Competition between the Internet and Conventional Retailer: A Strategic Analysis of the Effect of Online Channel Efficiency

Hyung Rae Cho, Sung Moon Bae and Jong Hun Park

Abstract— This study analyses the effect of the online channel efficiency in the context of price competition between the Internet retailer and conventional retailer. Based on the circular spatial market model, it is found that the Internet retailer's channel efficiency plays a crucial role in determining the equilibrium price, market share, and profit. First, the conventional retailer prefers price-leader position if the Internet retailer's efficiency is lower than a certain level, while prefers price-follower position if the Internet retailer's efficiency is higher than the level. On the other hand, the Internet retailer prefers price-follower position regardless of the level of its efficiency. Second, even if the Internet retailer's efficiency becomes extremely high, it is still possible for conventional retailers to get a certain level of market share and a positive price covering the cost of goods sold. However, the Internet retailer can be thrown out from the market if its efficiency becomes very low. Third, counterintuitively, the Internet retailer can make less profit by improving its efficiency gradually when its efficiency belongs to a certain interval.

Keywords — circular spatial market model, conventional retailer, Internet retailer, Nash equilibrium, Stackelberg equilibrium

I. Introduction

Marketing on the Internet, a very active area of electronic commerce [4][11], is emerging as a powerful communication and distribution medium. Although marketers all over the world agree that the Internet will have a major impact on the way modern companies operate management and marketing activities [9], the conventional retailer will still remain as an enduring reality [3]. Even with the presence of Internet retailer capable of providing electronic service for consumers to choose a desired product with just a simple mouse click, the option of purchasing from nearby conventional retailers such as an outlet or a store will continue to be available to consumers [3]. In this regard, competition between the Internet retailer and the conventional retailer will become intense as electronic commerce progresses.

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Suppose an Internet retailer specifies a new electronic commerce channel supplying products and product-related information to the consumers by simply using the Internet, and that the conventional retailer denotes traditional retailing channels where consumers can touch and feel products and have a shopping atmosphere. Then the research issue still unexplored is how competition between the Internet retailer and the conventional retailer can be conceptualized rigorously in terms of Nash equilibrium and Stackelberg equilibrium to induce strategic marketing implications for both channels. Such research issue has clearly remained untouched in literature—how each channel should develop and modify strategies regarding pricing, market share, and profit according to the channel's level of efficiency. A good analysis of this research issue can result in the formulation of strategic marketing implications for both channels.

Different from the conventional retailer, an Internet retailer needs no physical market presence to attract customers. Rather, it takes advantage of telepresence that is usually characterized by easy Internet access, lack of physical location, and interactivity. Presence, in this case, is defined as the subjective experience of being in a certain place or environment even though one is physically situated in another [18]. Interactivity refers to the extent of user participation in modifying the form and content of a virtual world environment in real time [16]. An Internet retailer conducts business through its presence that is felt in the mediated environment. In this sense, conventional wisdom dictates that an Internet retailer may have a capability to eventually control the market in terms of pricing, market share, and even profit by intense price competition with conventional retailers. In addition, Internet technology continues to rapidly develop, hence the Internet retailer would be able to extremely enhance its channel efficiency in the near future such that any additional cost related to buying on the Internet would not occur. However, whether this concept is true or just a myth should be investigated.

This study addressed the research issues raised above by first providing a theoretical framework to conceptualize the competition between Internet retailer and conventional retailer, and then deriving several marketing implications from the framework's application to specific price competition between both channels. At the same time, this study attempts to support future electronic commerce researchers to think about more interesting parameters and more realistic situations beyond the current scope of this study.

The rest of the paper is organized as follows. Section 2 reviews related works. The basic competition model used in this study is introduced in section 3. In section 3, building a dynamic pricing strategy by adopting Nash and Stackelberg equilibrium methods is also discussed. Based on the analytical results from section 3, insightful marketing implications for the Internet retailer are presented in section 4. In section 5, channel efficiency control strategy for the sake of improving management performance of Internet and conventional retailers are described. This study ends with conclusions and suggestions for further research issues.

II. RELATED WORKS

Literature in marketing and electronic commerce often focuses on competition between pure conventional retailers [8], retailers' pricing behavior in oligopolistic market [17], and local customers' choice of retailers [5]. Brynjolfsson and Smith [4] analyzed pricing behavior of Internet retailers and conventional retailers dealing with books and CDs. Balasubramanian [3] addressed a strategic analysis of competition between direct marketers and conventional retailers. Hart and Doherty [7] also discussed the retailer's adoption of Internet implications for retail marketing. Lynch and Ariely [10] showed how price sensitivity changes when search cost diminishes in Internet marketing. Recently, Artola et al. [2] analyzed price levels of experienced goods sold in online environment, and Yoo et al. [14] numerically analyzed the hybrid channel structure.

