

# Spatial Competition with Internet Retailers\*

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We study a spatial competition model where there are two conventional sellers and one Internet retailer. The Internet retailer tries to enter the market where there are two brick-and-mortar stores. Compared with the conventional retailers that incur linear transportation cost to customer, the Internet retailer incur fixed transportation cost. This distinctive characteristic gives us a new form of Nash equilibria.

Key words: Spatial competition; Internet retailer; Nash equilibrium

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## 1. Introduction

In the so-called new economy, we see several Internet retailers appear and take away market share from the conventional sellers. The Internet retailers sell almost anything from popular items such as CDs, books, and toys even to groceries. Equipped with e-commerce capability, they attack conventional firms. They can develop several advantages in cost and service. Due to more efficient management of logistics and inventory, they can reduce operating cost. Amazon.com enjoys the rapid inventory turnover compared with Barnes & Noble. Amazon turns over its inventory 20 times a year while every other retailer is under 15(F. Vogelstein, 2003). It offers about five

times of selections for electronic products compared with the conventional electronics stores. Internet retailers can offer convenience to customers by letting them order on-line and receive products without visiting a brick-and-mortar store.

However we should accept that there are several obstacles before e-commerce is fully accepted among general people. In addition to the huge cost of constructing infra structure and an operating system for e-commerce, Internet retailers suffer intrinsic disadvantages. For example, people feel more confident when they actually see, touch, hear, and smell the product before making a purchase decision. In this paper, we incorporate the advantage and disadvantage of an Internet retailer.

Before the Internet technology becomes available to the general public, there used to be a fair amount of stability in several markets in spite of modest evolutionary changes. Here stability means that a potential entrant doesn't have an incentive to enter the market and the pricing strategy is predictable among incumbents. But equipped with the new technology of Internet, a new entrant can be a viable player in the previously stable market. New entrants can sometimes affect the whole distribution channel, and displace many conventional retailers in the industry. It is thus meaningful to investigate the effect resulting from the appearance of Internet retailers. In our model, we consider the dynamic effect as the cost of new Internet retailer decreases. Our research was motivated by (Brynjolfsson and Smith, 2000). It shows the empirical results on the prices of books and CDs among Internet retailers and conventional sellers. In our paper we will call Internet retailer as e-tailer for convenience.

Our model uses the framework of spatial competition. Spatial competition was studied and extended by many researchers since Hotelling's seminal paper (Hotelling, 1929). In the spatial competition, retailers sell homogeneous products to the customers in the market. The products are homogeneous other than the location of the retailers in the market. That is, the differentiation comes

from the location of the retailers. The location can be in product characteristics space as well as in physical space. Usually sellers decide their locations in the first stage, and then choose their prices in the second stage. According to the location of retailers, each customer has different distance from the retailer and thus suffers different transportation cost. Here we should note that the terminology of distance and transportation cost is used for convenience and their meanings can be quite broad. The transportation cost is what customers suffer from the distance to the retailer in addition to the purchase price. The transportation cost can surely occur from the physical distance from the customer and the retailer of his choice. A customer would feel lower cost for visiting nearby bookstore or grocery store than that for using distant one. Although the distance may represent the gap from the preference point of a customer to the characteristics in the product offered, in our model we consider that the transportation cost for conventional stores comes mainly from physical distance in order to contrast the characteristic that customers can order to Internet retailer from "anywhere" regardless of physical location.

Customers suffer different transportation costs in conventional transactions from those in Internet commerce. When customers purchase through Internet, they may feel

insecure about the delivery. Wrong item may be delivered, delay can occur, or no delivery is made at all. Customers may rightfully worry about the credit card information for misuse. All of these costs can be regarded as transportation costs for customers who want transactions with e-tailers. The distinct point here is that this kind of transportation cost is independent of distance from the customer to the seller. Although distance actually affects the shipping charge to the customers of e-tailers, the shipping charge is more or less the same among larger area than in conventional retailers. Thus we assume the shipping charge portion of transportation cost is fixed for modeling simplicity. We will incorporate this characteristic into our model.

Since there are so many papers on spatial competition and our focus is on the incorporation of e-tailer characteristics, we do not go for the detailed literature review here. Hotelling (1929) asserted that spatial competition results in minimal differentiation. D'Aspremont et al. (1979) showed that the minimum differentiation equilibrium does not exist by pointing out a mistake in Hotelling's model. Economides(1986) generalized D'Aspremont et al. (1979) by considering the family of transportation cost functions  $f(d) = d^\alpha, 1 \leq \alpha \leq 2$ . Economides(1989) considered a three-stage game in spatial competition, where he added the entrance game in the first stage

in addition to the location and pricing decisions in the second and the third stages. He established a subgame-perfect equilibria where products are symmetrically located in the space of characteristics and are offered at the same prices. Vickrey(1999) offers general explanation on spatial competition and deals with the number of firms in equilibrium. Hinloopen et al.(1999) considered a linear market with a finite reservation price. They analyzed an equilibrium depending on the range of the reservation price. Tabuchi(1999) studied discriminatory and mill pricing policies with quadratic transportation cost. Discriminatory price is the one that the seller has to bear with the transportation cost. In his scheme, each firm selects a pricing strategy (whether to use discriminatory pricing or mill pricing) in the first stage and chooses a price in the second stage. Salop(1979) analyzed a unit-circle model of spatial competition where a second commodity is explicitly treated. Bakos(1997) also considered a unit-circle model for the role of buyer search costs in markets with differentiated product offerings. The impact of reducing these search costs was analyzed in the context of an electronic marketplace.

There may be several criteria according to which we can categorize the papers on spatial competition. Some of them are: the

market is linear or circular; price is fixed or a decision variable; transportation cost is linear, quadratic, or other; the number of sellers is fixed or not, etc. As will be shown later, our model deals with a unit-circle market with a linear transportation cost for conventional sellers. The locations of incumbent sellers are fixed and they adjust their prices accordingly. In our paper, we adapt Hotelling's model such that it can accommodate e-commerce characteristic. Two major differences of our model from the other papers on spatial competition are as follows. Firstly we consider a market where the location of conventional sellers is fixed. We do not deal with the conventional sellers' location problem but consider their pricing strategy instead. Regarding the e-tailer, we deal with its entrance and pricing strategy. This modeling scheme is motivated by the fact that e-tailers attack the stable market where conventional sellers are fixed in locations. The second difference is that the transportation cost for an e-tailer is independent of its distance from the customers. When you think of an e-book, you can understand that the transportation cost does not depend on the physical distance. Due to this characteristic, e-tailer may firstly attract the customers in disadvantage who are located far from the conventional sellers.

