

Ishikawa, Toshiharu

**Conference Paper**

## An analysis of the effects of the variety of items on the retailer's market areas and the urban system

53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy

**Provided in Cooperation with:**

European Regional Science Association (ERSA)

*Suggested Citation:* Ishikawa, Toshiharu (2013) : An analysis of the effects of the variety of items on the retailer's market areas and the urban system, 53rd Congress of the European Regional Science Association: "Regional Integration: Europe, the Mediterranean and the World Economy", 27-31 August 2013, Palermo, Italy, European Regional Science Association (ERSA), Louvain-la-Neuve

This Version is available at:

<https://hdl.handle.net/10419/123826>

**Standard-Nutzungsbedingungen:**

Die Dokumente auf EconStor dürfen zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden.

Sie dürfen die Dokumente nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, öffentlich zugänglich machen, vertreiben oder anderweitig nutzen.

Sofern die Verfasser die Dokumente unter Open-Content-Lizenzen (insbesondere CC-Lizenzen) zur Verfügung gestellt haben sollten, gelten abweichend von diesen Nutzungsbedingungen die in der dort genannten Lizenz gewährten Nutzungsrechte.

**Terms of use:**

*Documents in EconStor may be saved and copied for your personal and scholarly purposes.*

*You are not to copy documents for public or commercial purposes, to exhibit the documents publicly, to make them publicly available on the internet, or to distribute or otherwise use the documents in public.*

*If the documents have been made available under an Open Content Licence (especially Creative Commons Licences), you may exercise further usage rights as specified in the indicated licence.*

# An analysis of the effects of the variety of items on retailers' markets and urban system

Toshiharu Ishikawa

Faculty of economics Chuo University

Hachioji Tokyo, 192-0393 Japan

e-mail: ishiy@tamacc.chuo-u.ac.jp

## Abstract

Due to a decrease in transportation costs, a retailer can increase the number of items stocked at a store. Customers are more attracted to the retailer that provides a wider variety of goods. The level of the variety may influence the retailer's market area size. This paper, first, examines the effects of the number of items on the market area and market area boundary and it shows how increasing item of goods alters the shape of the market area boundary. Secondly, classifying the retailing stores into the three categories, convenience store, supermarket store, and department store, the paper examines their market situations in spatial free-entry equilibrium; it obtains the number of items, the average price of items, and the market size in spatial competitive equilibrium for each category. It is shown that the number of items at a convenience store decreases and the market area shrinks as the transportation costs reduce, while, in the cases of supermarket and the department store, the items increase and the market areas expand.

Thirdly, the paper examines the influence on the urban system of the enlargement of the department stores' market areas due to a decrease in transportation costs. By the expansion of their market areas, some of the department stores in the large and middle sized cities are forced to be expelled from the retailing market. It may lead that the tertiary function of some large cities which are ranked at the first level is reduced, and many cities ranked at the second level are seriously damaged. As a result, some of the urban systems become to be formed by a large city and many small cities. This result is inspected by an empirical analysis using the Japanese data in 1996-2006.

Keywords: Number of items, Market area boundary, Urban system,  
Spatial free-entry equilibrium,

JEL: R30.

## I Introduction

Decrease in transportation costs changes the retailers' market areas and locations. Since the retailers' location networks build the basic structure of the urban system, the decrease of transportation costs per mile alters the urban systems laid in regions. A mechanism in which the decrease in the transport costs alters the urban system is explained as follows: The decrease of the transport costs makes the mobility of retailing goods ease, and the number of variety at a store increases. Corresponding to the increase of variety of goods, consumers become to attach a deal of importance of the variety of goods sold by the retailers. The customers' taste of love of variety directs them to visit large cities where there are many retailers that are able to provide a wide of variety of items. Contrarily, consumers decrease to visit the medium sized cities which cannot supply enough variety of goods as much as large cities. Some of the medium cities, thus, cannot maintain the high retailing function so that they are forced to deal with daily commodities. Consequently, the medium cities from which the retailers come out fall into the group of small cities. As a result, some of the urban systems become to be formed by a large city and many small cities.

Reviewing the literature on the retailers' market areas, it is found that traditional theory mainly paid attention to the influence of the price and the freight rates of goods on the market areas<sup>1</sup>. There were a few works which examined the effects of the variety of goods on the retailers' markets<sup>2</sup>. From the end of the 1970s the analyses have increased which deal with the variety of items at stores and shopping malls by using the utility function developed by Dixit-Stiglitz (1977). These recent analyses have been providing the many significant insights about the role of the variety of items in spatial economy<sup>3</sup>. Nevertheless, it seems that the analyses which incorporate the variety of items into the traditional framework are useful. Because they make use of the existing tools and provide some meaningful insights and the derived results may complement those derived from the recent models.

This paper analyzes the relationships between the variety of goods at a store and retailer's market area: Incorporating the competition styles between the retailers and the concept of the average price of items into the model developed by Baumol-Ide (1956), it firstly examines the effects of the variety of items on the market area and the market boundary. And then, it derives the number of items, the average price of items, and the market area size in spatial free-entry equilibrium. In addition, utilizing the results

---

<sup>1</sup> For example, see Parr(1995)

<sup>2</sup> Baumol-Ide (1956) incorporates the variety of the retailing goods into the analysis of the firm's market size and quantity demanded in its market area.