According to the classification of electronic commerce research [11], electronic commerce literature can be classified into four categories: applications, technological issues, support and implementation, and others. Although a great deal of research had been made about electronic commerce with respect to these categories, studies investigating competition between the conventional retailer and the Internet retailer from the marketing strategy perspective are rare, suggesting a need for further research that addresses this issue. This study seeks to fill such need.

In addressing the above mentioned research need, this study was basically influenced by the works of Brynjolfsson and Smith [4] and Balasubramanian [3]. For two categories of homogeneous products like books and CDs, Brynjolfsson and Smith empirically analyzed price competition between Internet retailers and conventional retailers. The results of their study can be summarized as follows: (1) prices offered by Internet retailers were lower than prices given by conventional retailers; (2) Internet retailers adjusted prices more often than conventional retailers, presumably due to lower menu costs; and (3) price dispersion is lower in Internet retailers than in conventional retailers. Balasubramanian addressed a strategic analysis of competition between direct marketers and conventional retailers by using the game approach.

This study differs from that of Brynjolfsson and Smith [4], since a strategic analysis of price competition between Internet retailer and conventional retailer was derived according to the Nash equilibrium model and the Stackelberg equilibrium model. Another difference is that the results of this study enables marketers and researchers to predict how both channels would compete with each other in the future. This study also suggests which marketing strategies in terms of price, market share, and profit each channel should take to win the competition and benefit more. Other differences of this study from that of Balasbramanian[3] include: (1) the Internet retailer was considered explicitly as a competition partner for the conventional retailer; (2) the Stackelberg equilibrium was incorporated to determine suitable conditions for playing as either a price-leader or a price-follower; and (3) the Internet retailer's channel efficiency was introduced as a controllable parameter to adjust price, market share, and profit. Overall, this research suggests many strategic points derived from the results, which were not found in the previous studies.

III. COMPETITION MODEL AND SOLUTION

The circular spatial market model [3][11] was used as a basic medium for analyzing competition. In the circular spatial market model (Fig. 1), consumers are distributed uniformly on a circle of unit circumference, and in the market each consumer is purchasing a standardized product in each period. Consumer demand is assumed to be inelastic.

In Figure 1, we have N conventional retailers denoted R, which are located at equal distances from each other on the circumference. When visiting a conventional retailer, consumers incur travel costs at a linear rate t per unit distance. The travel costs include the opportunity cost of time, the real cost of travel, and the implicit cost of inconvenience [3].

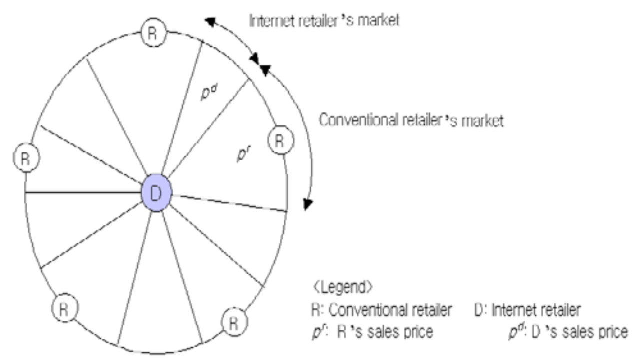


Fig. 1. Circular spatial market model for both conventional retailer and Internet retailer

Since the web can always be electronically accessible from anywhere, the exact location of Internet retailers does not have to be defined. However, for the sake of convenience, the Internet retailer (denoted D) is assumed to be located at the center of the circle in Figure 1. Consumers of the Internet retailer do not incur any travel costs to buy the product. But additional cost μ is still incurred when buying on the Internet because consumers are not able to touch and feel the product to check its quality [1][15]. Aside from this, a certain amount of delivery time is necessary before the product can be used, a certain level of computer literacy is needed on the part of the consumers, and there is security anxiety about the Internet retailers and the Internet itself [6][13].

Based on the above model we can derive the market share and profits of the conventional retailer and the Internet retailer as follows[1]. A consumer located at a distance x from a retailer is indifferent between purchasing from the retailer and D when $p^r + tx = p^d + \mu$. Thus the market share of each conventional retailer is confined to:

$$S^r = 2x = 2\frac{p^d - p^r + \mu}{t}. \quad (1)$$

The conventional retailer tries to maximize the profit:

$$\Pi^r = 2(p^r - c)\frac{p^d - p^r + \mu}{t}. \quad (2)$$

Because there are N conventional retailers in the market, the market share of the Internet retailer becomes:

$$S^d = 1 - 2N\frac{(p^d - p^r + \mu)}{t}. \quad (3)$$

The Internet retailer tries to maximize the profit:

$$\Pi^d = N(p^r - c)\left\{\frac{1}{N} - 2\frac{p^d - p^r + \mu}{t}\right\}. \quad (4)$$

In equations (2) and (4), c represents cost of goods sold(COGS) per unit product. For the conventional retailers, inventory cost as well as store management cost are incurred. The Internet retailers are exempted from these costs but instead have to pay the delivery costs. The COGS of the conventional retailer may differ from that of the Internet retailer. In this paper, for convenience, we assume COGSs of the two channels are the same.

