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The Game between Retailer and e-Tailer: Implications for Grocery Industry

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Abstract

With the advent of electronic commerce, it was expected that electronic retailers would replace conventional retailers. However, in industries such as grocery industry, electronic commerce itself is struggling and many e-tailers are dying out. Meanwhile, conventional retailers such as off-line travel agencies still seem to stay in business in the industries where dot-com companies are successful. What will be the evolutionary paths of different industries and what portion of the markets will conventional retailers be able to keep?

Salop’s circular market model is extended to examine the direction of evolution with the advent of electronic commerce. We find that the evolution of an industry depends on the set of the demand and technology parameters. The e-tailer will be more successful in a less competitive and larger market. Even though the entry of e-tailer forces retailers to close their businesses, surviving retailers can enjoy greater market sales with more specialized products.

Keywords

e-Tailer, Equilibrium, Game Theory
INTRODUCTION

With the advent of electronic commerce, it was expected that electronic retailers (e-tailers) would replace conventional retailers by employing advanced information technologies. However, in many industries such as the grocery industry, electronic commerce itself is struggling for survival and many e-tailers are dying out. In the grocery industry, Webvan and many other companies started with high expectations. However, they have closed down and the survivors are struggling to remain in business. Even in industries such as travel where dot-com companies are successful, the conventional retailers, the off-line travel agencies, still seem to stay in business with some changes in their roles and targets. In this paper, we examine the impact of the advent of e-tailers in different industries.

There are several unanswered questions in assessing the impact of the advent of e-tailers to consumer commerce. What portion of the market in different industries will conventional retailers be able to keep? What factors will affect the success of e-tailers? What will be the strategies and roles of conventional retailers with e-tailers? How will the welfare of consumers and society be affected? These are the questions we examine in this study. Salop’s circular market model is extended to examine the direction of each industry with the advent of e-tailers.

In the next section, related studies are reviewed. Then we introduce our basic model, and the results and the discussion on their implications are followed.

E-TAILER IN RETAIL MARKET

The advent of electronic commerce was expected to be the one of the greatest innovations in recent history. However, the performance of electronic commerce up to now has been disappointing compared to the hype it has received. In some industries such as the grocery industry, electronic commerce has been a failure. Even in some other industries, the electronic retailers are not dominating conventional retailers. Malone et al. (1987) expect that, in an industry with products difficult to describe, electronic commerce would not become all powerful even though the authors predict the expansion of electronic commerce. Because of the technical limitations in web technology for consumers to investigate products—they cannot see and feel the actual products—there is disutility for consumers when they consider purchasing certain products from an e-tailer. This is an important disadvantage for e-tailers in comparison to conventional retailers even though e-tailers do have some advantages provided by information technologies.

Even though the performances up to now may be disappointing, electronic commerce has had some impacts on markets and it has increased the benefits of buyers. With increased competition among retailers by web technology, the average prices for consumers were reduced (Brynjolfsson and Smith, 2000). Even if reduced price is not considered, Brynjolfsson et al. (2003) show that electronic commerce has increased the surpluses of consumers by presenting a greater set of choices.

Products can be differentiated horizontally in features depending on consumers’ preferences such as colors, or vertically in quality. In the literature on product differentiation, Hotelling (1929) proposes a model where consumers with different preferences are represented on a line. He explains why the competing companies make products with similar attributes. Salop (1979) proposes a circular horizontal product differentiation model to avoid the corner solutions of the
Hotelling model. And he explains the strategies and numbers of competing companies with the impact of the strength of disutility to consumers when a product’s attributes are different from consumers’ preferences.

Balasubramanian (1998) proposes a revised circular model with a direct marketer at the center of the circle when conventional retailers are distributed around a circle. He analyzed the optimal strategies of direct marketers, which have target segments of consumers. Although his model focuses on direct marketing, the model can also be applied to the phenomena in electronic commerce by removing some restrictions. However, his model represents only a competitive market structure, ignoring the monopoly and predatory structures raised by Salop. The model does not allow the retailers’ endogenous decision on the entry and exit. Our model relaxes the restrictions on the market assumed by Balasubramanian.

MODEL

Competition among Retailers

Salop (1979) has shown the Nash “Symmetric Zero Profit Equilibrium (SZPE)” outcomes of the game with N retailers of differentiated commodity brands on a circular spatial market. L consumers are distributed uniformly and the N retail firms are evenly spaced from each other on the circumference. Thus, as in figure 1a, a consumer on location x purchases from a retailer \( r \) one unit of the brand satisfying

\[
\max[v - tx - p_r] \geq 0 \quad (1)
\]

\( v \) is the effective reserve price representing the consumer preferences. \( t \) is the constant transportation cost per unit distance and \( x \) is the locational distance of consumers from the nearest brand \( r \). This distance reflects real travel cost, information acquisition cost, time cost, and the implicit cost of inconvenience in real world cases. This also represents the implicit value of product differentiation with \( x \) implying deviation of preference. \( p_r \) is the unit price of the brand \( r \).

