

$$p_1 = c_0 + (c_{1n} - c_0 + 4 - s\sigma_1)/6, \tag{A.1}$$

$$p_2 = c_0 + (c_{1n} - c_0 + 1 - \sigma_1)/3, \tag{A.2}$$

$$p_{1n} = c_{1n} + (c_0 - c_{1n} + 2 - 2\sigma_1)/3. \tag{A.3}$$

$$\pi_1 = \frac{9 - 5\sigma_1}{36\sigma_1(1-\sigma_1)}(c_0 - c_{1n})^2 - \frac{1}{18}(c_0 - c_{1n}) + \frac{16 - 7\sigma_1}{36}. \tag{A.4}$$

And the necessary condition under which this case can happen in equilibrium is

$$-\sigma_1(1-\sigma_1)/(3-\sigma_1) < c_0 - c_{1n} < \min\{\sigma_1, 1-\sigma_1\}. \tag{A.5}$$

Case 2: Retailer 1 drives Retailer 2 out of the market and keeps its old channel

The equilibrium prices and Retailer 1's profit are as follows:[1]

$$p_1 = c_0 + (c_0 - c_{1n} + \sigma_1)/2, \tag{A.6}$$

$$p_{1n} = c_0, \tag{A.7}$$

$$\pi_1 = (c_0 - c_{1n} + \sigma_1)^2/(4\sigma_1). \tag{A.8}$$

[1]When we solve equilibrium price in this case and in case 4, we need to take into account that Retailer 2 has no demand even when $p_2 = c_0$.

And the necessary condition under which this case can happen in equilibrium is

$$-\sigma_1 < c_0 - c_{1n} < \sigma_1. \tag{A.9}$$

Case 3: Retailer 1 coexists with Retailer 2 and withdraws its old channel

The equilibrium prices and Retailer 1's profit are as follows:

$$\begin{aligned} p_2 &= [2c_0 + c_{1n} + (1-\sigma_1)]/3, && \text{(A.10)}\\ p_{1n} &= [c_0 + 2c_{1n} + 2(1-\sigma_1)]/3, && \text{(A.11)}\\ \pi_1 &= [(c_0 - c_{1n} + 2(1-\sigma_1)]^2/[9(1-\sigma_1)]. && \text{(A.12)} \end{aligned}$$

And the necessary condition under which this case can happen in equilibrium is

$$-2(1-\sigma_1) < c_0 - c_{1n} < 1 - \sigma_1. \tag{A.13}$$

Case 4: Retailer 1 drives Retailer 2 out of the market and withdraws its old channel

Retailer 1's equilibrium price and its profit are as follows:

$$\begin{aligned} p_{1n} &= c_0, && \text{(A.14)}\\ \pi_1 &= c_0 - c_{1n}. && \text{(A.15)} \end{aligned}$$

A.1.2. Profit comparison

First, we compare Retailer 1's profit in these four cases with 4/9, its profit in case 0, and derive the condition under which Retailer 1's profit is higher. We get the following results:

$\pi_1(\text{case 1}) > 4/9$, if and only if $\dfrac{(1-\sigma_1) + 2[(1-\sigma_1)(16-9\sigma_1)]^{1/2}}{9-5\sigma_1}\sigma_1 < c_0 - c_{1n} < \min\{\sigma_1, 1-\sigma_1\}$ and $0 < \sigma_1 < 9/16$. (A.16)

$\pi_1(\text{case 2}) > 4/9$, if and only if $-\sigma_1 + 4\sigma_1^{1/2}/3 < c_0 - c_{1n} < \sigma_1$ and $4/9 < \sigma_1 < 1$. (A.17)

$\pi_1(\text{case 3}) > 4/9$, if and only if $-2(1-\sigma_1+2(1-\sigma_1)^{1/2} < c_0 - c_{1n} < 1-\sigma_1$ and $0 < \sigma_1 < 5/9$. (A.18)

$\pi_1(\text{case 4}) > 4/9$, if and only if $c_0 - c_{1n} > 4/9$. (A.19)

After we get these conditions, we need to know the ranges of $c_0 - c_{1n}$ under which Retailer 1's profits in more than one case are higher than 4/9.

Then we compare Retailer 1's profits in those cases to determine in which case Retailer 1's profit is the highest.