<sup>3</sup> For example, see works of Henkel-Stahl-Walz(2000) and Peng-Tabuchi (2007).

derived here, it is clarified how the urban system is altered by the decrease of the transportation costs.

The paper is organized as follow: In the next Section II assumptions and the framework of the analysis are explained, and then, the retailer's profit function is derived. Based on the assumptions, it is inquired how the variety and the average price of items sold by a store influence the market area and alter the shape of border between competitive retailers' market areas. Section III examines the retailer's market situation in the equilibrium: it derives the number of items and their average price, and the market area size in spatial free-entry equilibrium. And then, it is shown that the equilibrium market area and the number of items are greatly different between the retailers' competition styles prevailed in the market. Section IV shows how the urban system is altered by the change of the retailers' market area sizes. The derived result is inspected by the using Japanese data in 1996-2006. Section V summarizes the conclusions obtained in the analyses.

## II Effects of variety of items on the market area boundary between the retailers

### 1 Assumptions of the analysis and derivation of the retailer's profit function

According to Baumol-Ide (1956) who systematically analyzed the relationships between the variety of items and the retailer's market area, following assumptions are made:

- (i) Consumers evenly live in a plain market area with density  $K$
- (ii) Retailers provide the number of items to consumers.
- (iii) The probability that the consumer visits a retailer becomes higher as the number of items increases. This provability,  $Z$ , is expressed by equation (1)<sup>4</sup>,

$$z(N) = (N/A)^\alpha \quad (1)$$

where  $N$  is the number of items and  $A$  and  $\alpha$  is positive parameter, respectively. And  $z(N)$  belongs to the range  $0 \leq z(N) \leq 1$ .

- (iv) While, in going to a retailer the customer incurs some costs: the difficulty of shopping increases with the congestion of the store and with the transportation costs to the store. The congestion level,  $J$ , increases with the number of items, and the transportation costs,  $S$ , increase with the distance to the retailer. The congestion is represented by equation,

---

<sup>4</sup> Baumol-Ide does not use a concrete function like equation (1).

$$J(N) = C_n N^\beta \quad (2)$$

Where  $C_n$  is marginal costs of congestion,  $\beta$  is positive parameter. The transportation cost is shown by equation (3),

$$S = tu \quad (3)$$

Where  $t$  is transportation costs per mile, and  $u$  is distance from a customer to the retailer's store.

- (v) The willingness of a customer to visit the retailer is influenced negatively by the average price of items,  $p$ , of items. This influence,  $Pa$ , is expressed by equation (4)<sup>5</sup>.

$$Pa(p) = \phi p^\phi \quad (4)$$

where  $\phi$  and  $\phi$  are positive parameters.

Based on these assumptions, a retailer's capacity of pulling customers,  $f$ , can be determined by the three factors, the number of items  $N$ , average price  $p$ , and distance  $u$ . And a retailer's capacity of pulling customers, that is, its traction power can be represented by equation (5),

$$f(N, p, u) = \omega (N/A)^\alpha - \nu (C_n N^\beta + tu + \phi p^\phi) \quad (5)$$

where  $\omega$  and  $\nu$  are positive parameters.

- (vi) The quantity demanded in a retailer's market area is proportional to the traction power of attracting customers to the store. When a retailer's market area is circle, the quantity demanded,  $Q$ , in the market area is expressed by equation (6),

$$Q = 2\pi \int_0^U \omega (N/A)^\alpha + \nu (tu + C_n N^\beta + \phi p^\phi) u du \quad (6)$$

where  $U$  is the radius of the circular market area. Since the average price of items is represented by  $p$ , the retailer's revenue,  $R_v$ , is derived by equation (7),

$$R_v = pQ. \quad (7)$$

---

<sup>5</sup> The average price of items is not incorporated into the analysis by Baumol-Ide.

(vii) Inventory costs of the retailer are shown by equation (8),

$$IC = (E/I)r + (I/2 + R)T, \quad (8)$$

where  $E$  is expected sales volume of all commodities per period,  $r$  is handling costs of reordering.  $I$  is the quantity ordered for inventory each time stocks are replaced.  $T$  is the warehousing costs per item per period and  $R$  is stock level at which inventory is replaced, that is, the stocks on hand fall to  $R$ , and the retailer replaces inventory. From equation (8), the optimal inventory,  $ICI$ , per item is derived by equation (9),

$$ICI = (2rTQ/N)^{0.5} + RT. \quad (9)$$

(viii) The fixed costs of the warehouse and the retail facility are shown by  $F$ . The dealing costs of goods are proportional to the number of items, and the costs are expressed as  $aN^{0.5}$ . The total costs of retailer are given by equation (10),

$$TC = N(2rTQ/N)^{0.5} + NRT + aN^{0.5} + F. \quad (10)$$

Finally, the retailer's profits,  $Y$ , is derived by equation (11),

$$Y = p(2\pi K U^2 (0.5(\omega(N/A)^\alpha - vC_n N^\beta - v\phi p^\phi) - vtU/3)) - N^{0.5} ((2rT(2\pi K U^2 (0.5(\omega(N/A)^\alpha - vC_n N^\beta - v\phi p^\phi) - vtU/3)))^{0.5} + a) - NRT - F \quad (11)$$

## 2 The effect of the variety of items on the market area

The purpose of this subsection is to analyze the change of the retailer's market area size and the market boundary when the variety of items is incorporated into consideration.