In the next section, we, for comparison purpose, deal with the base model that represents a stable market only with two conventional sellers. This model considers the case before an e-tailer appears. Then we study the main model considering the effect of e-tailer's entrance. In the following section, we interpret the Nash equilibrium in terms of market share, price, and profit. The last section offers implications and concluding remarks. In order to have a more concrete idea of this paper, readers can think of the industry of homogeneous products such as books and CDs. Also we note that as in reality it is less costly to go to a nearby store when a customer tries to visit a physical store.

## II. Base Model

### 2.1 Assumptions and Notations

In this section, we deal with a stable market where there are two conventional sellers, denoted as firms 1 and 2 respectively. Customers are uniformly distributed around a circle whose total measure is one. Two sellers are located with equidistance on the circle. Let us correspond the boundary of the circle to  $[0, 1]$  counterclockwise to represent the location. Then firms 1 and 2

are assumed to be located at 0 and 0.5 respectively on the circle. The location is fixed, and two sellers compete with each other through price. There occurs a linear transportation cost to a customer due to the distance from the customer to the seller of his choice. The unit transportation cost is denoted as  $t$ , and we should note that the customers should bear the transportation cost. Thus the *effective price* for a customer is the transportation cost plus the price the seller charges. All of the customers are assumed to have the same reservation price of  $r$ . This means that  $r$  is the value of the product to all customers, and thus a customer would not purchase the product if his effective price were greater than  $r$ . The marginal production cost of the product is denoted as  $c$ , and  $c \leq r$  is assumed. A customer would purchase a unit of the product from the seller which offers lower effective price as long as it is less than or equal to  $r$ . The price charged by firm  $i$  is

denoted as  $p_i$ . Each firm is assumed to charge at least its marginal production cost in order not to make negative profit.

### 2.2 Nash Equilibria

We start from a customer's decision problem. A customer located at  $l$  on the circle would solve the following problem for making a purchase decision:

$$\max [r - (p_1 + \min\{l, 1-l\}t), r - (p_2 + |0.5-l|t), 0]$$

Obviously the purchasing decision depends on  $r$  as well as the pair of prices of  $(p_1, p_2)$  and the location  $l$ . In this paper we will restrict our attention to pure strategy equilibrium. We now display the symmetric Nash equilibria and the resulting profit for the base model. As we can expect, the Nash equilibria depend on the value of reservation price,  $r$ .

Range of $r$	$0 \leq \frac{r-c}{t} \leq 0.5$	$0.5 \leq \frac{r-c}{t} \leq 0.75$	$0.75 \leq \frac{r-c}{t}$
$(p_1, p_2)$	$(\frac{r+c}{2}, \frac{r+c}{2})$	$(r-0.25t, r-0.25t)$	$(c+0.5t, c+0.5t)$
Profit	$\Pi_i = \frac{(r-c)^2}{2t}$	$\Pi_i = \frac{1}{2}(r-c-\frac{t}{4})$	$\Pi_i = \frac{t}{4}$
Market Coverage	Partial	Full	Full

We note that the Nash equilibrium pricing strategy is such that only part of the customers purchase when the reservation price is relatively small ( $c \leq r \leq c + 0.5t$ ). That is, there exist customers who do not purchase the product (partial market coverage) at equilibrium for small  $r$ . When  $r \geq c + 0.5t$ , all the customers purchase the product (full market coverage) even though the equilibrium prices vary depending on whether  $r \geq c + 0.75t$  or not. For  $r \geq c + 0.75t$ , the equilibrium price of each firm becomes  $c + 0.5t$ , which is independent of  $r$ . For  $c + 0.5t \leq r \leq c + 0.75t$ , the equilibrium price of each firm is  $r - 0.25t$ . To explain the meaning of this price, we consider the most disadvantaged customer who is farthest from firms 1 and 2. This customer must be located either at 0.25 or at 0.75, and thus its distance to firms 1 and 2 is 0.25. Thus when both firms 1 and 2 charge  $r - 0.25t$ , the effective price to the most disadvantaged customer becomes  $r$  with its residual value being zero. Thus for the range of  $c + 0.5t \leq r$

$\leq c + 0.75t$ , the equilibrium price is such that the most disadvantaged customer is indifferent to whether purchasing or not, and the measure of market coverage becomes one. In the main model, we will compare the result with the case of  $r \geq c + 0.5t$ . If we also include asymmetric equilibria, the Nash equilibria for  $0.5 \leq (r - c)/t \leq 0.75$  can be divided into two subcases as shown in the Appendix. However we will consider only the symmetric equilibria shown above throughout this paper.

Denoting  $r = c + q_r t$ , we can represent the Nash equilibria shown above as follows:

### III. Main Model

#### 3.1 Additional Assumptions and Notations

In this section, we introduce an e-tailer (firm 3) with different cost parameters from those of conventional sellers. For the moment,

Range of $q_r$	$0 \leq q_r \leq 0.5$	$0.5 \leq q_r \leq 0.75$	$0.75 \leq q_r$
$(p_1, p_2)$	$(c + \frac{t}{2}q_r, c + \frac{t}{2}q_r)$	$(c + (q_r - 0.25)t, c + (q_r - 0.25)t)$	$(c + 0.5t, c + 0.5t)$
Profit	$\Pi_i = \frac{q_r^2 t}{2}$	$\Pi_i = \frac{(q_r - 0.25)t}{2}$	$\Pi_i = \frac{t}{4}$
Market Coverage	Partial	Full	Full

we assume that the fixed cost for entering into the industry,  $f'$ , is zero for the e-tailer. This assumption will be relaxed later. The marginal production cost for the e-tailer is denoted as  $c'$ . When a customer tries to buy a product from the e-tailer, he suffers a cost of  $t'$  in addition to the price. This new form of transportation cost may come from the inconvenience for using Internet, transaction insecurity, reputation of the e-tailer, delay of delivery, etc. We should note that this transportation cost is fixed regardless of the distance between a customer and the e-tailer. And this is the distinct point compared with the conventional spatial competition models. We define  $t'+c'$  as the *virtual cost* of the e-tailer, which represents the effective cost for one unit of production and consumption to be achieved. We should note that part of