Alternatively, we can compare Retailer 1's profits in every possible pair of cases. By "possible", we mean the intersection of the sets of $c_0 - c_{1n}$ in the pair of cases is not empty. Another alternative is that we compare profits first, taking into account the necessary conditions (A.16)-(A.19), and then come back to the intersection of the sets if necessary. Sometimes this way reduces the amount of calculations since it is possible that the profit in one case is always higher than in another case anyway and thus we do not need to be bothered by finding the intersection. For example, simple calculations yield

$$\begin{aligned} & \pi_1(\text{case } 1) - \pi_1(\text{case } 2) \\ = & \frac{1}{9(1-\sigma_1)}\left((1-\sigma_1)-(c_0-c_{1n})\right)\left(4(1-\sigma_1)-(c_0-c_{1n})\right) \end{aligned}$$

and

$$\pi_1(\text{case } 1) - \pi_1(\text{case } 3) = \frac{1}{4\sigma_1}(c_0 - c_{1n} - \sigma_1)^2.$$

Clearly $\pi_1(\text{case } 1) \geq \pi_1(\text{case } 2)$ since (A.16) is a necessary condition for case 1 to be optimal and $\pi_1(\text{case } 1) \geq \pi_1(\text{case } 3)$.

Similar calculations lead us to the results presented in subsection 4.2.

APPENDIX: BAD REPUTATION RETAILER'S INCENTIVE TO SELL THROUGH A NEW CHANNEL

A.2.1. Four cases

Case 1: Retailer 2 coexists with Retailer 1 and keeps its old channel

Following the same procedure, we obtain the equilibrium prices and Retailer 2's profit:

$$\begin{aligned} p_1 &= c_0 + 2/3, && \text{(A.20)} \\ p_2 &= c_0 + 1/3, && \text{(A.21)} \\ p_{2n} &= c_{2n} + (3c_0 - 3c_{2n} + 2)/6, && \text{(A.22)} \\ \pi_2 &= (c_0 - c_{2n})^2/[4(\sigma_2 - 1)] + 1/9. && \text{(A.23)} \end{aligned}$$

And the necessary condition under which this case can happen in equilibrium is

$$0 < c_0 - c_{2n} < 2(\sigma_2 - 1)/3. \qquad \text{(A.24)}$$

Case 2: Retailer 2 drives Retailer 1 out of the market and keeps its old channel

The equilibrium prices and Retailer 2's profit are as follows:

$$p_2 = c_0 - 1, \tag{A.25}$$
$$p_{2n} = c_{2n} - 1 + (c_0 - c_{2n})/2, \tag{A.26}$$
$$\pi_2 = (c_0 - c_{2n})^2/[4(\sigma_2 - 1)] - 1. \tag{A.27}$$

And the necessary condition under which this case can happen in equilibrium is

$$0 < c_0 - c_{2n} < 2(\sigma_2 - 1) \tag{A.28}$$

Case 3: Retailer 2 coexists with Retailer 1 and withdraws its old channel

The equilibrium prices and Retailer 2's profit are as follows:

$$p_1 = (2c_0 + c_{2n} + 2\sigma_2)/3, \tag{A.29}$$
$$p_{2n} = (c_0 + 2c_{2n} + \sigma_2)/3, \tag{A.30}$$
$$\pi_2 = [(c_0 - c_{2n}) + \sigma_2]^2/(9\sigma_2). \tag{A.31}$$

And the necessary condition under which this case can happen in equilibrium is

$$-\sigma_2 < c_0 - c_{2n} < 2\sigma_2. \tag{A.32}$$

Case 4: Retailer 2 drives Retailer 1 out of the market and withdraws its old channel

Retailer 2's equilibrium price and its profit are as follows:

$$p_{2n} = c_0 - \sigma_2, \tag{A.33}$$
$$\pi_2 = c_0 - c_{2n} - \sigma_2. \tag{A.34}$$

A.2.2. Profit comparison

After comparison, we get the following results:

π_2(case 1) $> 1/9$, if and only if (A.24) is satisfied.

π_2(case 2) $> 1/9$, if and only if $2[10(\sigma_2 - 1)]^{1/2}/3 < c_0 - c_{2n} < 2(\sigma_2 - 1)$ and $\sigma_2 > 19/9$. (A.35)

$$\pi_2(\text{case } 3) > 1/9, \text{ if and only if } -\sigma_2 + \sigma_2^{1/2} < c_0 - c_{2n} < 2\sigma_2. \quad (A.36)$$
$$\pi_2(\text{case } 4) > 1/9, \text{ if and only if } c_0 - c_{2n} > \sigma_2 + 1/9. \quad (A.37)$$

Examining (A.24), (A.35) and (A.36), we find that the two sets described by (A.24) and (A.35) are two subsets of the set described by (A.36). Examining (A.23), (A.27), (A.31) and (A.34), we find that π_1(case 3) is the highest. Therefore, we get the results presented in Section 5.

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