HOW TRANSPORT IMPROVEMENT CHANGES CONSUMER WELFARE THROUGH CHANGES IN RETAIL STORE LOCATION

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ABSTRACT

Concentration or hollowing-out of retail stores is the result of market interactions. If it involves market failures, then the spatial location equilibrium of retail stores is not optimal in terms of social welfare. We investigate two important market failures involving retail store location: "monopolistic competition among retail stores" and "shopping externality caused by multipurpose shopping". Retail store locations in market equilibrium and in a social optimum are derived. Moreover, we derive the mechanism by which transport improvement changes the store location using comparative statics.

Keywords: hollowing-out, monopolistic competition, shopping externality

1. INTRODUCTION

Hollowing-out of urban center commerce has proceeded apace in the past few decades. Retail store location is footloose: locations are not so constrained by inputs such as resources and labor supplies. Large markets are more attractive for retail stores. Their profit-seeking location brings concentration of many kinds of retail stores in urban areas. Therefore, a main cause of the recent hollowing-out is the suburbanization of commerce which results from motorization, improvement of transportation network, and the expansion of suburban areas over the last few decades.

The spatial allocation of retail stores, such as concentration and hollowing-out, is an outcome of market equilibrium. The allocation is socially optimal if no market failure occurs. However, because market failures of several kinds exist in any real economy, the allocation is not socially optimal. Accordingly, retail store location should be controlled from the perspective of social welfare in a real economy.[1]

Hollowing-out of urban center commerce is not optimal if it involves technological externalities attributed to market failures. In fact, the relevant literature has described several factors of market failure in commerce: 1) spatial price competition of commercial location, 2) imperfect competition among retail stores, and 3) shopping externality (O'Sullivan (1993)) caused by multipurpose (one-stop) shopping.

1) "Spatial price competition of commercial locations" is a phenomenon among firms that supply a homogeneous good. Hotelling's "ice cream vendor" problems (Hotelling (1929)) serve as illustrative examples. Each firm decides its price and the location under the prevailing competition with neighboring firms in the market area. Spatial price competition is examined in many studies using the framework of that model (see e.g., Cappoza and Order (1978), Anderson, de Palma and Thisse (1992), and Beckmann (1999)). However, although this spatial competition framework can represent competition among suburban retail stores such as same-sized shopping malls, gas stations, and convenience stores, it is not useful for treating goods of various kinds supplied in the urban center and suburban areas. Therefore, we investigate the two remaining factors of market failure.

We review 2) "Imperfect competition among retail stores". Indeed agglomeration of retail stores is advantageous for each because it creates an attractive area for consumption and more consumers visit the region. However, it can be disadvantageous for each; agglomeration of retail stores brings competition of other retail stores. In an urban center, widely various retail stores locate and mutually compete for profits. Such a competitive framework is monopolistic competition. With price competition, each retail store differentiates its services and assortment to compete with other retail stores.

Therefore the monopolistic competition model is suitable for representing the location of differentiated retail stores. Monopolistic competition is modeled by Dixit and Stiglitz (1977). The Dixit–Stiglitz model has already been used in many papers for analyses of various problems related to spatial issues[2]. The formulation of monopolistic competition in our model follows that of Fujita et al. (1999).

We review 3) "shopping externality (O'Sullivan (1993)) caused by multipurpose (one-stop) shopping". If different categories of retail stores are agglomerated in one region, then consumers can purchase goods of several kinds with one trip, which is so-called "multipurpose shopping" or "one-stop shopping". Consequently, agglomeration of retail stores provides a positive externality for consumers, which was designated as the "shopping externality" (but not fully demonstrated with a model) by O'Sullivan (1993).

Some papers have explained the mechanics generating commercial agglomeration by the existence of shopping externality. Wolinsky (1983) explains information asymmetries between stores and consumers cause a commercial agglomeration that sells imperfectly

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[1] In the United States, the suburbanization of cities advanced explosively during the 1970s, but it was followed by the decay of city centers. In Germany and France in the 1970s, the necessity for revitalization of city centers was a common theme for policymakers and researchers. It remains an important policy issue in the United Kingdom. Following such trends in the US and Europe, since regulations of commercial development in suburban areas were loosened in Japan in the 1990s, the hollowing-out of urban center's commerce in most small cities has become an increasingly important social issue.