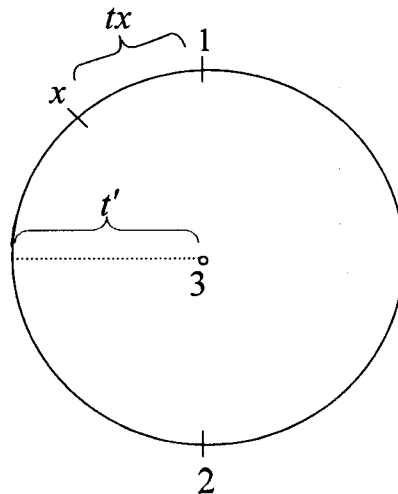
the virtual cost ( $t'$ ) is borne by the customer and the other ( $c'$ ) by the e-tailer. And we assume, for now, that the reservation price,  $r$ , is sufficiently high such that it does not affect the equilibria.

Similarly as in the base model, a customer located at  $l$  should now solve the following problem:

$$\max [r - (p_1 + \min\{l, 1-l\}t), \\ r - (p_2 + |0.5-l|t), r - (p_3 + t'), 0]$$

The first three elements in the bracket represent the residual value, denoted as  $R_i$ , which a customer gets when he purchases a unit of product from firm  $i$ ,  $i=1, 2, 3$ . When the last element of 0 in the bracket is

(Figure 1) Location and Transportation Cost of Each Firm



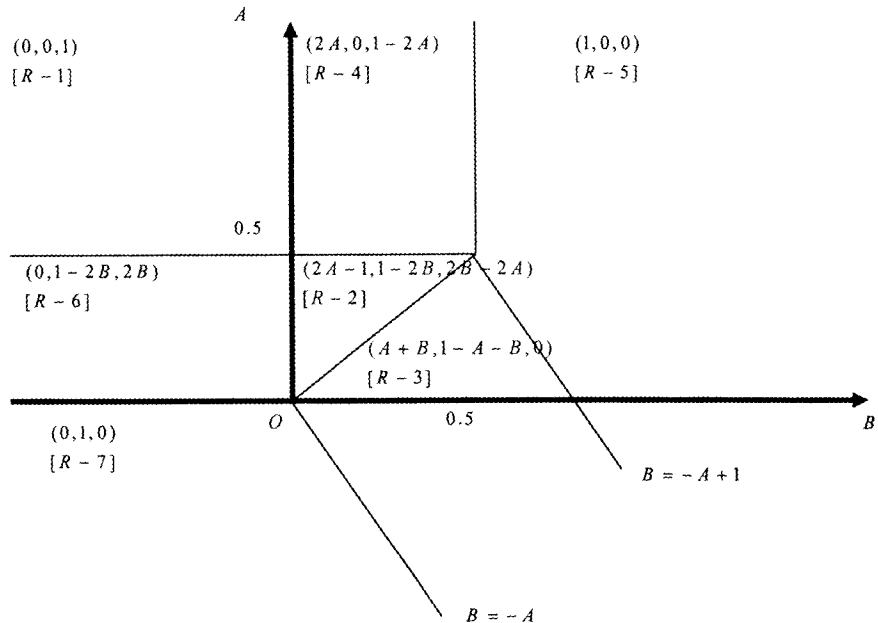
chosen, it means that the customer decides not to purchase from any firm. For the time being, we assume sufficiently high value of  $r$  and thus the maximization would occur in one of the first three elements in the bracket, which means that every customer would purchase a unit of the product anyway. In order to represent the fact that the transportation cost for firm 3 is independent of the distance, we draw the diagram such that the location of firm 3 is in the center of the market as in (Figure 1).

### 3.2 Market Share Diagram

In this subsection we consider a customer's

purchasing decision. Using the residual value for each firm, we can analyze market share of each firm. Let  $A$  and  $B$  be the value of location  $l$  such that  $R_1 = R_3$  and  $R_2 = R_3$  respectively. That is, a customer located at  $A$  is indifferent to purchasing from firm 1 or from firm 3. Likewise a customer at  $B$  is indifferent to purchasing from firm 2 or from firm 3. Depending on the values of  $A$  and  $B$ , we divided the whole plane into 7 regions. The market share of each firm varies according to  $A$  and  $B$ , and can be shown as in (Figure 2). Due to the assumption of sufficiently high reservation price of  $r$ , we can see the measure of market covered by three firms is one. This market

(Figure 2) Market Share of Each Firm



share diagram can be used as a basis to get the Nash equilibria.

### 3.3 Nash Equilibria

Using the market share diagram, we can derive the Nash equilibria. Given the cost parameters of conventional sellers ( $c, t$ ), the equilibria depend on the virtual cost of firm 3. Noting  $p_1=p_2$  in the symmetric equilibria, we have the following Nash

equilibria depending on the range of  $t'+c'$ .

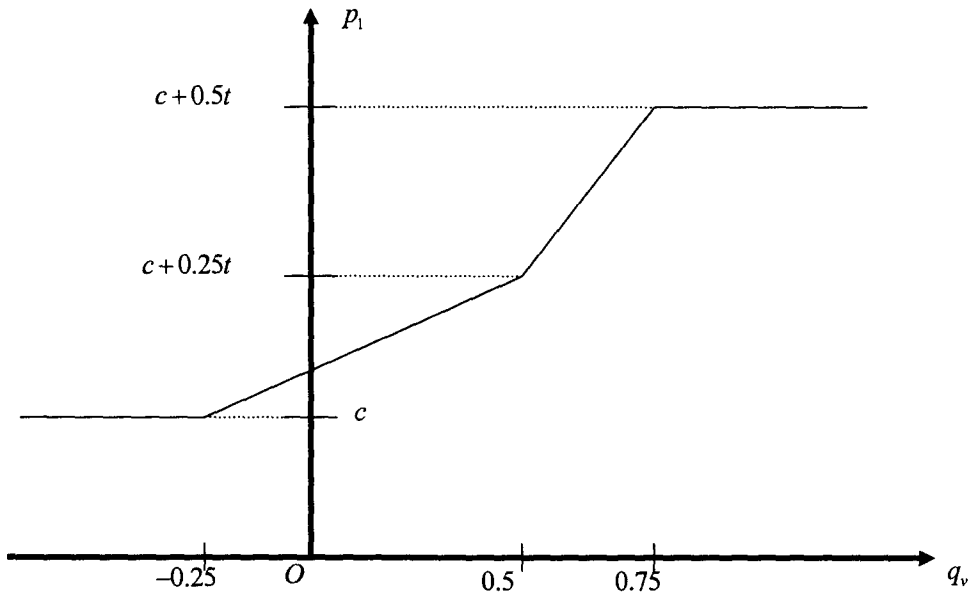
Unitizing the virtual cost of firm 3,  $t'+c'$ , in terms of single dimensional measure of  $q_v$  using  $c$  and  $t$  such that  $t'+c'=c+q_v t$ , we can show the Nash equilibria and the corresponding profit as follows depending on the value of  $q_v$ .