### 1) Analysis of the effect of the variety of items on the retailer's market area size

Assigning the following numerical values to the parameters in equation (5),  $\omega=45$ ,  $v=5.6667$ ,  $t=0.2$ ,  $C_n=1.2$ ,  $\alpha=0.26$ ,  $\beta=0.5$ ,  $\phi=0.2$ ,  $\phi=1.05$ , the retailer's capacity of pulling customers is shown by equation (12),

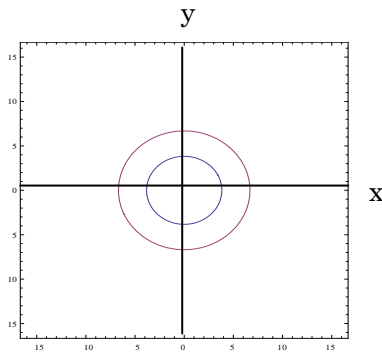
$$f(N,p,u) = 45(N/20)^{0.26} - 5.6667(0.2u + 1.2N^{0.5} + 0.2p^{1.05}) \quad (12)$$

When a retailer locates in a market field, the retailer's market area is formed by points at which the retailer's traction power of customers is zero; that is, equation (12) is zero. For example, suppose that the retailer locates at the origin of coordinates of x and y, and the number of items N is 0.5, the average price p is 4.0. The points at which the retailer's power to pull customers is zero are derived by solving equation (13) with respect to x and y,

$$f(x,y) = 45(0.5/20)^{0.26} - 5.6667(0.2(x^2 + y^2)^{0.5} + 1.2 \cdot 0.5^{0.5} + 0.2 \cdot 4^{1.05}) = 0 \quad (13)$$

In this case, the retailer's market area is indicated by a circle which is depicted by the larger circle in Figure 1. The radius, U, of the circle is 6.69. If the number of items N decreases to 0.1, the circular market area shrinks to the small circle with the radius of 3.83, which is shown by the smaller circle in Figure 1. Keeping the average price at the same level, the reduction in the number of items shrinks the market area by 95.53. This shrink area reveals the effect of the variety of items on the size of the market area.

Figure 1 Formation of a retailer's market area



## 2) Determination of the market area boundary

Let us suppose two rival retailers A and B in market area, and the retailer A and B locate at point (-2, 0) and (2, 0), respectively. In addition, it is assumed that the retailers' varieties of items are shown by  $N_A$  and  $N_B$ , their transportation costs per mile and the average prices are represented by  $t_A$ ,  $t_B$  and  $p_A$ ,  $p_B$ , respectively.

The market area boundary is formed by points where the retailers' powers to tract

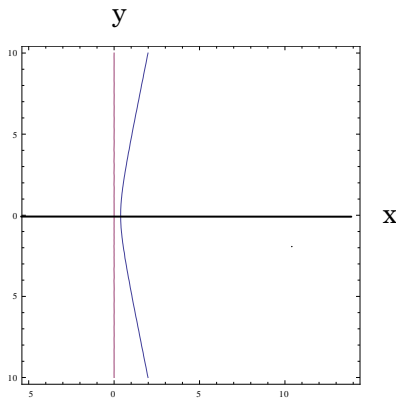
customers are the same<sup>6</sup>. Equation (14) must be satisfied at the market area boundary,

$$45(N_A / 20)^{0.26} - 5.6667(t_A((x+2)^2 + y^2)^{0.5} + 1.2N_A^{0.5} + 0.2p_A^{1.05}) =$$

$$45(N_B / 20)^{0.26} - 5.6667(t_B((x-2)^2 + y^2)^{0.5} + 1.2N_B^{0.5} + 0.2p_B^{1.05}) \quad (14)$$

Supposing that  $N_A = N_B = 0.98, t_A = t_B = 0.2, p_A = p_B = 1.1$ , the market area boundary is obtained from equation (14). In this case, the market area boundary is a straight line which is shown by the line in Figure 2. And then, when the number of items stocked at the retailer A increases from 0.98 to 1.27, keeping the average prices of both retailers at the same level, the boundary becomes hyperbola which is represented in Figure 2. The retailer expands its market area toward the retailer B. It is significant to know the fact that on this boundary the delivered average price level of the retailer A is higher than that of the retailer B, and since the retailer A provides more variety of items than the rival B, the retailer A occupies larger market area than the retailer B.

Figure 2 Market area boundaries indicated by a straight line and a hyperbola



Then, assume that retailer A and B locate at  $(-0.5, 0)$  and  $(0.5, 0)$ , respectively. And suppose that the number of items are the same between retailers,  $N_A = N_B = 0.98$ , while

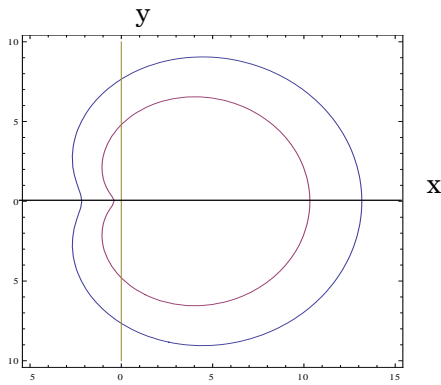
---

<sup>6</sup> It is known from traditional theory that the shapes of the market area boundary are the straight line, hyperbola, circle, limaçon and the curves which belong to ellipse family (Parr (1995), Ishikawa-Toda (2002)).



the average price and transportation costs per mile are different  $p_A = 2, p_B = 1.1, t_A = 0.2, t_B = 0.24$ . In this case the boundary is depicted by the small closed ellipse in Figure 3. The area enclosed by the small ellipse is the market area of the retailer B. When the number of items of the retailer B increases  $N_B = 1.37$ , the boundary expands to the large ellipse in Figure 3. The increase of the variety of items expands the market area of the retailer B. It can be said that incorporating the variety of items stocked at the stores into considerations gives the flexibility of the market area analyses and raise the ability to explain the location of the retailers in the real world.