In the context of pricing game, each player has his own reaction function with which he plans to adjust price accordingly. The usual form of reaction function considers the competitor's price as a significant component. Therefore, by referring to the reaction function, a player can determine its own counter price with respect to the competitor's price.

Let us consider determining the conventional retailer's reaction function that has the Internet retailer's price as one of the components. If the Internet retailer's (selling) price is P^d, then the conventional retailer will determine his profit-maximizing price P^r, as shown in equation (2). Therefore, the conventional retailer's profit-maximizing reaction function is obtained by letting $\partial \Pi^r / \partial p^r = 0$. The reaction function for the conventional retailer is as follows.

$$p^r = \frac{p^d + \mu + c}{2} \quad (5)$$

Similarly, the Internet retailer's profit-maximizing reaction function is obtained by calculating $\partial \Pi^d / \partial p^d = 0$, yielding equation 7.

$$p^d = \frac{p^r - \mu + c}{2} + \frac{t}{4N} \quad (6)$$

In this paper we consider two types of game, namely, Nash and Stackelberg games. In Nash game, each player continuously reacts (i.e., changes its price) to its competitor's counter price. If this chain of reaction leads to stable prices for the players, the resulting prices are called a Nash equilibrium. The Nash equilibrium can be derived by solving the reaction functions of the game players simultaneously, where the reaction function of a player can be derived from differentiating its profit function by its price. In this sense, the Nash game is sometimes called as simultaneous price setting. Meanwhile, in the Stackelberg game, a price-leader (first mover) first determines its price by using the counterpart's (price-follower's) reaction function, then the price-follower sets his price based on the price-leader's price. In this sense, the Stackelberg game is sometimes called as sequential price setting. Calculation of the Nash and Stackelberg equilibria is not so complex, thus we show only the results in Table 1,2,3.

Table 1. Nash Equilibrium

Price	Market Share	Profit
Internet retailer		
$p_N^{d*} = c - \frac{\mu}{3} + \frac{t}{3N}$	$S_N^{d*} = \frac{2}{3} - \frac{2}{3}\frac{\mu N}{t}$	$\Pi_N^{d*} = \frac{2}{9}\frac{(t-\mu N)^2}{Nt}$
Conventional retailer		
$p_N^{r*} = c + \frac{\mu}{3} + \frac{t}{6N}$	$S_N^{r*} = \frac{1}{3N} + \frac{2}{3}\frac{\mu}{t}$	$\Pi_N^{r*} = \frac{1}{18}\frac{(t+2\mu N)^2}{N^2 t}$

Table 2. Stackelberg Equilibrium
(Case: Conventional retailer as price-leader)

Price	Market Share	Profit
Internet retailer		
$p_F^{d*} = c - \frac{\mu}{4} + \frac{3t}{8N}$	$S_F^{d*} = \frac{3}{4} - \frac{\mu N}{2t}$	$\Pi_F^{d*} = \frac{(3t - 2\mu N)^2}{32Nt}$
Conventional retailer		
$p_L^{r*} = c + \frac{\mu}{2} + \frac{t}{4N}$	$S_L^{r*} = \frac{1}{4N} + \frac{\mu}{2t}$	$\Pi_L^{r*} = \frac{(t+2\mu N)^2}{16N^2 t}$

Table 3. Stackelberg Equilibrium
(Case: Internet retailer as price-leader)

Price	Market Share	Profit
Internet retailer		
$p_L^{d*} = c - \frac{\mu}{2} + \frac{t}{2N}$	$S_L^{d*} = \frac{1}{2} - \frac{\mu N}{2t}$	$\Pi_L^{d*} = \frac{(t-\mu N)^2}{4Nt}$
Conventional retailer		
$p_F^{r*} = c + \frac{\mu}{4} + \frac{t}{4N}$	$S_F^{r*} = \frac{1}{2N} + \frac{\mu}{2t}$	$\Pi_F^{r*} = \frac{(t+\mu N)^2}{8N^2 t}$