These Nash equilibria are represented in <Figure 3>.

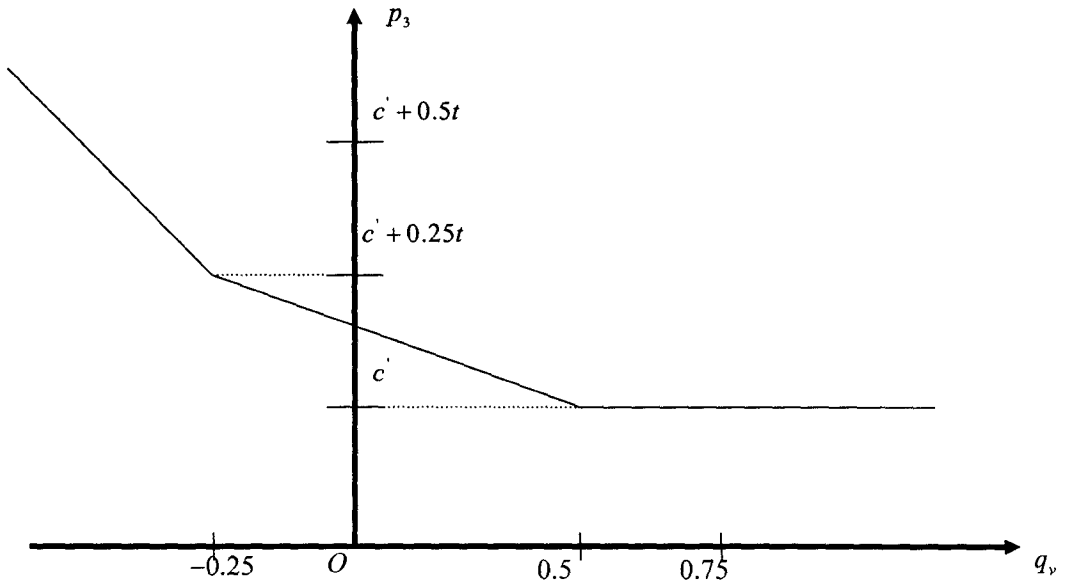
Case	Nash Equilibrium
$t'+c' \leq c-0.25t$	$(p_1, p_3) = (c, c-t')$
$c-0.25t \leq t'+c' \leq c+0.5t'$	$(p_1, p_3) = \left(\frac{2(t'+c')+0.5t+4c}{6}, \frac{-t'+2c'+0.5t+c}{3}\right)$
$c+0.5t' \leq t'+c' \leq c+0.75t$	$(p_1, p_3) = (t'+c'-0.25t, c')$
$c+0.75 \leq t'+c'$	$(p_1, p_3) = (c+0.5t, c')$

Range of $q_v$	Nash Equilibrium
$q_v \leq -0.25$	$(p_1, p_3) = (c, c'-tq_v)$ $\Pi_1 = \Pi_2 = 0, \Pi_3 = -tq_v$
$-0.25 \leq q_v \leq 0.5$	$(p_1, p_3) = \left(c + \frac{t}{3}q_v + \frac{t}{12}, c' - \frac{t}{3}q_v + \frac{t}{6}\right)$ $\Pi_1 = \Pi_2 = (2t/9)(q_v + 0.25)^2, \Pi_3 = (4t/9)(q_v - 0.5)^2$
$0.5 \leq q_v \leq 0.75$	$(p_1, p_3) = \left(c + tq_v - \frac{t}{4}, c'\right)$ $\Pi_1 = \Pi_2 = tq_v/2 - t/8, \Pi_3 = 0$
$0.75 \leq q_v$	$(p_1, p_3) = (c+0.5t, c')$ $\Pi_1 = \Pi_2 = t/4, \Pi_3 = 0$

<Figure 3-1> Nash Equilibrium Price of <Firms 1> and <Firms 2>



<Figure 3-2> Nash Equilibrium Price of Firm 3



Here we should note that the current Nash equilibria are under the assumption that all three firms prefer to exist in the market even though they make zero profit. This is the same assumption that firms would rather stay in the market when they are indifferent to staying in or exiting the market. The existence of a competitor can work as a deterring factor for the other firm not to price like a monopolist. And since  $t' + c' \geq 0$ , the Nash equilibria are valid for  $q_v \geq q_0 = -c/t$ .

#### IV. Interpretation of Nash Equilibria

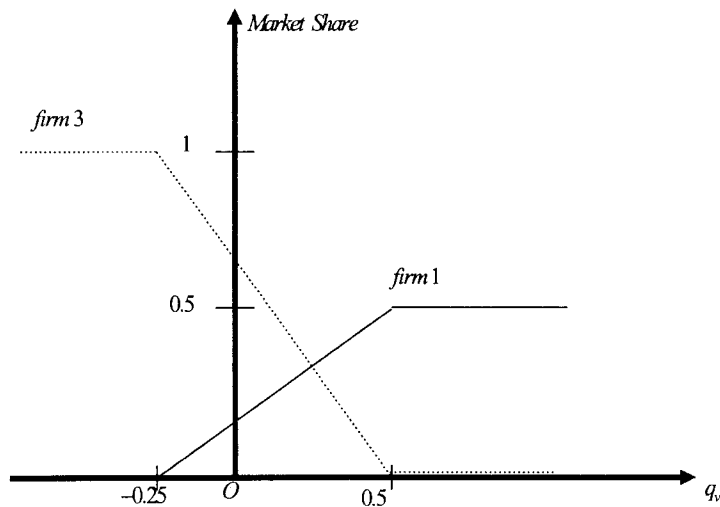
##### 4.1 Market Share

Market share between the conventional

firms (firms 1 and 2) and the e-tailer (firm 3) at the Nash equilibrium can be depicted as in (Figure 4). We can see that as the virtual cost of firm 3 decreases, i.e., as  $q_v$  decreases, the market share of firm 3 grows linearly for  $-0.25 \leq q_v \leq 0.5$ .