Figure 3 Market area boundary indicated by ellipses



### III The retailer's market situation in spatial free-entry equilibrium

#### 1 The influence of the competition style on the equilibrium market situation

This subsection, assuming the free-entry competition is prevailed in the market field, derives the number of items, their average price and the market area size in a spatial free-entry equilibrium.

There are three conditions for a free-entry equilibrium to be established in a spatial free-entry market: Every retailer determines the number of items and the average price to maximize its profit. And new retailer comes into the market until the retailer's profits is just zero. These conditions are shown by equations (15), (16), and (17).

$$\frac{\partial Y}{dN} = \frac{\partial Y}{\partial N} + \frac{\partial Y}{\partial U} \cdot \frac{\partial U}{\partial N} = 0 \quad (15)$$

$$\partial Y/\partial p = \partial Y/\partial p + \partial Y/\partial U \cdot \partial U/\partial p = 0 \quad (16)$$

$$Y=0 \quad (17)$$

$\partial U/\partial N$  equation (15) represents the variation of the radius of the market area when a retailer changes the number of items by one unite,  $\partial U/\partial p$  in equation (16) the variation of the radius of the market area when a retailer changes the price by one unite.  $\partial U/\partial N$  and  $\partial U/\partial p$  are given by equation (18) and (19), respectively.

$$\partial U/\partial N = (((\omega/v)(\alpha/A^\alpha) N^{\alpha-1} - \beta C_n N^{\beta-1})/2t)(1 - dN'/dN) \quad (18)$$

$$\partial U/\partial p = ((1/2t)\phi\phi^{\phi-1})(1 - dp'/dp) \quad (19)$$

where  $N'$  in equation (18) is the rival retailer's number of items, and  $p'$  in equation (19) is the rival retailer's price.  $dN'/dN$  is the conjectural variation of the variety and  $dp'/dp$  is the conjectural variation of the price.

When the values of  $dN'/dN$  is equals 1, the Lösch competition type is indicated in terms of items. In this case, when a retailer increases an item at the store, the retailer conjectures that the rival also increases one item at its store. Similarly the  $dp'/dp$  is equals to 1, the Lösch competition type is indicated in terms of average price. When a retailer lowers average price by unite, it conjectures that the retailer conjectures that the rival lowers its price by unite. Assuming that the values of  $dN'/dN$  and  $dp'/dp$  are 1, and solving the simultaneous equations (15), (16), and (17) with respect to  $N$ ,  $p$ ,  $U$ , the number of items, the average price and market size in the Lösch equilibrium are obtained. When the values of  $dN'/dN$  and  $dp'/dp$  are assumed 0, it indicates Nash competition, and using the same way the values are obtained in the Nash equilibrium.

Let us equilibrium values in the Lösch and Nash equilibria, assigning the following numerical values to parameters;  $A=20$ ,  $F=20$ ,  $K=1.75$ ,  $R=5$ ,  $T=2$ ,  $a=0.15$ ,  $r=1.6$ ,  $\alpha=0.26$ ,  $\omega=45$ ,  $v=5.6667$ ,  $t=1.2$ ,  $\phi=0.2$ ,  $\phi = 1.05$ ,  $\beta=0.5$ ,  $C_n=1.2$ . First, the retailer's profit function  $Y$  is shown by equation (20).

$$Y = p(2 \cdot 3.14 \cdot 1.75U^2(0.5(45(N/20)^{0.26} - (5.6667 \cdot 1.2)N^{0.5} - (5.6667 \cdot 2p^{1.05})) - (5.6667 \cdot 1.2/3)U)) - 20 - N^{0.5}((2 \cdot 3.14 \cdot 1.75U^2(0.5(45(N/20)^{0.26} - 6.8N^{0.5} - (5.6667 \cdot 0.2p^{1.05})) - (5.6667 \cdot 1.2/3)U)))^{0.5} + 0.15) - N \cdot 5 \cdot 2$$

(20)

And  $\partial Y/\partial N$  and  $\partial Y/\partial p$  are given by equations (21) and (22),

$$\begin{aligned} \partial Y/\partial N = & -10 + 5.49778 (5.3693/N^{0.74} - 3.40002/N^{0.5}) p U^2 - (2.09719 \\ & (5.3693/N^{0.74} - 3.4/N^{0.5}) N^{0.5} U^2) / ((0.5 (20.6512 N^{0.26} - 6.8 N^{0.5} - 1.13334 \\ & p^{1.05}) - 2.26668 U) U^2)^{0.5} - (0.5 (0.15 + 8.38878 ((0.5 (20.6512 N^{0.26} - 6.8 \\ & N^{0.5} - 1.13334 p^{1.05}) - 2.26668 U) U^2)^{0.5})) / N^{0.5} \end{aligned} \quad (21)$$

$$\begin{aligned} \partial Y/\partial p = & -6.5424 p^{1.05} U^2 + 10.9956 (0.5 (20.6512 N^{0.26} - 6.80004 N^{0.5} - 1.13334 \\ & p^{1.05}) - 2.26668 U) U^2 + (2.49568 N^{0.5} p^{0.05} U^2) / ((0.5 (20.6512 N^{0.26} - 6.8 \\ & N^{0.5} - 1.13334 p^{1.05}) - 2.26668 U) U^2)^{0.5} \end{aligned} \quad (22)$$