Figure 1a. and 1b. Retail Symmetric Game on the Circular Market

The retailers face three distinctive demand curves:

- a monopoly demand curve for consumers focusing only on one seller in his location,
• a competitive demand curve for consumers indifferent between two sellers,
• and a super-competitive demand curve when the consumers of the neighboring brand are captured.

Figure 1a and 1b show the markets where the retailers face competitive demand and monopolistic demand. Salop finds price, quantity, number of retail firms, and welfare for different equilibria. He ignores the super-competitive demand curve since he believes the demand never exceeds both monopoly and competitive demand. We will show the nonexistence of the super-competitive equilibrium later.

At the competitive equilibrium as in figure 1a, the retailer competes with neighboring retailers with price \( p \). The competitive retailer \( r \) with price \( p_r^C \) captures all consumers within a distance \( x \) if

\[
\nu - tx - p_r^C \geq \nu - t\left(\frac{1}{N} - x\right) - \bar{p}
\]

(2)

At the monopoly equilibrium as in figure 1b, some consumers lying between two neighboring brands may not purchase the differentiated commodity. Thus the market of neighbors may not overlap and each can act as a monopolist, constrained only by the outside commodity. A consumer at distance \( x \) purchases one unit of the brand satisfying (1). The equilibrium holds for a consumer at \( x \) indifferent to buying or not buying, and implies

\[
\nu - tx - p_r^M = 0
\]

(3)

At both equilibria, the profit, price, market sales and number of retailers \( (\pi_r^C, p_r^C, q_r^C, N_r^C, \pi_r^M, p_r^M, q_r^M, N_r^M) \) are solved and summarized later in table 1.

**Competition between Retailer and E-tailer**

Balasubramanian (1998) set a direct marketer’s position at the center of the circular market. Like a direct marketer who is location independent, it is assumed that an e-tailer who enters the market is located at the center of the circular market. Because the impact of the advent of e-tailer is different in monopolistic and competitive retail markets, the impacts in two markets are analyzed separately as follow.

**Equilibrium in Competitive Retail Market**

As an e-tailer enters the competitive retail market, consumers with weak preference to the retailer in each market segment will switch their suppliers to the e-tailer. Because the delivery of its products depends on independent delivery firms and the information about its products is accessible via web, the e-tailer is location independent and is assumed to be located at the center of the circle. The e-tailer competes with retailers in each market segment. Figure 2 is an example showing the segmentation of consumers both without and with the e-tailer in the competitive retail market. A consumer in a 1/N circular market segment is now able to purchase from both retailer and e-tailer. However, those consumers who opt to buy from the e-tailer face a disutility of reflecting the inconvenience of using an e-tailer (e.g., physical inspection, delivery and access).
Figure 2. Competition among Retailers vs. Competition between Retailers and E-tailer

The consumer at distance $x$ from $r$ is indifferent between buying from e-tailer with price $p_e$ and from the retailer $r$ with price $p_r$, resulting $\nu - tx - p_r = \nu - \mu - p_e$ or $x = \frac{p_e - p_r + \mu}{t}$. Thus, the retailer's competitive demand will be

$$q_r = 2xL = \frac{2(p_e - p_r + \mu)L}{t}$$

(4)

and the slope of competitive retail demand curve will be:

$$\frac{\partial q_r}{\partial p_r} = -\frac{2L}{t}$$

(5)

With the e-tailer in the market, the competitive retailer now faces twice steeper and less elastic demand curve and finds itself in local monopoly. A viable strategy for local retailers would be to provide highly differentiated products and services to avoid direct competition with e-tailers. The e-tailer's demand curve for each local market segment is obtained from gaps left by retailers as

$$q_e = \left(\frac{1}{N} - 2x\right)L = \left[\frac{1}{N} - \frac{2(p_e - p_r + \mu)}{t}\right]L$$

(6)

and the e-tailer's demand curve for the entire circular market will be:

$$Q_e = Nq_e = \left[\frac{1}{N} - \frac{2(p_e - p_r + \mu)}{t}\right]NL$$

(7)

Thus, the slope of the e-tailer's demand curve will be:

$$\frac{\partial Q_e}{\partial p_e} = -\frac{2NL}{t}$$

(8)