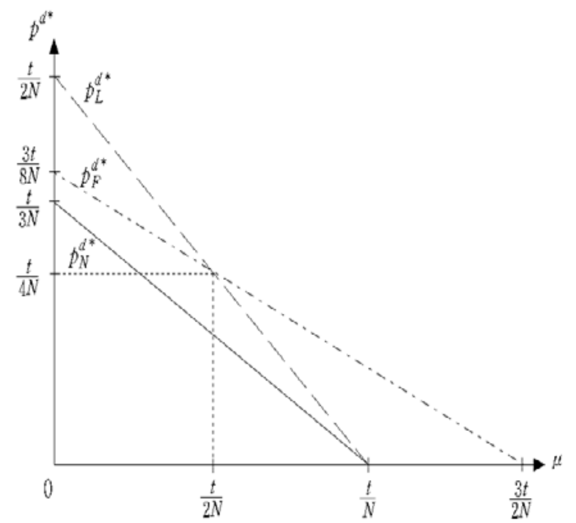
IV. INTERNET RETAILER'S MARKETING STRATEGY

This section elaborates on the Internet retailer's marketing strategy by performing sensitivity analyses of equilibrium solutions. The conventional retailer becomes *efficient* (or *inefficient*) as t becomes small (or large). Meanwhile, the Internet retailer becomes *efficient* (or *inefficient*) as μ becomes small (or large), because μ denotes additional cost incurred in shopping on the Internet.

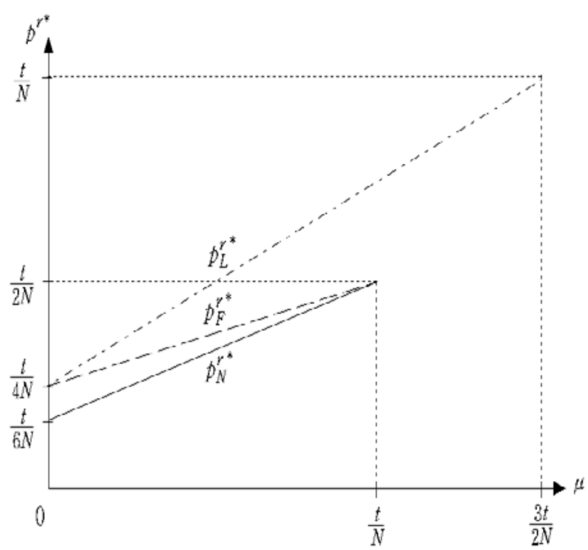
It should be noted that t and μ are semi-controllable because retailers can adjust them according to the quality of services that they provide to customers. For instance, the conventional retailer can lower t by providing shuttle or delivery services. Likewise, the Internet retailer can reduce μ by introducing the policy of certified product quality assurance, unconditional refund and goods return, on-time delivery, and payment security. Considering the intrinsic characteristics of t and μ, it is easy to identify that μ is more controllable in comparison with t. Henceforth, under the assumption that the conventional retailer's channel efficiency is fixed at t, we investigate the sensitivity of profits of the conventional retailer and the Internet retailer according to μ.

IV-1. Price Sensitivity Analysis

Price sensitivity analysis is performed with respect to changes in μ, meaning that the purpose is to see how many changes occur in the equilibrium price as well as in μ. Fig. 2(a) depicts the Internet retailer's equilibrium price sensitivity with respect to changes in μ, while Fig. 2(b), the conventional retailer's price sensitivity. By analyzing Fig. 2, a subsidiary research goal, which is to investigate how much sensitivity each channel equilibrium price shows with respect to changes in μ, is accomplished. Before proceeding further, it should be noted that from Fig. 2, the Stackelberg equilibrium price is always greater than the Nash equilibrium price regardless of channel. This characteristic remains constant no matter how many changes are made in μ.



(a) Internet retailer's equilibrium price sensitivity to μ



(b) Conventional retailer's equilibrium price sensitivity to μ

Fig. 2. Equilibrium Price Sensitivity to μ

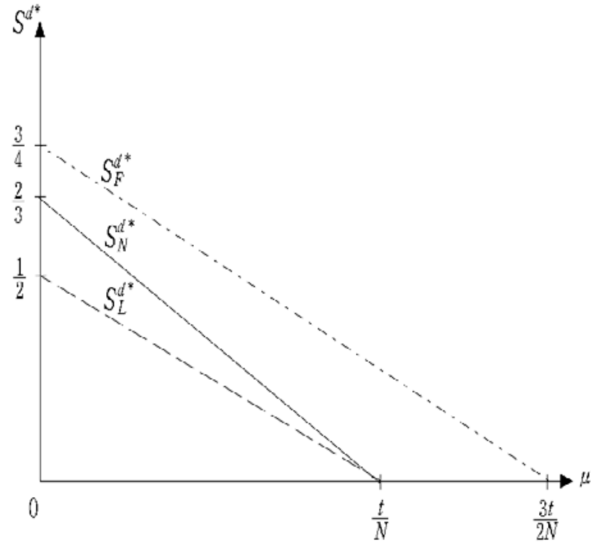
The Internet retailer's equilibrium price sensitivity (Fig. 2(a)) should first be checked. When $\mu < t/2N$, the Internet retailer's equilibrium price as price-leader, $P_L^{d^*}$, is greater than its equilibrium price as price-follower, $P_F^{d^*}$. However, when $\mu > t/2N$, the Internet retailer's equilibrium price as price-follower, $P_F^{d^*}$, is greater than its equilibrium price as price-leader, $P_L^{d^*}$. On the contrary, regardless of changes in μ, the conventional retailer's equilibrium price as price-leader, $P_L^{r^*}$, is always higher than its equilibrium price as price-follower, $P_F^{r^*}$ (Fig. 2(b)).