[2] See, e.g., Fujita et al. (1999) and Baldwin et al. (2003).

substitute goods. Information asymmetries mean that consumers do not know the price and the quality of goods perfectly until they visit each store. De Palma et al. (1985) describe that the agglomerated configuration of three or more retail stores at the market center is stable in a Hotelling location model if goods are sufficiently differentiated and if the transport costs are sufficiently low. Ago (2008) presents the same result as that of de Palma et al. (1985) in the case of monopolistic competition. These papers present interesting implications for the formation of agglomeration. Ago (2008) demonstrates that monopolistic competition is a cause of agglomeration of firms under a Hotelling location model. However, he does not address shopping externality, which is one cause of agglomeration of retail stores. Additionally, neither addresses the change in utility level by transportation improvement, which the current paper targets.

In our shopping behavior, we spend much time and cost to obtain some of our favorite goods. Therefore consumers have the benefit of saving the cost of window-shopping for comparison of goods if there is a commercial agglomeration that sells imperfectly substitute goods. Accordingly, the shopping externality has a much greater impact on our choice of shopping place. Furthermore, if a commercial agglomeration sells complementary goods, then consumers have the benefit of purchasing goods of several kinds in one-stop shopping and can therefore save transport costs. These merits for consumers increase the demand accruing to neighboring stores.

Such shopping behavior of consumers is modeled in the previous literature (see e.g., Hanson (1980), Mulligan (1985, 1987), and Ingene and Ghosh (1990)). Our model, proposed in Section 2, specifically examines one-stop shopping behavior in the same manner as many previous studies have done[3]. Some analyze retail store location. For example, Eaton and Lipsey (1982) show the mechanism of retail store agglomeration caused by one-stop shopping behavior. Henkel et al. (2000) model one-stop shopping behavior to analyze coalition formation among retail service suppliers. Tabuchi (2009) models self-organization marketplaces under a one-stop shopping situation. Our research is related to social welfare in market equilibrium and in social optimum in addition to retail store location.

The existence of these two factors of market failure, monopolistic competition and shopping externality, brings socially “non-optimal” spatial allocation of retail stores in market equilibrium. As described above, these two factors are general and fundamental in an environment of retail store competition and consumer shopping activity. Our research objective is to analyze how these two factors affect consumer welfare through the change in retail store location caused by transport improvement.In the following, we first outline the model in Section 2. Then, we derive retail stores’ location in market equilibrium and in social optimum. Second we derive how transport improvement changes consumers’ welfare depending on the retail store location by comparative statics with respect to transport cost in Section 3. Section 4 explains how social welfare changes with respect to transport improvement through the change in retail store location. Section 5 concludes the paper.

[3] Several papers model such consumer behaviour with random utility frameworks (see e.g. Popkowski et al. (2004) and Sinha (2000)) or the hazard model (see e.g. Popkowski et al. (2000)). In these models, all consumers buy goods at all shopping clusters scattered geographically. However, as Christaller (1933) modeled the hierarchical marketplace, a large marketplace usually has all kinds of products supplied in a smaller marketplace. In this case, modelling one-stop shopping behavior is sufficient for our manuscript’s purpose by appropriately adjusting the time interval.

2. MODEL

PICTURE OF THE CITY

For simplicity, we consider a linear residential area, which is expressed as a line segment where homogeneous consumers are distributed uniformly and continuously. The total population of consumers is fixed as $\bar{N}$. Each person resides on a plot of land, the length of which is normalized to 1. Consequently, the length of the line segment is equivalent to $\bar{N}$.

Each of the two ends of the interposed residential area has a transportation facility to a commercial area. Figure 1 shows that the transportation facilities are represented as "TF1" and "TF2". The two commercial areas are called, respectively, "region 1" and "region 2". Retail stores locate in the two commerce regions 1 and 2. However, they are not allowed to locate in the housing area. In real cities also, zoning regulations restrict large-size store locations in housing areas. Moreover, most cities have a center commerce area and suburban shopping centers. The two commerce regions in the model can be interpreted as them. In both regions, retail stores locate in the existence of monopolistic competition[5]. Considering the transport cost and the variety of the commodities that are supplied, each consumer purchases goods at either region. No congestion arises in relation to their shopping trips.