Substituting (4), (5), (6) and (8) into the maximum profit conditions for retailers and e-tailer to solve the Nash equilibrium yields
\[ p_r = c + \frac{\mu}{3} + \frac{1}{6N}, \quad p_e = c - \frac{\mu}{3} + \frac{1}{3N}, \]
\[ q_r = \left( \frac{1}{3N} + \frac{2\mu}{3t} \right)L, \quad Q_e = \left( \frac{2}{3} - \frac{2\mu N}{3t} \right)L, \quad q_e = \left( \frac{2}{3N} - \frac{2\mu}{3t} \right)L. \quad (9) \]
\[ \pi_r = \frac{(t + 2\mu N)^2}{18tN^2}L - F_r, \quad \pi_e = \frac{2(t - \mu N)^2}{9tN}L - F_e \]

Notice that the market is fully covered with \( q_r + q_e = \frac{L}{N} \) or \( Nq_r + Q_e = L \), by both retailers and direct marketer. The Nash equilibrium for retailers exists if
\[ 0 \leq \mu \leq \frac{t}{N} \]

This condition allows market sales for each participant to be greater than zero. With the maximum value of disutility at \( \frac{t}{N} \), we get \( p_e = c \) and \( Q_e = 0 \). Thus, the maximum disutility provides the most unfavorable condition and serves as an unintentional and natural entry barrier for the e-tailer.

The zero profit condition for retailers and (9) yield the equilibrium number of retailers in the market
\[ N_r^E = \frac{1}{\sqrt{18} \left( \frac{F_r}{tL} - \frac{2\mu}{t} \right)} = \frac{1}{\sqrt{18} \left( \frac{1}{N_r^C} - \frac{2\mu}{t} \right)} \]

The entry condition (10) requires the value of \( \mu \) within \([0, 1/N_r^E]\). Thus, the number of retailers in equilibrium varies in the following interval
\[ \frac{N_r^C}{\sqrt{18}} \leq N_r^E \leq \frac{1}{\sqrt{2}} N_r^C \]

We know that the number of retailers decreases with the e-tailer in the market. The survival rate of the retailers is in the range of the 23.5% to 71.7% depending on the value of demand parameter \( \mu \) and \( t \). Substituting (11) into (9) yields
\[ p_r^E = c + \frac{1}{\sqrt{2}} \sqrt{tF_r/L}, \quad p_e^E = c - \mu + \sqrt{2} \sqrt{tF_r/L}, \]
\[ q_r^E = \sqrt{2} \sqrt{\frac{F_rL}{t}}, \quad Q_e^E = \frac{2\sqrt{2}}{\sqrt{18} \left( \frac{F_r}{tL} - \frac{2\mu}{t} \right)}L \leq \frac{2}{3} L. \]
\[ \pi_r^E = 0 \]
\[ \pi_e^E = \frac{2t(t - \mu N^2)}{3\sqrt{2} \left( \frac{F_r}{tL} - \frac{2\mu}{t} \right)}L - F_e \]

Table 1 compares the number of retailers, prices, market sales, and the profits before and after the e-tailer joins the competitive retail market.
Players in Game & \( \frac{\partial q}{\partial p} \) & Price & Market Sales & Profit & Number of Retailers \\
--- & --- & --- & --- & --- & --- \\
Competitive & \(- \frac{L}{t}\) & \(p_r^C = c + \frac{tF_r}{\sqrt{L}}\) & \(q_r^C = \sqrt{\frac{F_rL}{t}}\) & \(\pi_r^C = 0\) & \(N_r^C = \frac{1}{\sqrt{2}}\sqrt{\frac{F_r}{L}}\) \\
Monopoly & \(- \frac{2L}{t}\) & \(p_r^M = c + \frac{1}{\sqrt{2}} \frac{tF_r}{L}\) & \(q_r^M = \sqrt{\frac{F_rL}{t}}\) & \(\pi_r^M = 0\) & \(N_r^M = 1\) \\
Retailers Only & \(- \frac{2L}{t}\) & \(p_r^E = c + \frac{1}{\sqrt{2}} \frac{tF_r}{L}\) & \(q_r^E = \sqrt{\frac{F_rL}{t}}\) & \(\pi_r^E = 0\) & \(N_r^E = \frac{1}{\sqrt{2}}\sqrt{\frac{F_r}{L}}\) \\
Retailers and e-tailer & \(- \frac{2NL}{t}\) & \(p_e^E = c - \mu \sqrt{2} \frac{tF_e}{L}\) & \(q_e^E = \frac{2\sqrt{2\frac{F_e}{L}} - 2\frac{\mu}{t}}{\sqrt{18} \frac{F_e}{L} - 2\frac{\mu}{t}} L - F_e\) & \(\pi_e^E = \frac{2\sqrt{2\frac{F_e}{L}} - 2\frac{\mu}{t}}{3\sqrt{2} \frac{F_e}{L} - 2\frac{\mu}{t}}\) & \(N_e^E = \frac{1}{\sqrt{2}}\sqrt{\frac{F_r}{L}}\) \\

**Table 1. The Equilibrium Outcome of Game between Retailers and E-tailer**

For the e-tailer to stay in the market, the disutility level must stay in the range

\[
0 \leq \mu \leq \sqrt{2} \sqrt{\frac{tF_r}{L}}
\]

which assures positive profit for the e-tailer. The condition implies the e-tailer has more chance to be in the market with bigger transportation cost and fixed cost for retailers.