Lastly, the term of  $\partial Y/\partial U$  in equations (15) and (16) is derived as equation (23),

$$\begin{aligned} \partial Y/\partial U = & 21.9911 p (0.5 (20.6512 N^{0.26} - 6.80004 N^{0.5} - 1.13334 p^{1.05}) - 2.26668 \\ & U) U - 24.9234 p U^2 - (4.19439 N^{0.5} (2 (0.5 (20.6512 N^{0.26} - 6.8 N^{0.5} - 1.13334 \\ & p^{1.05}) - 2.26668 U) U - 2.26668 U^2)) / ((0.5 (20.6512 N^{0.26} - 6.8 N^{0.5} - 1.13334 \\ & p^{1.05}) - 2.26668 U) U^2)^{0.5} \end{aligned} \quad (23)$$

Now, using the above four equations (20) ~ (23), equations (15), (16), and (17) are rewritten to be calculable. Solving the simultaneous equations system (15), (16), and (17) with respect to N, p, U gives the equilibrium number of items, average price, and market size. The equilibrium values are shown in Table 1.

Table 1 The equilibrium number of items, average price, and market size

Style	item, N	average price, p	market size, U
Lösch	1.081	4.894	0.506
Nash	2.822	7.011	0.659

When the transportation costs per mile t lower from 1.2 to 0.2, the equilibrium values of

the retailer are changed. In this case the equilibrium values are shown in Table 2.

Table 2 The equilibrium values when the transportation costs is low

Style	item, N	average price, p	market size, U
Lösch	0.881	5.491	0.422
Nash	5.188	10.941	1.035

By comparing the figures shown in Table 1 and 2, it is found that the number of items in Nash equilibrium is higher than that of Lösch equilibrium, the average price in Nash is lower than Lösch, and the market size in Nash is larger than Lösch. In addition, the changes of the equilibrium values due to the decrease in transportation costs per mile are different according to the competition style between the retailers. When the Lösch competition is prevailed between the retailers, as the transport costs is the lower, the number of items decreases and the market size shrinks, while in Nash competition the number of items becomes increases and the market size expands. It is possible from the results obtained in the above analysis to characterize the two competition styles:

- (1) The Lösch competition is a style to invite the new retailers to the market since the market area of the retailer becomes small and the variety of goods decreases due to the decrease in the transportation costs.
- (2) While the Nash completion is a style to expel the existing retailers from the market since the retailer's market area becomes large and the variety of goods increases due to the decrease in the transportation costs

## 2 Changes of the number of items and market size by decreasing transport costs

Now, the retailing types in the real world can be roughly classified into the three categories, convenience store, supermarket store, and department store. It would be possible to assign the conjectural variation of item and price to the competition style prevailed in each category:

The distances among convenience stores are short and they deal with small and light goods with low prices. Thus the conjectural variation of item and price would be assumed as  $dp'/dp=1$  and  $dN'/dN=1$ , that is Lösch competition style.

The distances among supermarkets are relatively long and they deal with daily goods with low and medium prices. Then it would be possible to assume that the conjectural variation of the average price is  $dp'/dp=1$ , and the conjectural variation of the item is  $dN'/dN=0.75$ . Supermarket store assumes that when it changes the number of items by

one unit, it assumes that the rival store changes the number of items by 0.75 since the rival cannot immediately change the number of items to the same level.

Lastly, it would be assumed in the case of department stores that the conjectural variations are  $dp'/dp = -0.5$  and  $dN'/dN = -0.25$ . Because the customers to visit a department store to purchase the goods with high prices and they attach the great importance to their taste. The department store attempts to provide many varieties of goods and plans to sell the goods differentiated from rivals' ones. Thus, the department store assumes that against the change of the number of items and the average price of the store, the rival does not respond like supermarket store: Conversely, the rival takes the opposite response. Hence in this analysis it is assumed that the department store set the conjectural variations of items and price as  $dp'/dp = -0.5$  and  $dN'/dN = -0.25$  in order to maximize its profits<sup>7</sup>.

Now, since the fixed costs, the number of the varieties and some parameters' values seems to be different between the three retailing types, this section supposes that for the convenient stores  $F=5, A=20, R=5, r=1.5, \omega=40$ ; for supermarket stores  $F=27, A=20, R=20, r=1.5, \omega=42$ ; and for the department stores  $F=30, A=16, R=10, r=1.7, \omega=46$ . Other values of parameters are assumed to be the same for simplicity of the analysis. Lowering the transportation costs per mile from 0.6 to 0.2, the equilibrium market values are derived for the three retailing types at each level of the transportation costs. The results are shown by Table 3A, B, C, respectively.

The comparison of the figures shown in these three Tables gives the following interesting facts: the market area of the convenience store becomes smaller and the number of variety stocked in the store decreases as the transportation costs per mile lowers. The market area of the supermarket store becomes smaller until transportation costs per mile lower to 0.4 and it begins to expand by the reduction in the costs, and the number of items stocked in the store increases by the decreasing transportation costs. The number of the items stocked in the department store increases and its market area expands as the transportation costs per mile lowers.