According to Economist (2004), we see several signs of decreasing  $q_v$ . Consumers enjoy the rising number of high-speed broadband links, which now connect 50 million American homes to the web. Older people, too, are using the Internet more to shop. Amazon.com is using the falling price of computer power to provide shoppers with new experiences. One example is its "Search Inside the Book" feature, introduced last autumn, which allows customers to search the entire text of more than 120,000 books. It is the online equivalent of being able to

(Figure 4) Market Share of Each Firm



browse pages, as people do in real bookshops. These are decreasing  $q_v$ , and thus help increase the market share of Amazon.

We will define coexistence as the case where all three firms have strictly positive market share. In our main model, we have coexistence for  $-0.25 < q_v < 0.5$ . Considering the coexistence case, we know that firm 3 would serve the customers who are in disadvantage from the conventional firms. That is, customers who are farthest from the conventional firms would be enticed by firm 3 that does not discriminate customers according to distance.

#### 4.2 Price

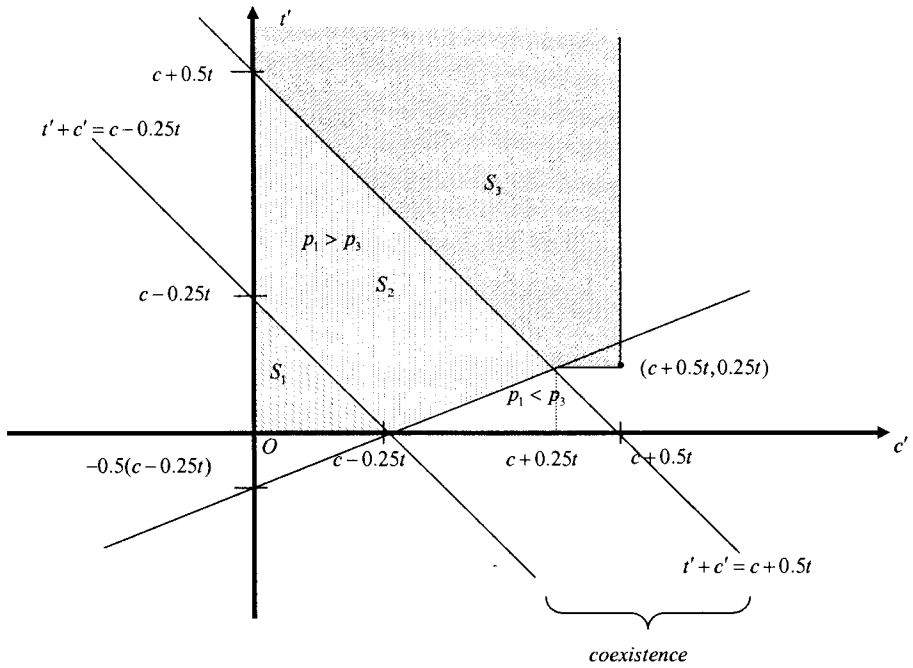
We interpret the equilibrium price change as  $q_v$  decreases in (Figure 3). Decrease of  $q_v$  implies the cost advantage of firm 3 compared with firms 1 and 2. As  $q_v$  decreases, the equilibrium prices of firms 1 and 2 also decrease from  $c+0.5t$ . The prices decrease convexly in a piecewise linear fashion with the slopes changing from  $-t$  to  $-t/3$ , and to 0. On the other hand, as  $q_v$  decreases, the equilibrium price of firm 3 increases convexly in a piecewise linear fashion with the slopes from 0 to  $t/3$ , and to  $t$ . But for  $p_3$ , the intersection with the  $p_3$  axis may change due to the change of  $c'$ . We should also note that the change in the slopes for the conventional firms is the reversed one as

that of the e-tailer.

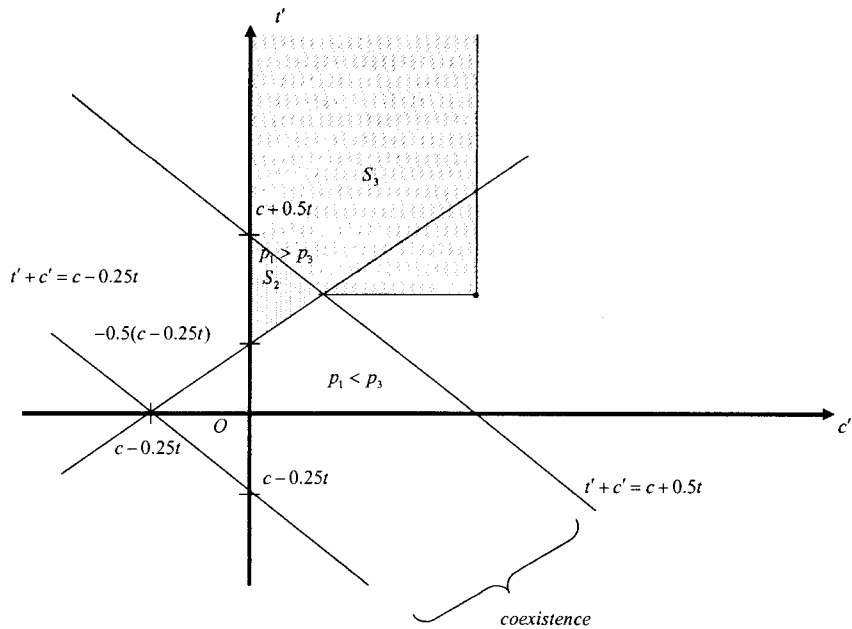
Let us consider, for comparison purpose, the base model where firm 2's marginal production cost is  $c + \delta$  while that of firm 1 is  $c$ . With sufficiently high reservation price, the Nash equilibrium price is  $(p_1, p_2) = (c + 0.5t + \delta/3, c + 0.5t + 2\delta/3)$ . From this we notice that the cost difference of  $\delta$  between conventional sellers impacts the equilibrium price in the same direction although with different magnitude. This can be contrasted with the main model.