Large market size requires small disutility levels. If the market size and the disutility level are both large, then retailers can cover a large number of buyers and easily stay in business. In a market with large number of consumers, only the e-tailer with low disutility level can have a chance to enter the market. Both retailers and the e-tailer set prices to be equal where \(\mu = \frac{1}{\sqrt{2}} \sqrt{\frac{tF_r}{L}}\). The equilibrium outcome varies depending on the level of disutility as shown in table 2. For a positive profit for the e-tailer, the equation (15) should also hold.

\[
0 \leq F_e \leq \frac{2\sqrt{2\frac{F_e}{L}} - 2\frac{\mu}{t}}{3\sqrt{2} \frac{F_e}{L} - 2\frac{\mu}{t}} L
\]
Table 2. The Equilibrium Outcomes with Various Values

<table>
<thead>
<tr>
<th>Values of □</th>
<th>0</th>
<th>…..</th>
<th>$\mu = \sqrt{\frac{2}{2} \sqrt{\frac{t F_r}{L}}}$</th>
<th>…..</th>
<th>$\mu = \sqrt{2 \sqrt{\frac{t F_r}{L}}}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail Price</td>
<td>…..</td>
<td>$p_e^E &gt; p_r^E$</td>
<td>…..</td>
<td>$p_r^E = c + \frac{1}{\sqrt{2}} \sqrt{\frac{t F_r}{L}}$</td>
<td>…..</td>
</tr>
<tr>
<td>e-tail Price</td>
<td>$p_e^E = c + \sqrt{\frac{t F_r}{L}}$</td>
<td>…..</td>
<td>$p_r^E = p_r^E$</td>
<td>…..</td>
<td>$p_e^E = c$</td>
</tr>
<tr>
<td>Sales per Retailer</td>
<td>…..</td>
<td>$q_r^E = \sqrt{2 \sqrt{\frac{F_r L}{t}}}$</td>
<td>…..</td>
<td>…..</td>
<td>…..</td>
</tr>
<tr>
<td>Total Retail Sales</td>
<td>$N_r^E q_r^E = \frac{L}{3}$</td>
<td>…..</td>
<td>$N_r^E q_r^E = \frac{L}{2}$</td>
<td>…..</td>
<td>$N_r^E q_r^E = L$</td>
</tr>
<tr>
<td>E-tail Sales</td>
<td>$Q_e^E = \frac{2L}{3}$</td>
<td>…..</td>
<td>$Q_r^E = \frac{L}{2}$</td>
<td>…..</td>
<td>$Q_e^E = 0$</td>
</tr>
<tr>
<td>Retail Profit</td>
<td>…..</td>
<td>$\pi_r^E = 0$</td>
<td>…..</td>
<td>…..</td>
<td>…..</td>
</tr>
<tr>
<td>E-tail Profit</td>
<td>$\pi_r^E = \frac{2}{3} \sqrt{\frac{t F_r}{L}}$</td>
<td>…..</td>
<td>$\pi_e^E = \frac{3}{4} \sqrt{\frac{t F_r}{L}}$</td>
<td>…..</td>
<td>$\pi_e^E = -F_e$</td>
</tr>
<tr>
<td>Number of Retailers</td>
<td>$N_r^E = \frac{N_r^C}{3\sqrt{2}}$</td>
<td>…..</td>
<td>$N_r^E = \frac{N_r^C}{2\sqrt{2}}$</td>
<td>…..</td>
<td>$N_r^E = \frac{N_r^C}{\sqrt{2}}$</td>
</tr>
</tbody>
</table>

Equilibrium in Monopolistic Retail Market

As an e-tailer enters the retail market of a local monopoly, consumers with weak preference to the local monopoly retailer in each market segment switch to the e-tailer as their supplier. The e-tailer is not location dependent and hence competes with a local monopoly retailer in each market segment. Figure 3 is an example which compares the monopolistic retailers competing without the e-tailer and with the e-tailer in the market when all other conditions are the same. Unlike the retailer in the competitive market, the local monopoly retailer is not concerned about the neighboring retailers.

Figure 3. Competition among Retailers vs. Competition between Retailers and E-tailer in 1/N Local Monopoly Market Segment
Consumers in a 1/N circular market segment now purchase from both the local monopoly retailer and e-tailer.