For convenience of our consideration, we merely assume that region 1 is an urban center, whereas region 2 is on the outskirts of a city. However, no technical difference exists among retail stores in region 1 and 2 in the model. The exchange of 1 and 2 does not influence the following analysis.

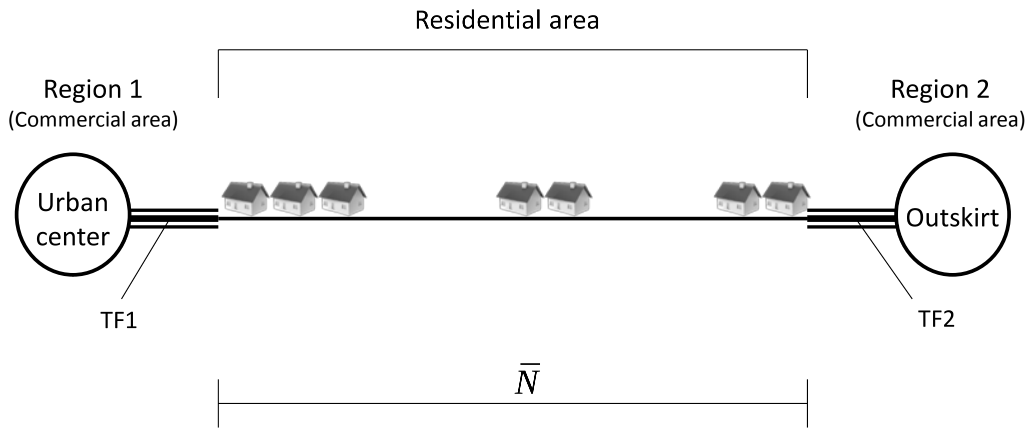

***FIGURE 1** – Shape of the City.*

[5] For simplification, we do not model the land market of commercial areas. In our model, retail stores can locate anywhere with no land rent. Our conclusions are fundamentally identical to those in the case in which the land market is introduced into the model if no market failure exists in the land market.

Transport cost

Transportation in the residential area and transportation facilities TF1 and TF2 requires some monetary expense, although it is costless in commercial areas[6]. It invariably compels consumers to purchase widely various goods during one shopping trip to save transport costs between the residence and the commercial area. The greater the amount of goods obtained in one shopping trip, the lower the transport cost per good. Put differently, scale economies relate to the consumers' shopping trips. To save their transportation cost, rational consumers purchase goods of many kinds in one shopping trip.

It is assumed that the transport cost per unit distance in the residential area is one, and that the travel cost of TF1 is t_1, and that of TF2 is t_2. Therefore, for the *nth* consumer from region 1, the respective transport costs $L_1(n)$ for region 1 and $L_2(n)$ for region 2 are given as $L_1(n) = n + t_1$ and $L_2(n) = (\bar{N} - n) + t_2$.

Consumer behaviour

In our model, we specifically examine consumers' one shopping behaviour in a certain fixed time interval, as assumed by Eaton and Lipsey (1982). Each consumer shares a log linear utility function:

$$V_i = \mu \ln M_i + (1-\mu) \ln A_i . \tag{1}$$

Therein, subscript i means that the consumer shops in region i, M_i represents a composite index of the consumption of commercial goods[7], A_i denotes the consumption of a numeraire good of which the price is one, and μ signifies a constant representing the expenditure share of commercial goods. The quantity index, M_i, is a sub-utility function defined over a continuum of varieties of commercial goods. In addition, $m_i(x)$ denotes the consumption of each available variety; f_i stands for the number of goods sold at region i, which is equivalent to the number of retail stores, and σ is the elasticity of substitution between any two varieties. We assume that M_i is defined by a constant elasticity of substitution (CES) function[8]:

$$M_i = \left[\int_0^{f_i} m_i(x)^{\sigma-1/\sigma} dx \right]^{\sigma/\sigma-1} .$$

[6] There is sufficient distance between the residential area and commercial area in usual therefore consumers spend a certain amount of transportation cost. However, in a commercial area, they will have lower transportation costs because retail stores are agglomerated. Our simplification is based on such circumstances.