We now deal with the equilibrium price of firm 1 for  $c + 0.5t \leq t' + c' \equiv c + q_v t \leq c + 0.75t$ , i.e.  $0.5 \leq q_v \leq 0.75$ . Even though firm 3 does not make positive profit with its price of  $p_3 = c'$ , its virtual cost of  $t' + c'$  works as the reservation price of the base model. At Nash equilibrium in this range, firm 3 charges its marginal cost,  $p_3 = c'$ , and thus the effective price of firm 3 becomes  $t' + c'$ , which is also a virtual cost. If firm 1 charges more than  $c + (q_v - 0.25)t$ , then firm 1's effective price to the most disadvantaged customer becomes larger than  $c + (q_v - 0.25)t + 0.25t = c + q_v t \equiv t' + c'$ , and thus the most disadvantaged customer would buy from firm 3. Thus by pricing  $c + (q_v - 0.25)t$  and making the most disadvantaged customer indifferent to purchasing either from conventional firms (firms 1 and 2) or from firm 3, both firms 1 and 2 would take the whole market share. Therefore  $c + q_v t \equiv t' + c'$

(Figure 5-1) Region of  $p_1 \geq p_3$  (in case of  $c - 0.25t < 0$ )



(Figure 5-2) Region of  $p_1 \geq p_3$  (in case of  $c - 0.25t < 0$ )



plays the role of reservation price,  $r$ , as in the base model for  $0.5 \leq q_v \leq 0.75$ .

We now compare the equilibrium prices of the conventional firms with that of the e-tailer. It is of interest whether the e-tailer charges lower price than conventional firms. That is, we derive the region where  $p_1 \geq p_3$ . This is the phenomenon observed in Brynjolfsson and Smith (2000). Depending on whether or not  $c - 0.25t \geq 0$ , we have two diagrams representing the region as in <Figure 5>. In the region of  $\sum_i S_i$ , we have  $p_1 \geq p_3$ .

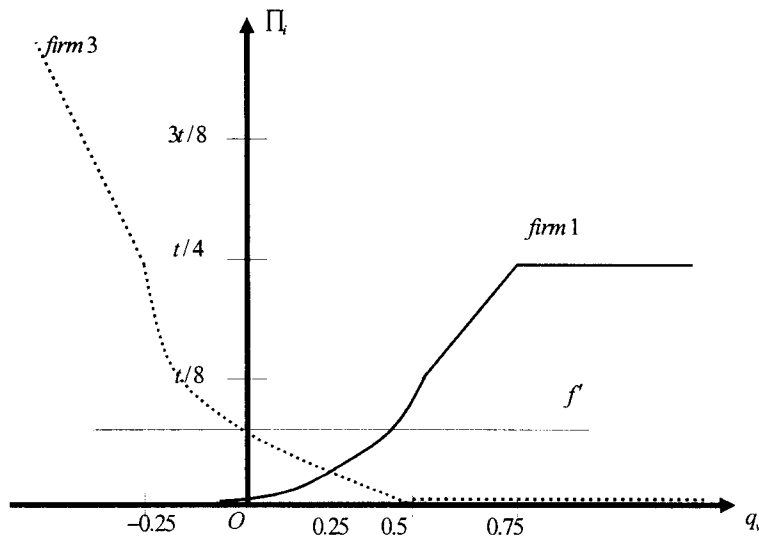
We should note that the region depends not only on the magnitude of virtual cost,  $t' + c'$ , but also on the relative size of  $t'$  and  $c'$ . When  $t'$  is relatively larger than  $c'$ , the

equilibrium price of the e-tailer is smaller than those of conventional sellers. This comes from the fact that the e-tailer had better set lower price as a way to compromise the high transportation cost of  $t'$ . Specifically the result of  $p_1 \geq p_3$  as shown in Brynjolfsson and Smith (2000) means that we are currently in  $S_2$ , where coexistence and  $p_1 \geq p_3$  are satisfied.

### 4.3 Profit

From the Nash equilibria, we can easily derive the profit functions as  $q_v$  varies. For the range of  $-0.25 \leq q_v \leq 0.5$ , the profit functions are quadratic in  $q_v$ . Other than this range, the profit functions are linear in  $q_v$ .