The consumer at distance x is indifferent between buying from the e-tailer e with price $p_e$ and from the retailer r with price $p_r$, resulting $\nu - tx - p_r = \nu - \mu - p_e$ or $x = \frac{p_e - p_r + \mu}{t}$. The retailer will face the same demand curve (4) and the slope of demand curve remains in $\frac{\partial q_r}{\partial p_r} = -\frac{2L}{t}$. Unlike the entry of the e-tailer into the competitive market, the slope of a monopoly retailer’s demand curve remains the same even after the entry of the e-tailer. While the presence of the e-tailer doesn’t change the behavior of monopoly retailers, it forces each competitive retailer to behave more like a monopolist in each segment. The e-tailer’s entry has the same effect on both competitive and monopolistic retail market and produces the same equilibrium outcome for the competitive and monopolistic retailers as shown in table 1 and 2. With the same equilibrium outcomes, a fewer number of monopoly retailers than the competitive retailers will exit the market.

By solving processes, the number of monopoly retailers can be induced as in (16).

$$N^E_r = \frac{1}{\sqrt{9 \left( \frac{1}{N^M_r} - 2 \frac{\mu}{t} \right)}} \quad (16)$$

and with the value of $\mu$ within $[0, \frac{t}{N^E_r}]$, the number of retailers varies in the following interval:

$$\frac{N^M_r}{3} \leq N^E_r \leq N^M_r \quad (17)$$

RESULTS AND ANALYSIS

Initial Impact of E-tailer Entry on the Market

When only retailers prevail in a market, there is no gap in the market as shown in table 2. All the consumers are fully served and each retailer’s profit remains at zero assuring no changes in the number of retailers. As an e-tailer enters the market, the equilibrium is disturbed. Initially, each retailer’s price and profit are expected to decrease with no immediate exit of retailers. Each retailer’s profit at this initial stage of transition can be obtained by substituting the number of existing retailers prior to the e-tailer’s entry, $N^C_r$ and $N^M_r$ into the equilibrium profit functions of (9). When we compare the competitive and monopolistic markets, we find the impact of e-tailer would be less in the monopolistic market than in the competitive market.

**Proposition 1** The initial impact of the e-tailer is less on the retailers’ profits in monopolistic market compared to the impact on profits in a competitive market when the e-tailer enters to the market.

**Proof.** The initial profits for retailers and e-tailer in the priori competitive market are
\[
\frac{\pi_c}{F_r} = \frac{(t + 2\mu \sqrt{\frac{tL}{F_r}})^2}{18t^2} - 1 \quad \text{and} \quad \frac{\pi_c}{F_e} = \frac{2(t - \mu \sqrt{\frac{tL}{F_r}})^2}{9t \sqrt{\frac{tL}{F_r}}} L - F_e.
\]

and those in the priori monopolistic market are

\[
\frac{\pi_c}{F_r} = \frac{(t + \sqrt{2\mu \sqrt{\frac{tL}{F_r}}})^2}{9t^2} - 1 \quad \text{and} \quad \frac{\pi_c}{F_e} = \frac{2(t - \mu \sqrt{\frac{tL}{2F_r}})^2}{9t \sqrt{\frac{tL}{2F_r}}} L - F_e.
\]

Thus, the initial profits on transitions are favorable for both retailers and e-tailer in case of an e-tailer entering the local monopoly market rather than a competitive market. Because the monopolistic market is already a more focused market, the increase in competition from the advent of the e-tailer would be less. (Q.E.D.)

However, the initial profits in any case fall below zero. For \(\mu=0\), implying the most favorable case for the e-tailer, the profits in transition are \(\frac{\pi_c}{F_r} = \frac{17}{18} F_r\) and \(\frac{\pi_c}{F_e} = \frac{2}{9} \sqrt{tLF_r} - F_e\) for an e-tailer entering the competitive market, and \(\frac{\pi_c}{F_r} = \frac{8}{9} F_r\) and \(\frac{\pi_c}{F_e} = \frac{2\sqrt{2}}{9} \sqrt{tLF_r} - F_e\) for the e-tailer entering the monopoly market. And for \(\mu = \sqrt{2 \sqrt{\frac{L}{F_r}}}\), the most unfavorable case for the e-tailer, the initial profits in transition are \(\frac{\pi_c}{F_r} = -\frac{9 + 4\sqrt{2}}{18} F_r\) and \(\frac{\pi_c}{F_e} = -\frac{2}{9} (\sqrt{2} - 1) \sqrt{\frac{L}{t}F_r} - F_e\) for the e-tailer entering the competitive market, and \(\frac{\pi_c}{F_r} = 0\) and \(\pi_e = -F_e\) for the e-tailer entering the monopoly market.

In any case, the suppliers suffer negative profit, but will remain in the market in the short run as their sales revenue covers the variable cost. However, in the long run, some of the retailers will exit the market since the business doesn’t pay their overall costs. As the number of the retailers decreases, each remaining retailer recovers the loss by serving additional consumers.