Another interesting fact can be observed in Fig. 2(a) if μ is made to converge to t/N or $3t/2N$. This means that the Internet retailer's channel efficiency is degraded sufficiently because additional cost involved in the shopping on the Internet is incurred. In that case, the Internet retailer's equilibrium price converges to almost zero, even if the Internet retailer takes either Stackelberg or Nash equilibrium pricing strategy. Therefore, the only viable option for the Internet retailer is to take the *'almost-zero-price'* policy when its channel efficiency becomes degraded. In this case, profit available for the Internet retailer will also become almost zero, indicating that the Internet retailer will eventually have to be thrown out from the market. However, what will happen to the conventional retailer's equilibrium price when the Internet retailer's channel efficiency improves extremely or μ approaches 0? In this situation, the conventional retailer's equilibrium price still converges to a certain positive level (Fig. 2(b)).

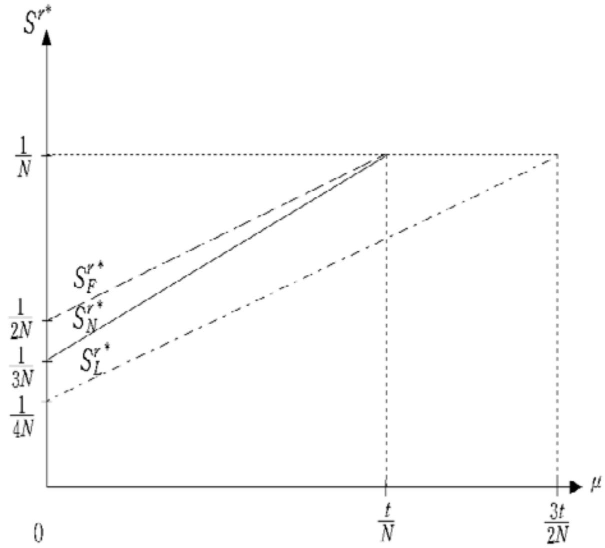
IV-2. Market Share Sensitivity Analysis

Fig. 3 shows how each channel's equilibrium market share changes in accordance with μ. An answer to the question "Under which condition can a maximum market share be acquired?" can be easily derived. For example, according to Fig. 3(a) and 3(b), market share is maximized when each channel acts as a price-follower available from Stackelberg equilibrium pricing strategy. This means that Nash equilibrium pricing is always inferior to Stackelberg equilibrium pricing if the concern is to acquire a greater market share. Therefore, each retailer, regardless whether Internet or conventional, should try to take a price-follower position in the market if he wants to have a greater market share than his competitor. What will then happen to the market share if the retailer takes a price-leader position? Fig. 3 shows that the market share obtainable by acting as a price-leader is always dominated by that which is obtained by a competitor exercising Nash equilibrium pricing strategy.

Integrating these comments so far leads to a tentative conclusion that if both the Internet retailer and the conventional retailer are trying to improve their own market share since they are involved in the Stackelberg equilibrium pricing competition, both will prefer a price-follower position as much as possible avoid a price-leader position. However, in this situation, competition will end up converging to the Nash equilibrium solutions.



(a) Internet retailer's equilibrium market share sensitivity to μ



(b) Conventional retailer's equilibrium market share sensitivity to μ

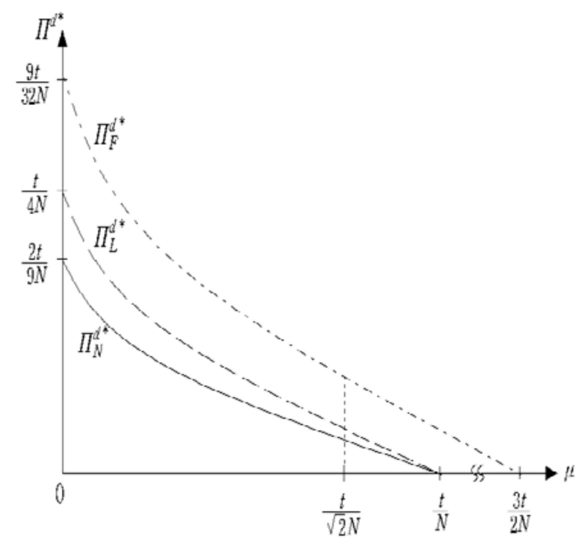
Fig. 3. Equilibrium market share sensitivity to μ