<Figure 6> Profit of Each Firm



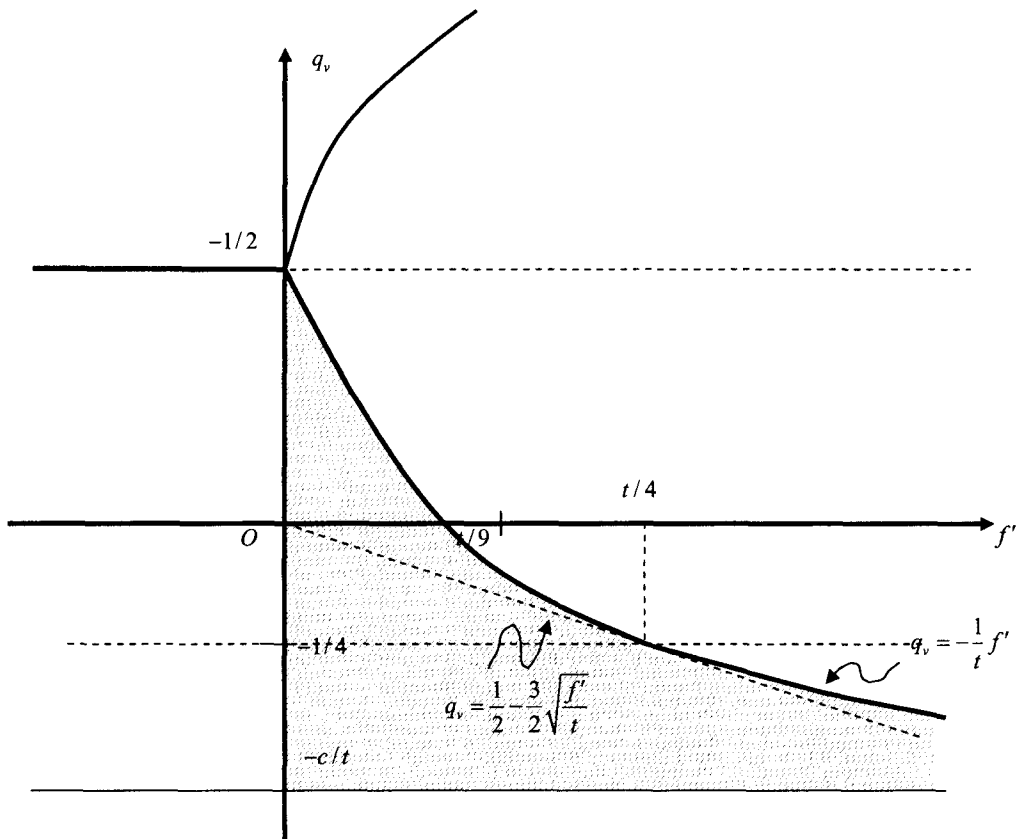
## V. Extension

### 5.1 Entrance Cost and Finite Reservation Price

We consider the case where positive fixed cost of entrance is required for firm 3. Regarding firms 1 and 2, the fixed costs are assumed to be sunk and thus we do not consider them in our model. When the fixed cost of entrance for firm 3,  $f'$ , is positive,

firm 3 would enter into the market only in the range where the equilibrium profit can cover  $f'$ . This can be interpreted as follows. For  $-0.25 \leq q_v \leq 0.5$ , we can apply the main model as long as  $f' \leq \Pi_3 = \frac{4t}{9}(q_v - 0.5)^2$ . For  $0.5 \leq q_v$ , no region is valid for the main model. Lastly for  $-c/t \leq q_v \leq -0.25$ , the main model is valid as long as  $f' \leq -tq_v$ . This region is represented as the shaded area in (Figure 7).

(Figure 7) Valid Region of the Main Model with Positive Entrance Cost of Firm 3



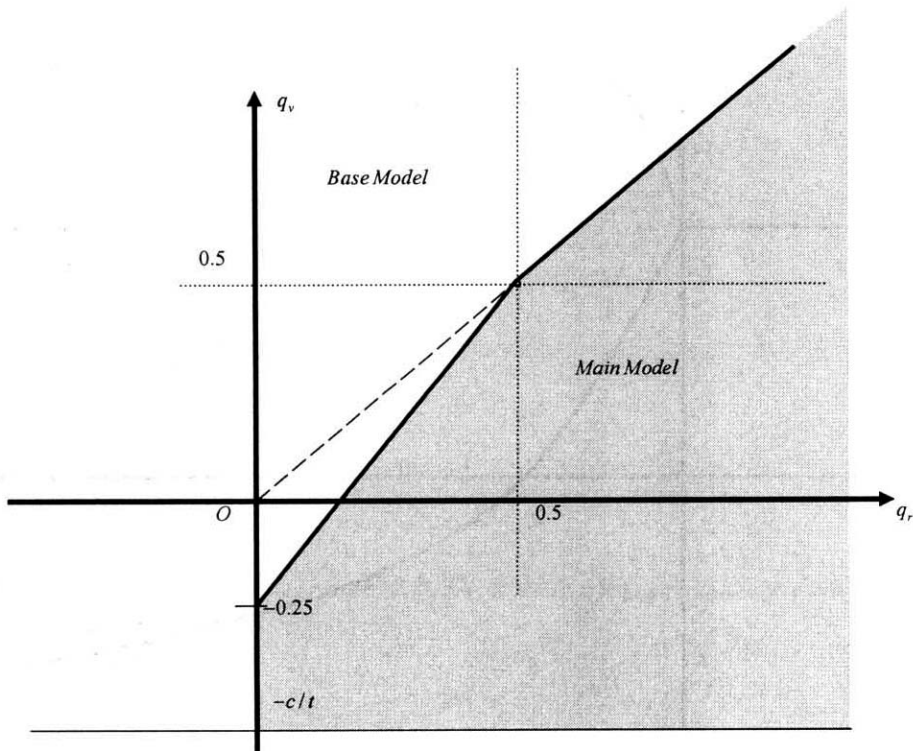
Now we turn to a finite reservation price of  $r$ . We first note that there should exist  $q_r \geq 0$  such that  $r = c + q_r t$ . Considering a customer at  $l$ 's decision problem  $\max[r - (p_1 + \min\{l, 1 - l\}t), r - (p_2 + |0.5 - l|t), r - (p_3 + t'), 0]$ , we can derive the residual value for firm 3 as follows:

$$R_3 = r - (p_3 + t') = c + q_r t - p_3 - t' = c + q_r t - (c + q_v t - c') - p_3 = c' + (q_r - q_v)t - p_3$$

Using  $p_3$  of the main model, we can derive

the following. In case of  $0.5 \leq q_v$ , we have  $p_3 = c'$  and thus  $R_3 \leq 0$  for  $q_r \leq q_v$ . And in case where  $-0.25 \leq q_v \leq 0.5$ , we have  $R_3 \leq 0$  for  $1.5(q_r - 1/6) \leq q_v$  since  $p_3 = c' - (tq_v)/3 + t/6$ . For  $-c/t \leq q_v \leq -0.25$ , we have  $R_3 \geq 0$ . In the region where we have  $R_3 \leq 0$ , we can disregard firm 3 for consideration. That is, the customer at  $l$ 's decision problem becomes that of base model. Readers can refer to the shaded region as in <Figure 8>. Considering the positive fixed cost of entrance and the finite reservation price all together, we can

<Figure 8> Valid Region of the Main Model with Finite Reservation Price



have the validity of main model in the intersection of <Figure 7> and <Figure 8>.

### 5.2 Endogenous Disadvantage of E-tailers

We can also consider some inherent disadvantages of e-tailers. One of the disadvantages occurs when the customers need the sensory characteristics in purchasing decision. It is still more comfortable to read an article on paper rather on the computer monitor. Searching a book through Internet gives us less confidence on the value of it than taking a look at some of the contents at a bookstore. It is difficult to feel the texture of clothes on the computer. Likewise we cannot smell and see the color of groceries on the computer. This disadvantage may work as the lower limit, below which  $t'$  cannot decrease. Even though there are advantages for an e-tailer in production and operation cost on the one hand, it may suffer a higher cost on the other. As transaction volume increases, the complexity and thus cost of logistics increase exponentially. This phenomenon is clear when e-grocery store should deliver fresh items for small time window. There should also be a barrier for reducing  $c'$  further. Considering the lower limits of  $t'$  and  $c'$ , we may thus have  $m$  such that  $c+mt \leq t'+c'$ , and the main model is valid for  $m \leq q_v$ .