**Implication of the advent of E-tailer**

The equilibrium outcomes (table 1 and 2) provide helpful insights for both market and participants. From table 1, we know that the e-tailer faces a more elastic demand curve than any retailers, both competitive and local monopoly retailers. It is reasonable since the e-tailer covers a broader market segment than retailers. The competitive retailers also face a more elastic demand curve with the entry of an e-tailer, implying more competition is being brought into the market with the new competitor, the e-tailer. Both the original and the change in the retailer’s demand curve are represented in figure 4 with their respective slope measures. The Nash equilibrium among the competitive retailers occurs at C where the average cost curve,
AC=c+F/q, meet the competitive demand curve with slope of -L/t. The new equilibrium with the e-tailer competing with retailers occurs at E where the average cost curve meets the new retail demand curve with slope of –2L/t.

When the e-tailer enters the market, the retailers face a more elastic demand curve and adjust to the change in the competitive environment by reducing their price until they meet the new demand curve. The retailer’s response is represented by a vertical drop from C to E in figure 4. Thus, they experience negative profit temporarily when the lower price does not bring more consumers at E. Some of the retailers close their businesses as the e-tailer applies more downward pressure on the retail price until it reaches the new equilibrium at E.

At the new equilibrium E, the remaining number of retailers face lower price but bigger market sales as shown in table 1. We have found a decrease in the number of retailers in the new equilibrium, which is not reflected in Balasubramanian (1998). The increased market sales proportionately compensate the retailers for the decreased price and hence the profit will remain at zero.

When the survival rates of retailers in different markets are compared as in table 2, we find that the survival rate of retailers in monopolistic market is greater than in a competitive market.

**Proposition 2** With the advent of the e-tailer, more retailers can survive in a monopolistic market than in a competitive market.

Compared to the competitive retailers, fewer monopoly retailers will exit the market. In our circular model with consumers uniformly distributed around the circle, the survival rate of the local monopoly retailers is between the 33.3% and
100% compared to between 23.5% and 71.7% for competitive retailers. The monopoly retailers are more likely to remain in the market than the competitive retailers since they have managed to keep the buyers loyal to their differentiated products and services. Their position of local monopoly doesn’t change as they face the same demand curve even after the e-tailer enters the market. There is already a fewer number of retailers in the monopoly market than in the competitive market. In contrast, the retailers in the competitive market have to face a tougher market environment with the e-tailer’s entry since they then face a monopoly demand curve instead of the competitive demand curve they faced before. Many competitive retailers exit the market by failing to adjust to the monopoly environment requiring more differentiation than the competitive market.

**Welfare Analysis**

The e-tailer’s entry into the market will have a positive impact on the consumer surplus by bringing about a decrease in retail prices and increase in varieties. However, it will also decrease the number of retailers in the market and limit consumer choices. Salop finds the optimal number of retailers to maximize the surplus is less than the equilibrium numbers of retailers in the competitive and monopoly market. He has argued that too much variety in the market would hurt scale economies and thus reduce the welfare of the society. However, it is also clear that too small a selection also hurts the welfare position.

**Proposition 3** The advent of the e-tailer increases the total welfare if the market sales of the e-tailer are less than a certain point \( \frac{5 - \sqrt{2}}{5 + \sqrt{2}} L \). However, if the e-tailer is too dominant and its market sales are greater than the threshold point \( \frac{5 - \sqrt{2}}{5 + \sqrt{2}} L \), the advent of the e-tailer reduces total welfare.

**Proof.** The welfare from the competitive market consists of the competitive retailer’s profit and the consumer surplus. Each retail brand serves to increase welfare up to the point where the net surplus to the marginal consumer at a distance \( x^C \) is zero. With \( N^C_r \) brands serving the market, the consumer surplus will be

\[
CS^C_r = N^C_r \left[ 2L \int_0^{x^C} v - tx - p^C_r \, dx \right]
\]

The social welfare is represented by

\[
W^C_r = N^C_r \left[ 2L \int_0^{x^C} v - tx - p^C_r \, dx \right] + \pi^C_r
\]

where \( \pi^C_r = 0 \). With solving process, we get the welfare of the competitive retail market \( W^C_r \) and the monopoly retail market \( W^M_r \) as

\[
W^C_r = (v - p^C_r) L - \frac{tL}{4N^C_r}; \quad W^M_r = (v - p^M_r) L - \frac{tL}{4N^M_r}
\]
Thus, the welfare difference between the monopoly and competitive market is

$$W_r^M - W_r^C = (p_r^C - p_r^M)L + \frac{tL}{4} \left( \frac{1}{N_r^C} - \frac{1}{N_r^M} \right)$$  \hspace{1cm} (21)$$

Substituting $N_r^C, p_r^C, N_r^M$, and $p_r^M$ of table 1 into (21) yields:

$$W_r^M - W_r^C = \frac{5 - 3\sqrt{2}}{4}\sqrt{tLF_r} > 0$$  \hspace{1cm} (22)$$

Thus, the welfare from a monopoly market is bigger than that of the competitive market. The results confirm that too much variety in the competitive market hurts the social welfare.