Additional interesting facts found in Fig. 3 is the market share that each channel can get as the Internet retailer's channel efficiency increases or decreases to the extreme. For example, referring to Fig. 3(a), the Internet retailer's market share approaches almost zero when its own channel efficiency is extremely degraded (i.e., $\mu \to t/N$ or $3t/2N$). The Internet retailer can get a fixed portion of market share like $3/4, 2/3, 1/2$ when its channel efficiency improves extremely to the extent that $\mu \to 0$. For example, $3/4$ is for a price-follower, $2/3$ for Nash equilibrium pricing, and $1/2$ for a price-leader (Fig. 3(a)).

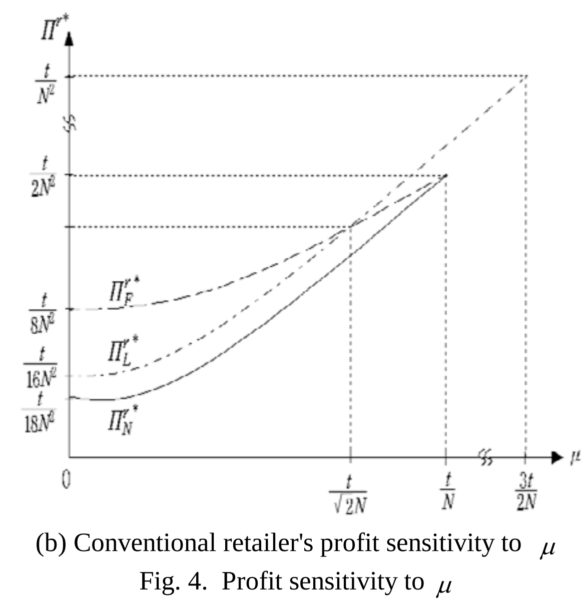
On the contrary, Fig. 3(b) shows that the conventional retailer's market share approximates to a certain level even if the Internet retailer's channel efficiency is extremely upgraded (i.e., $\mu \to 0$). For example, $1/2N$ is for a price-follower, $1/3N$ for Nash equilibrium pricing, and $1/4N$ for a price-leader. From this, an important fact that can be identified is that the conventional retailer can get a certain portion of market share even if the technological as well as the legal and business environment for Internet shopping becomes so well-advanced and well-organized to the extent that μ is almost not incurring to customers. Also, the conventional retailer can get a certain fixed level of market share like $1/N$ when the Internet retailer's channel efficiency is so degraded to such a level as $\mu \to t/N$ or $3t/2N$.

IV-3. Profit Sensitivity Analysis

Fig. 4 shows the sensitivity of profits of the conventional retailer and the Internet retailer with respect to changes in μ. For the sake of convenience, we assume that $c = 0$, where c represents COGS per unit product.



(a) Internet retailer's profit sensitivity to μ



(b) Conventional retailer's profit sensitivity to μ

Fig. 4. Profit sensitivity to μ

The implications directly derived from Fig. 4 can be summarized as follows. First, the Internet retailer can not make any profit (i.e. can not survive in the market) if the Internet retailer becomes extremely inefficient (Fig. 4(a)). Meanwhile, the conventional retailer can mark a certain level of profit (i.e. can survive in the market) even if the Internet retailer accomplishes an ideal level of channel efficiency (i.e., $\mu \to 0$) (Fig. 4(b)).

Second, when the efficiency of the Internet retailer is relatively low ($\mu > t/\sqrt{2}N$), the Stackelberg profit by a price-leader is greatest for the conventional retailer (Fig. 4(b)), while the Stackelberg profit by a price-follower is greatest for the Internet retailer(Fig. 4(a)). This makes the conventional retailer be willing to act as a price-leader, while the Internet retailer as a price-follower. Thus, when $\mu > t/\sqrt{2}N$, the Stackelberg equilibrium (the conventional retailer as the price-leader and the Internet retailer as the price-follower) becomes the optimal strategy for both the conventional and the Internet retailer.

Third, when the efficiency of the Internet retailer is relatively high ($\mu < t/\sqrt{2}N$), both the Internet and conventional retailer prefer to play as a price-follower. However, if both retailers compete severely to secure that position, it will lead to Nash equilibrium solutions after all [12]. But the problem is that the profit from Nash equilibrium is always lower than from Stackelberg equilibrium (Fig. 2). In other words, even if a player acted as a price-leader instead of a price-follower under the same channel cost condition ($\mu < t/\sqrt{2}N$), its profit is greater than Nash equilibrium. Therefore, if two players know this fact beforehand, they would compromise halfway at some point instead of competing for the price-follower position at the risk of ending up with a Nash equilibrium.