For some items, we may have high  $m$  and

this implies that there is no room for an e-tailer to remain viable under current technology. At the time of this writing, several e-grocery stores, once highly valued by investors, filed bankruptcy. We suppose the grocery might fall into this category of no-survival. Thus potential e-tailers need to examine critically the values of  $q_v$ ,  $m$ ,  $f'$  and their changes along time before entering into a market.

### 5.3 Coordination

In the main model we considered the case where three firms interact independently in order to maximize their own profits. But it is possible for a conventional firm to enter into the market as an e-tailer taking advantage of its current assets. Established firms are asserted to have strong points in extending through Internet if they coordinate well enough. Barnes & Noble can be a good example in this case. It offers two channels for book retailing (through physical bookstores and through Internet). In this situation we should solve different kinds of optimization to get the Nash equilibrium. Suppose that firm 1 introduces firm 3 using the e-business model. Then unlike in the main model we dealt with previously, the maximization problems for the Nash equilibrium are:

$$\max_{p_1, p_3} [\Pi_1 + \Pi_3] \quad \text{and} \quad \max_{p_2} [\Pi_2]$$

Here we note that firms 1 and 3 are actually one firm and can coordinate with each other to maximize their total profit. In the coexistence case where  $c < t' + c' < c + 0.4t$ , we get the Nash equilibrium:

$$(p_1, p_2, p_3) = \left( \frac{t' + c' + 2t + 5c}{6}, \frac{2t' + 2c' + t + 4c}{6}, \frac{-t' + 2c' + t + c}{3} \right).$$

We can easily show that each firm's equilibrium price is larger than that in the uncoordinated case of main model.

## VI. Implications and Concluding Remarks

In this paper we studied a spatial competition model where there are two conventional sellers and one e-tailer. The Nash equilibrium price of each firm varies according to the relative magnitude of the e-tailer's virtual cost with respect to conventional seller's cost parameters. As the e-tailer's virtual cost gets smaller, its market share and equilibrium price increase. In order to make the model more realistic, we considered a finite reservation price and a positive entrance cost.

In our model, we note that conventional firms can assert some rent due to their

locations. The distinct locations can give competitive advantage to the firms and thus may reduce the intensity of price competition. But this formerly competitive advantage from location can be attacked by e-tailers who disregard distance. Disregarding distance implies that e-tailers can reach every part of the world where Internet can cover. Due to this characteristic, the competition among e-tailers in the same industry can be fiercer. With fierce competition, we can expect two scenarios. In case of virtual cost difference, this characteristic of e-tailers would lead to a monopoly by the cost leader. We can interpret that Amazon.com pursued 'get big fast' policy in a way to reduce its virtual cost and take a major market share. In the other case where there is no cost difference, the competition would lead to price war such that there remains no positive profit as in Bertrand game. We can thus predict that expecting more intense competition the e-tailers would try to build some differentiating factors. If an e-tailer can set up a differentiating factor such as high customer service, it is no longer competing on homogeneous products. It is actually competing on the circle of a market, and the location in characteristics becomes relevant. Thus if each e-tailer can develop a differentiating factor successfully, we are back to the spatial competition and it can reap some rent from a particular location.

According to the State of Online Retailing Study by www.shop.org/Boston Consulting Group similar characteristics as those of e-tailer in that the customers are in disadvantage from the conventional sellers and/or have low reluctance in purchasing without actually seeing the products and/or are in no hurry getting the purchased products. These characteristics may imply low  $t'$ . Therefore the mail-order companies have low virtual cost and are in advantageous position in competing with other retailers.

For the future research, we should expect several empirical studies on the behavior of conventional firms and e-tailers. We can expect that the appearance of e-tailers results in price reduction among conventional firms. We need to check whether the price charged by an e-tailer goes up as its virtual cost decreases and becomes more competitive along time. In case of electronic bookstore such as Amazon, tracking price is rather difficult since most books have a short lifetime. Price reduction comes from the combination of competition, value decrease, and the

reduction of transaction cost through Internet.

The competition among e-tailers is an interesting and important subject to be explored. The competition among e-tailers in the same industry may force the decrease in equilibrium price unlike in the sole e-tailer case. We can also extend our model where the reservation price is not constant among customers. Customers, in general, have different utility for the product and we should consider the reservation price to be a random variable in such a case. Also the transportation cost to the e-tailer,  $t'$ , can vary among customers. Due to different characteristics of customers, some of them have lower reluctance to e-commerce. As mentioned previously the  $t'$  can, in some cases, be affected by the decisions of e-tailers

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#### Appendix:

Range of $r$	$0.5 \leq \frac{r-c}{t} \leq 0.6$	$0.6 \leq \frac{r-c}{t} \leq 0.75$
$(p_1, p_2)$	$\overline{G_1 G_2}$ , where $G_1 = \left( \frac{r+c}{2}, \frac{3r-c}{2} - \frac{t}{2} \right)$ , $G_2 = \left( \frac{3r-c}{2} - \frac{t}{2}, \frac{r+c}{2} \right)$ .	$\overline{H_1 H_2}$ , where $H_1 = \left( \frac{4r-c}{3} - \frac{t}{2}, \frac{2r+c}{3} \right)$ , $H_2 = \left( \frac{2r+c}{3}, \frac{4r-c}{3} - \frac{t}{2} \right)$ .

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## 인터넷 소매상 진입에 따른 경쟁게임

남익현\*

### 요 약

본 논문에서는 두개의 전통적인 소매상과 하나의 인터넷 소매상이 존재하는 시장에서의 경쟁게임을 다룬다. 두개의 전통적 소매상이 선점하고 있는 시장에 인터넷 소매상이 새로이 진입을 하고자 하는 상황이 관심대상이 된다. 전통적 소매상과는 차별화되는 요소가 인터넷 소매상의 경우 수송비가 '고정비' 형태로 발생한다는 것이다. 이러한 특성으로 인해 발생하는 새로운 양상의 경쟁관계를 규명하도록 한다.

한글색인어: 경쟁 게임, 인터넷 소매상, 내쉬 균형

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