The welfare of the market with the e-tailer and retailers consists of the consumer surplus and profits of sellers. Each retail brand serves up to the point where the net surplus to the marginal consumer at the distance $x^E$ is zero. With $N_r^E$ brand serving the market, the consumer surplus from the retailers and the e-tailer will be:

$$CS_r^E = N_r^E \left[ 2L \int_0^{x^E} v - tx - p_r^E dx \right], \quad CS_e^E = N_r^E \left[ 2L \int_{\frac{1}{2N_r^E}}^{x^E} v - \mu - p_e^E dx \right]$$ \hspace{1cm} (23)$$

The profits of the sellers are shown in (13). We know $\pi_r^E = 0$ and expect $\pi_e^E \geq 0$ since the e-tailer would not enter the market where he expects negative profit. Note that our characterization of the e-tailer is not the same as the dot coms of the Internet bubble era.

The social welfare of the market with e-tailer and retailers is represented by:

$$W_r^E = N_r^E 2L \left[ \int_0^{x^E} v - tx - p_r^E dx + \int_{\frac{1}{2N_r^E}}^{x^E} v - \mu - p_e^E dx \right] + \pi_r^E + \pi_e^E$$

$$W_e = 2L \int_{\frac{1}{2N_r^E}}^{x^E} (v - \mu - p_e^E) - (v - tx - p_r^E) dx + \pi_e^E$$

$$W_r^E = N_r^E 2L \left[ \int_0^{x^E} v - tx - p_r^E dx \right] + w_e$$  \hspace{1cm} (24)$$

where $w_e = N_r^E 2L \int_{\frac{1}{2N_r^E}}^{x^E} (v - \mu - p_e^E) - (v - tx - p_r^E) dx + \pi_e^E$ which is the surplus of the e-tailer and consumers who choose to buy from the e-tailer. The consumers in the market segment $[x^E, \frac{1}{2N_r^E}]$ have chosen the e-tailer over the retailers. By the revealed preference, the consumer in that region has more surplus by using the e-tailer than the retailers, implying $w_e > 0$.

Solving the integration, we get the welfare as

$$W_r^E = (v - p_r^E)L - \frac{tL}{4N_r^E} + w_e$$  \hspace{1cm} (25)$$

The welfare difference between the market with and without e-tailer is

$$W_r^E - W_r^C = (p_r^C - p_r^E)L + \frac{tL}{4} \left( \frac{1}{N_r^C} - \frac{1}{N_r^E} \right) + w_e$$  \hspace{1cm} (26)$$
Substituting $N_r^C, p_r^C, N_r^E$, and $p_r^E$ of table 1 into the (26) yields

$$W_r^E - W_r^C = \frac{5 - 5\sqrt{2}}{4} \sqrt{tL \mu} + \frac{\mu L}{2} + W_0$$

(31)

The first right hand side term remains positive unless $\mu < \frac{5}{2} (\sqrt{2} - 1) \sqrt{\frac{tF_r}{L}}$. Thus, in general we find the welfare of the market increases after the e-tailer’s entry (for $0.517 < \mu \sqrt{\frac{L}{tF_r}} < 1.414$). As the disutility of using e-tailer decreases further than the critical value ($0 < \mu \sqrt{\frac{L}{tF_r}} < .517$), the welfare loss may eventually occur with a smaller value of $w_e$. Thus, the disutility level, which is smaller than the critical value, will result in a smaller number than the optimal number of retailers remaining in the market. The market equilibrium in this case does not prevent any social welfare loss. As we have found earlier, a larger selection of variety than the optimal level also hurts the economy.

By substituting the critical value of disutility into (11) and (13), we find the minimum number of competitive retailers to remain as $\frac{2}{5 + \sqrt{2}} N_r^C$ and the market sales of e-tailer as $\frac{5 - \sqrt{2}}{5 + \sqrt{2}} L$. (Q.E.D.)

As the e-tailer covers over 56% of the market in our model, consumers will suffer a loss of welfare since their preference loss from limited brand choices surpasses the gains from the price decrease due to economies of scale. There will also be welfare loss to society unless the e-tailer’s profit gain can cover the consumer’s loss.