It is interesting to know that the changes of the number of the items and the market area size of retailers, which are raised by the decrease in the transportation costs, are different between the retailing types.

Table 3A The changes of the equilibrium values of the convenience store

---

t	N	p	U
---	---	---	---

---

<sup>7</sup> Schöler, K. (1993) shows the cases that the conjectural variation of price takes minus value.

0.6	0.140	1.883	0.391
0.5	0.136	1.914	0.382
0.4	0.132	1.945	0.374
0.3	0.129	1.974	0.367
0.2	0.126	2.002	0.360

Table 3B The changes of the equilibrium values of the supermarket store

t	N	p	U
0.6	0.689	4.211	0.738
0.5	0.822	4.550	0.731
0.4	0.847	4.585	0.712
0.3	1.056	4.831	0.720
0.2	1.389	5.097	0.745

Table 3C The changes of the equilibrium values of the department store

t	N	p	U
0.6	5.085	10.763	0.979
0.5	5.471	11.229	1.036
0.4	5.912	11.724	1.113
0.3	6.424	12.262	1.224
0.2	7.042	12.864	1.402

### 3 The difference of the traction powers at a store and the market boundary

This subsection examines the retailer's capacity to pull customers, traction power, at a store's location and the market area boundary. Figure 4 illustrates the traction powers at store's location for the three kinds of retailers to the six transport cost levels from 0.6 to 0.2. The supermarket store's traction power, which is indicated by brown square, is the highest between three kinds of stores. And its traction power change like U shape as the transport costs decrease. The department store's traction power, which is green triangle,

is the lowest between them. The convenience store's power, which is shown by blue diamond, is in between three kinds of stores. Both of them decrease as the transport costs reduce.

Figure 5 illustrates the traction powers at the market area boundary for each kind of retailers to the six transport cost levels. The supermarket store's traction power is the highest between three kinds of stores. And its traction power increases as the transport costs decrease. The department store's traction power is the lowest between them. The traction powers of both supermarket store and convenience store increase as the transport costs decreases. The department store's power decreases as the transport costs reduces.