V. CHANNEL EFFICIENCY CONTROL STRATEGY

So far, price, market share, and profit sensitivity analyses were performed with respect to changes in channel cost μ , and in the process identifying several unique and interesting points. One significant point obtained from the sensitivity analyses is that the Internet retailer's channel cost μ affects each channel's pricing strategy in a decisive way. It is therefore necessary to elaborate on the Internet retailer's channel efficiency control strategy. However, although the conventional retailer's channel cost t was not focused on in the sensitivity analyses, it seems worthwhile to look into the conventional retailer's channel efficiency control strategy as well. Before proceeding further, assume that when $\mu < t/\sqrt{2}N$, two channels continue to compete with each other to become a price-follower until their competition ends up Nash equilibrium solutions.

Let us start with conventional retailer's channel efficiency control strategy. The conventional retailer can certainly increase profit when the Internet retailer's channel efficiency becomes low (i.e., μ gets large). When $\mu > t/\sqrt{2}N$, the conventional retailer is able to decide alone to be the price-leader. In addition, if the conventional retailer can enhance its channel efficiency by successfully lowering t , its profit will improve much more. In this regard, the conventional retailer will have a strong intention to lower t for more profit. As is often the case, lowering t does not come cheaply, meaning that a considerable investment is required to reduce t into a target level. Therefore, such a strategy for maintaining channel efficiency by lowering t should be double-checked by paying a balanced consideration to the incurred investment cost.

With regard to the Internet retailer's channel efficiency control strategy, a different situation occurs in this case as shown in Fig. 5 which depicts the maximum profit which the Internet retailer can obtain as μ changes. As mentioned previously, the profit by Nash equilibrium becomes maximized in interval I and II, while the profit by Stackelberg equilibrium, where the Internet retailer plays a price-follower, gets maximized in interval III. At this point, the Internet retailer can increase profit by adjusting μ .

First of all, suppose that in Fig. 5, "d" is denoting a profit computed from $\mathrm{d} = \prod_{\mathrm{F}}^{\mathrm{d}^*}(t/\sqrt{2}N)$ and a is defined as the value of μ satisfying $\prod_{\mathrm{N}}^{\mathrm{d}^*}(a) = \prod_{\mathrm{F}}^{\mathrm{d}^*}(t/\sqrt{2}N)$. Suppose that the Internet retailer's channel efficiency μ is any value b satisfying $a \le b \le t/\sqrt{2}N$. In this case, the Internet retailer may have two ways for improving profit by controlling its channel cost μ .

The first is by having a lower μ like the conventional retailer as mentioned before. However, lowering μ also causes additional cost for the Internet retailer. It is generally accepted that marginal cost increases as μ decreases. Therefore, before making a final decision to adopt this way of increasing profit, it would be better for the Internet retailer to compare profit increment with cost increment.

The second way of increasing profit is more complicated—to increase μ (or decrease channel efficiency level) contrary to common sense. By referring to Fig. 5, c is defined as μ satisfying $\prod_{F}^{d^*}(c) = \prod_{N}^{d^*}(b)$. Then the second way simply means increasing μ from b to any value denoted by an interval $t/\sqrt{2}N \le \mu \le c$, which is a region on axis μ of Fig. 5 with a crossed line. By increasing μ like this, the Internet retailer does not only save cost incurred by maintaining μ intentionally within a specified low level, but also increases profit because its pricing strategy is changed from Nash equilibrium to a price-follower strategy of Stackelberg equilibrium guaranteeing more profit. In addition, the Internet retailer can expect more profit by maintaining μ very close to $t/\sqrt{2}N$. The bold line in Fig. 5 represents a maximum profit which the Internet retailer can obtain by the lowering channel cost to $\mu = t/\sqrt{2}N$ in case its channel cost belongs to $a \le \mu \le t/\sqrt{2}N$.

From the previous discussions so far, it can be concluded that the Internet retailer may make more profit and expect cost savings by increasing μ (or sacrificing channel efficiency) in a specific interval. In other words, for the Internet retailer, lowering μ (or improving channel efficiency) does not always lead to profit increase, which is not only counterintuitive but sharply different from the conventional retailer.