On the contrary, the retailers will prevail in the market where consumers feel uncomfortable going on-line to purchase. It will make it difficult for the e-tailer to enter the market and more than the optimal number of retailers will remain in the market. Consumers and society will suffer a loss of welfare since they face higher prices with diseconomies of scale. The results support Salop’s finding that too much variety hurts the economy, but we also find that too little variety hurts the economy. The result provides the rationale for the policy to prevent over competition where the consumer access to the e-tailer is easy as well as under competition where access is difficult. The similar welfare analysis can be done for the entry of e-tailer into a monopoly market.

EMPIRICAL FINDINGS

Table 3 presents empirical data in various Korean retail markets including retail and e-tail for Computer and Related Products and so on. All retailers face competitive markets with large number of competitors. However, Cosmetics products market is less competitive with least number of retailers and Agro-Food market is more with more number of retailers compared to other markets. Clothing & Fashion products and Electronic Home Appliances show bigger e-tailer sales volume, and Agro-Food and Cosmetics products show smaller e-tail volume.

E-tailer has highest market share in Electric Home Appliances market with 17.38 % and lowest share in Agro-Food Products market with 0.26 % in 2006. The result support equilibrium outcomes in table where e-tailer market share should
stay in 0 to 66.7% range. E-tailer marker share conversely related to the inconvenience parameter using an e-tailer, which seemed to be supported by empirical data. Agro-Food market shows almost minimal share for e-tailer, and Clothing and Fashion product market next to it. Both products require customer inspection. Electronic Home Appliances and Book & Stationary market shows good market share for e-tailer. Both products are well standardized and delivered easily by e-tailers. Since none of e-tailer market share has gone over critical welfare threshold of proposition 3, the advent of the e-tailer should increase welfare of consumers and total social surplus. As consumers’ and social welfare increase, e-tailer market share is increasing all retail markets in Korea.

<table>
<thead>
<tr>
<th></th>
<th>Number of Retailers 2006</th>
<th>EC Market Volume ($ mil) 2006</th>
<th>e-tailer Market Share 2005 (%)</th>
<th>e-tail Market Share 2006 (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer &amp; Related</td>
<td>16,280</td>
<td>1,261</td>
<td>11.00</td>
<td>12.71</td>
</tr>
<tr>
<td>Electric Home Appliances</td>
<td>48,058</td>
<td>2,011</td>
<td>16.11</td>
<td>17.38</td>
</tr>
<tr>
<td>Books &amp; Stationary</td>
<td>26,038</td>
<td>758</td>
<td>13.33</td>
<td>15.82</td>
</tr>
<tr>
<td>Clothing &amp; Fashion</td>
<td>114,662</td>
<td>2,372</td>
<td>4.96</td>
<td>7.22</td>
</tr>
<tr>
<td>Cosmetics</td>
<td>14,702</td>
<td>699</td>
<td>8.65</td>
<td>9.94</td>
</tr>
<tr>
<td>Agro-Food</td>
<td>101,519</td>
<td>312</td>
<td>0.25</td>
<td>0.26</td>
</tr>
</tbody>
</table>

Table 3. Retailer vs. E-tailer, Various Markets in Korea


CONCLUSION

We have extended the circular market model by Salop to analyze the competition between conventional retailers and an e-tailer to answer to questions related to the impact of advent of e-tailers to traditional retailers and society. Our model has shown the new equilibrium for the market and useful insights for the adjustment by retailers with the entry of an e-tailer. The welfare analysis shows how the well-being of the society is affected by the introduction of e-commerce and provides policy implications for bringing proper e-tailers into the industry.

The e-tailer will more likely enter a less differentiated and competitive market. More retailers could keep their business with bigger retail brand differentiation, bigger disutility of on-line purchase, bigger market size, and smaller fixed cost. Once the new equilibrium between retailers and the e-tailer is achieved, the retailers will keep their distance from the e-
etailer in their target market and act as a local monopoly, regardless of the prior market structure. The results explain why industries with higher product differentiation are not conducive to e-commerce and why retailers in industries with strong e-tailers differentiate their products and services from the on-line retailers. The local travel agencies are now selling more packaged travel products than simple products such as airplane tickets.

In general, the entry of the e-tailer would increase the welfare of market. However, there will be consumer welfare loss in markets where the consumers experience too much difficulty to access the e-tailer. In our model with a uniform distribution of retailers, consumers will suffer a loss of welfare if the e-tailer covers over 56% of the market. As consumers have less variety of brands than optimal, their loss of preferences surpasses the gains by the price decrease obtained from economies of scale. There will also be welfare loss to society unless the e-tailer’s profit gain can cover the consumer’s loss. If the access to the e-tailer is limited, more than the optimal number of retailers will remain in the market. Then consumers and society will also suffer a loss of welfare since they face higher prices due to diseconomies of scale. The results support Salop’s finding that too much variety hurts the economy, but we also find that too little variety hurts the economy. This result provides the rationale for the policy to prevent welfare loss and maintain the optimal division of the market between retailers and e-tailer.

REFERENCES