Figure 4. Retailers' capacity to pull customer at a store

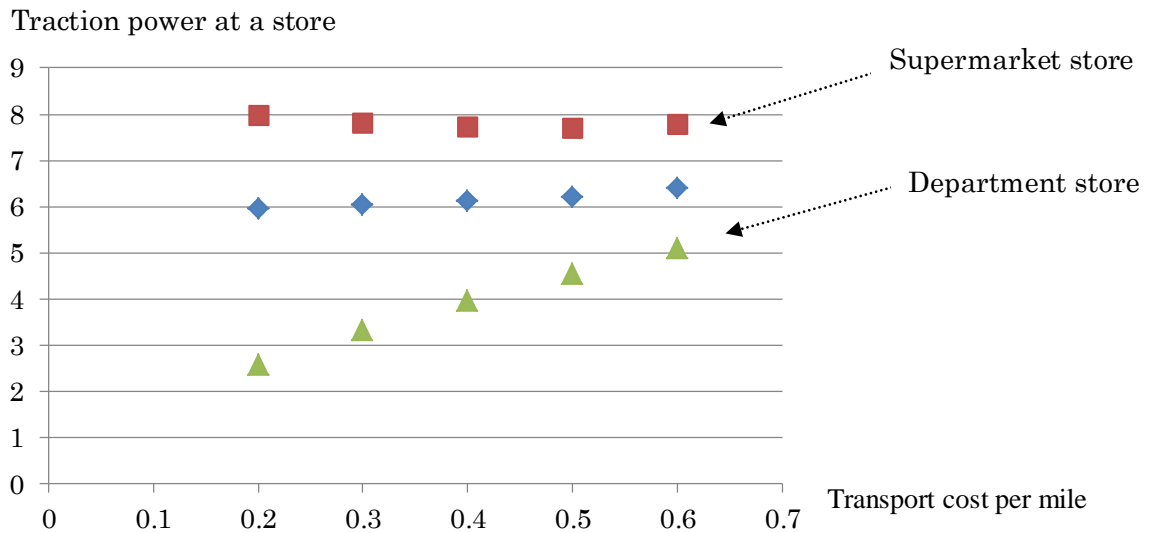


Figure 5. Retailers' capacity to pull customer at boundary

Traction power at boundary

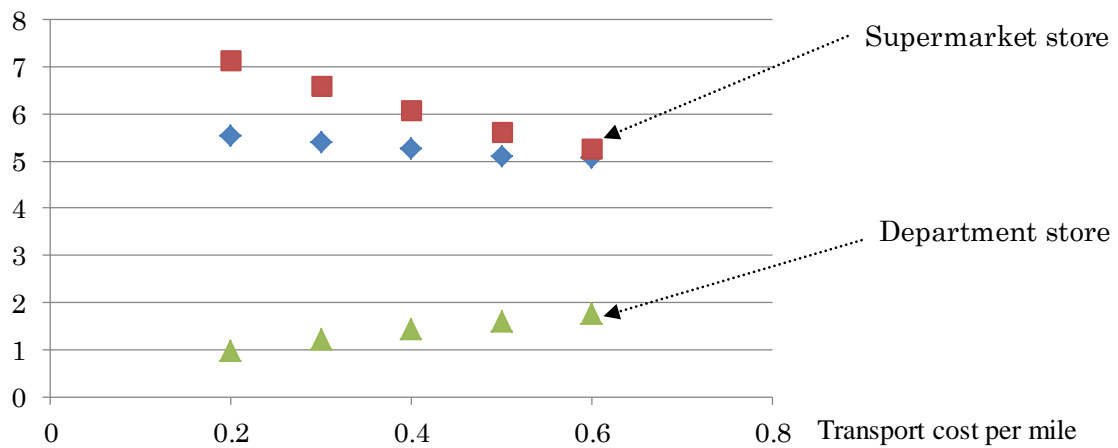
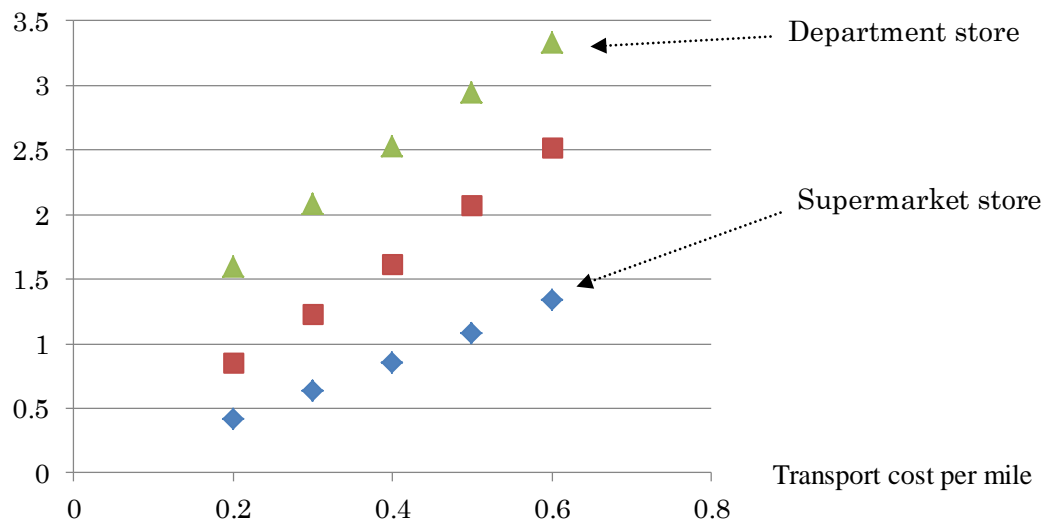


Figure 6 shows the difference between the traction powers at a store and its market area boundary for the three kinds of retailers to the six transport cost levels from 0.6 to 0.2. The difference of the traction powers of the every kind of retailer becomes shorter as the transport costs reduce. Although the directions of the change of the number of items, market size, and price of goods are different between the three kinds of stores, there is a common trend between them: the difference of the traction powers at stores' location and the market area boundary becomes shorter as the transportation costs decreases.

Figure 6. Difference of the traction powers at a store and the boundary

Difference of the traction power



#### IV Polarization of the location distribution of the retailers in the urban system



## 1 A theoretical hypothesis on the urban system

As transport costs fall, the equilibrium market areas of the department stores become larger. The expansion of these market areas decisively changes the location pattern of these stores. Hence, the location change of the department stores gives a crucially serious impact on the retailing structure in the urban system: It is considered that when the department store must expand its market area to survive in the market field, some department stores at large city are relatively ease to enlarge its market area to the necessitated size since a large city takes some advantages to attract potential consumers: While, since the middle-sized cities do not have the same traction capacity as a large city, many department stores in the middle-sized cities do not easily secure necessary market area and the number of items. Thus, many department stores in the medium cities must reduce the retail function to deal with daily commodities which are provided by a supermarket store, and some of them are forced to come out of these cities.

Because the department stores usually have played a representative role in the tertiary sector of the cities, the decay of these stores in the middle sized cities seriously damages the retail activity in the medium cities, It can be inferred that due to the decline of the medium cities, the location distribution of the retailing stores in a region becomes divided into a large city and many small cities. And then, the change of the retail structure of the urban system in a region generates many urban systems which are composed with a large city providing many varieties of goods and many small cities dealing with daily goods.

## 2 Test of the hypothesis by an empirical analysis of Japanese urban system

In order to test the above hypothesis, the data of Japanese cities' retailing workers in 1996 and 2006 are used. Assuming Japan as a whole covered by an urban system, it is examined how the medium cities' shares of the retailing workers declined in this period<sup>8</sup>.