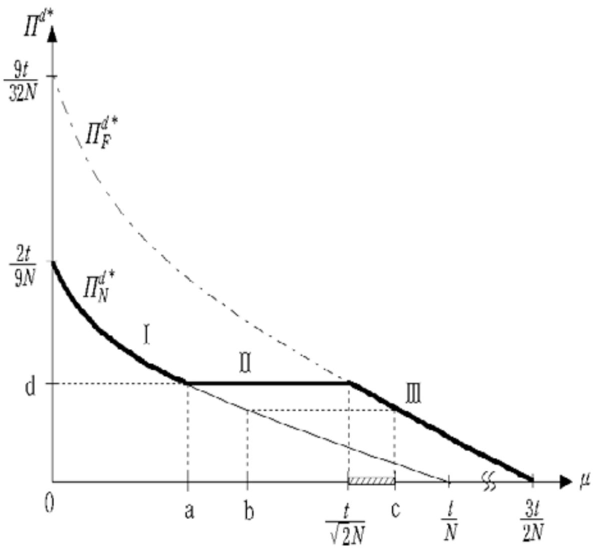


Fig. 5. Internet retailer's maximum profit according to μ

VI. CONCLUDING REMARKS

Under the condition that both the Internet retailer and the conventional retailer are selling a homogeneous and inelastic product in the market, the optimum pricing strategy for both channels is analyzed as the Internet retailer's channel efficiency changes. Two typical types of pricing game models such as Nash and Stackelberg equilibrium were used, and the implications derived from the analysis are as follows.

Pricing by Stackelberg equilibrium was found to always outperform pricing by Nash equilibrium. An interesting phenomenon discovered in this study is that when the Internet retailer's channel efficiency is greater than a certain level (or μ is lower than a certain point), both channels prefer price-follower position. On the contrary, when the Internet retailer's channel efficiency becomes degraded under a certain level (or μ is rising above a certain level), the conventional retailer prefers to take a price-leader position while the Internet retailer, a price-follower position. This phenomenon contradicts conventional wisdom such that the first mover (or price-leader) usually benefits more in the price competition.

Even if the Internet retailer's channel efficiency improves extremely (or μ decreases very much), it is still possible for the conventional retailer to get a market share greater than a certain level and set a price covering COGS. Therefore, there always exists a market left available for the conventional retailer, indicating that the Internet retailer's market share cannot reach 100% under any market circumstances.

Another interesting note from this study is that the Internet retailer can benefit more in terms of profit by lowering its efficiency when its channel efficiency is maintained within a certain interval. Meanwhile, the conventional retailer should always upgrade its channel efficiency to increase profit when additional cost incurred by providing service to increase channel efficiency is negligible.

By comparing this study's results with those of Brynjolfsson and Smith[4], the following interesting points can be made. First, as shown in Fig. 2, the Internet retailer's price is crossed with conventional retailer's price, depending on the channel efficiency that the Internet retailer affords to maintain. This means that price of the Internet retailer may be higher than the conventional retailer's price if the Internet retailer's channel efficiency is high. However, considering Brynjolfsson and Smith's empirical result (1), which says that prices for books and CDs sold on the Internet are less than the identical items sold via conventional retailer, the current channel efficiency of the Internet retailer is not high enough to allow him to raise price higher than the conventional retailer's price.

Second, Brynjolfsson and Smith's empirical results (2) and (3), which says that the Internet retailer changes prices in smaller increments than does the conventional retailer, and that there exists considerable price dispersion among Internet retailers, indicate that the conventional retailer is still acting as a price-leader, whether intentionally or not. The reason is that the conventional retailer is not able to change its posted price so easily, while the Internet retailer can modify its price relatively easily after considering the conventional retailer's posted price.

Integrating these two points above, it can be concluded that the Internet retailer's μ is greater than $t/\sqrt{2}N$. This means that the Internet retailer's channel efficiency needs to be improved more, causing μ to be lower than $t/\sqrt{2}N$. Therefore, the competition between the Internet retailer and the conventional retailer is predicted to go on as follows: If the Internet retailer gradually (not drastically) tries to improve its channel efficiency and successfully penetrates into the market that the conventional retailer presently dominates, and μ is still greater than $t/\sqrt{2}N$, then the conventional retailer, sensing a crisis may not tend to act as a price-leader any longer.

In this case, the conventional retailer will refer to the Internet retailer's price and accordingly adjust its own price more often than now, ending up with fierce price competition between the two channels. However, the Internet retailer will have to endure some profit loss for the time being until channel efficiency reaches the point a as depicted in Figure 5. The only way for the Internet retailer to avoid such profit loss is to come up with an innovative business model or technology to lower its channel cost μ below a (or upgrade its channel efficiency level above) in a relatively short period of time.

The study is hoped to pave the way for providing useful guidelines for decision-making about how to determine optimum pricing strategy as well as optimum channel efficiency control strategy where the Internet retailer and the conventional retailer are competing with each other in terms of price for a single product in the market.

A few research issues remain to be tackled in the future. First, the parameters of circular spatial model should be segmented to show the difference between the Internet retailer and the conventional retailer more clearly and realistically. Second, this study should be extended such that the consumer's demand is affected by price, and that two or more Internet retailers exist in the market.

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