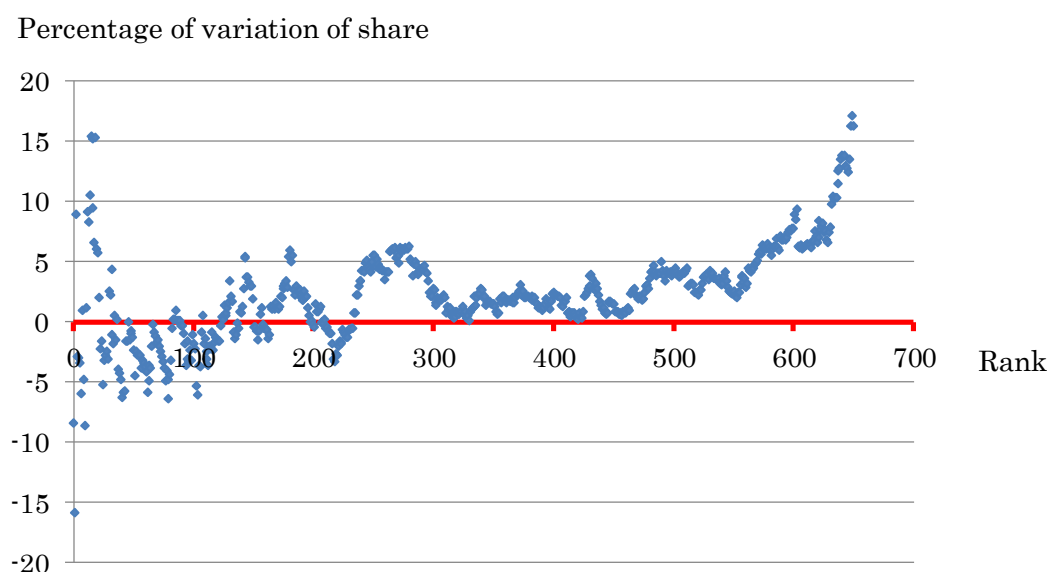
This examination is conducted as follows. (1) All cities' shares of the workers in the tertiary sector are derived in 1996. (2) The cities are ranked from 1<sup>st</sup> to 650<sup>th</sup> in 1996 with large share. (3) The same procedures are taken as of 2006. (4) The share variation between the two years of the same ranked city' share are derived<sup>9</sup>. Figure 7 illustrates the percentage of share variation of each ranked city from the 1<sup>st</sup> to the 650<sup>th</sup>.

---

<sup>8</sup> The data of the retailing workers are provided by the data book (Toyo keizai, 1998 and 2008).

<sup>9</sup> Note that the variation is not derived by the comparison of the two shares of the same city. But it is derived by the comparison of the two shares of the same *ranked* city.

Figure 7 Decrease in the middle cities' share of workers of the tertiary (1996~2006)



Note : Chiiki keizaisoran( Data book, Japanese),1998,2008.

Viewing the range from the 1<sup>st</sup> to the 40<sup>th</sup>, some large cities increase in their shares of retailing works, others decrease in their shores. Almost all cities in the range from the 50<sup>th</sup> to the 120<sup>th</sup> decrease their shores and also the cities listed around 220<sup>nd</sup> reduce the share. All cities ranked lower than the 220<sup>th</sup> increase their shares. That is to say, some relatively large cities decrease the share of retailing workers; especially the cities ranked the second level in Japan greatly reduce the share of the retailing workers. It is considered that these changes shown in figure 7 are partly caused by the decay of the large retailing firms located at relatively large cities which are greatly influenced by the decrease of transportation costs.

#### V Concluding remarks

Due to a decrease in the transportation cost, the retailers become to be able to deal with many kinds of goods and to increase the number of items stocked at the stores. Corresponding to the increase of items stocked at stores, the customers are attracted to the retailer that provides a wide of verities of goods. Hence, besides of the price of goods, the number of items influences the retailer's market area. Thus, this paper examines the effects of the number of items on the market area and it shows how the increase of the number of items alters the market area boundary. Secondly, classifying the retailers' stores into the three categories, convenience store, supermarket store, and

department store, the paper analyzes the number of items, the average price of items and the market size in free-entry equilibrium. It is shown in this analysis that in the category of the convenience store, the number of items decreases and the market area shrinks as the transportation costs reduce, while, in the categories of the supermarket and the department store, the number of items increases and the market area expands due to the decrease in transportation costs.

The fact that a decrease in the transportation costs expands the necessitated size of the market area of the retailers is crucially important to the retailing structure of the urban system. Because the decreasing transportation costs expel some department stores from the large and middle-sized cities and damage the tertiary function of these cities. It causes the relatively large cities' economic activity decay. As a result, many urban systems become to be formed by one large city and many small cities. This obtained result may be supported by an empirical analysis using the Japanese data. The conclusions derived in this paper are worth studying by detail methods.

## References

- Baumol, W.J. and Ide, E.A. (1956) Variety in retailing, *Management Science* 3, pp.93-101.
- Dixit, A.K., and J.Stiglitz, (1977) Monopolistic competition and optimal product diversity, *American Economic Review*, 67, pp.297-308.
- Ishikawa, T. and M. Toda, (1998) An application of the frontier price concept in spatial equilibrium analysis, *Urban Studies*, 35, 8, pp.1345-1358.
- Ishikawa, T. and M. Toda, (2002) On the optimal locational policy for the offshore firm entering a foreign market area, *Canadian Journal of Regional Science*, Vol.25,3, pp.355-375.
- Henkel, J.K. Stahl and U. Walz (2000) "Coalition building in a spatial economy," *Journal of Urban Economics*, 47, 136-163.
- Lösch, A. (1940) *Die räumliche Ordnung der Wirtschaft*, G. Fischer.
- Parr, J.B. (1995) The Economic Law of Market Areas: A Further Discussion, *Journal of Regional Science*, 35, 599-615.
- Peng, S.K. and T. Tabuch (2007) "Spatial competition in variety and number of stores," *Journal of Economics and Management Strategy*, 16, pp.227-250.
- Toyo Keizai (1998, 2008) *Chiikikeizai Soran* (Data Book, in Japanese). Tokyo.