[7] Horizontally differentiated goods are goods that have elasticity of substitution with each other. In a real economy, a large number of retail stores supply quite a variety of goods: food, clothes, electronic equipment, furniture, and so on. Some have no elasticity of substitution with other goods. We specifically examine retail stores, which supply horizontally differentiated goods. Other goods are regarded as numeraire goods in the same manner as described in the literature (see e.g. Tabuchi (2009)).

[8] We specify the utility function, the production funcition and the travel cost function for simple analysis. The results of our analysis are not essentially changed as far as the indirect utility funtion -which is derived in Section 3- is concave with regard to the number of consumers.

Given income Y and price $p_i(x)$ for each commercial good, and transport costs for region i, the consumers' budget constraint is

$$A_i + \int_0^{f_i} p_i(x) m_i(x)\,dx + L_i(n) = Y .$$

The *nth* consumers' utility maximization is represented as shown below.

$$\max_{M_i, A_i} V_i \qquad s.t.\ A_i + G_i M_i + L_i(n) = Y \tag{2}$$

Therein, G_i is the price index of commercial goods supplied in region i. Because it is assumed that no technical difference exists among retail stores, all commercial goods are sold at the same price p^*. Therefore, G_i is represented as presented below.

$$G_i = \left[\int_0^{f_i} p(x)^{1-\sigma}\,dx \right]^{1/1-\sigma} = p^* f_i^{\frac{1}{1-\sigma}} \tag{3}$$

Maximized utility by consumers' utility maximization (2), is expressed as a function of income, price of retail stores and number of goods, giving the indirect utility function of

$$V_i = \ln\left(\frac{\mu}{p^*}\right)^{\mu} (1-\mu)^{1-\mu} + \ln(Y - L_i) + \frac{\mu}{\sigma - 1} \ln f_i . \tag{4}$$

Equation (4) is derived from maximizing the utility of a *nth* consumer who goes shopping in region i. The first term in eq. (4) is a function of the good price; the second term is that of income. The third term is that of the number of kinds of goods. In eq. (4), L_i is a function of n, which represents the place where the consumer lives, whereas f_i is a function of market boundary b (see Appendix A). Therefore we have

$$V_i \equiv V_i(n, b),$$

which is a utility function of a *n*th consumer to visit region i when the market boundary is b.

Retail store behaviour

Each retail store supplies a horizontally differentiated good under conditions of free entry and exit. Under monopolistic competition, they do not supply the same kind of good as the others. Therefore, their number in a region is equivalent to the number of kinds of goods.

Their technology is the same in both regions: it involves a fixed input cost F and marginal input cost requirement c. Consequently, the production of a quantity q of any good at any location requires the cost given as $F + cq$.

Considering a particular retail store supplying a specific good, its profit, π, is given as

$$\pi = pq - F - cq ,$$

where p is the mill price. Its price index, G_i, is given for each retail store because it is determined by all the retail stores in region i. So, an effect of the price of each store on G_i is negligible. The perceived elasticity of demand is therefore σ,. Consequently, the first order condition of profit maximization implies that equilibrium price p^* is

$$p^* = \frac{\sigma}{\sigma - 1} c \qquad (5)$$

for all retail stores. Given the pricing rule, the profit is

$$\pi = \frac{1}{\sigma - 1} cq - F .$$

Therefore, the zero-profit condition implies that equilibrium output q^* is

$$q^* = \frac{F(\sigma - 1)}{c} . \qquad (6)$$

It is constant for every active retail store in the economy.

The number of kinds of good in each region, f_i, depends on the demand in each region. Put differently, f_i is a function of the market area size, equivalent to the number of consumers who visit the region. Differentials of f_1 and f_2 with respect to their own market area are

$$\frac{\partial f_1}{\partial b} = \frac{\mu}{F\sigma}(Y - b - t_1) > 0 \text{ and } \frac{\partial f_2}{\partial(\overline{N} - b)} = \frac{\mu}{F\sigma}\left(Y - \left(\overline{N} - b\right) - t_2\right) > 0$$ [9].

They show that the expansion of the market area increases the number of varieties of goods in the region. It corresponds to such a situation that increasing consumers makes the commercial area more attractive for retail stores from the standpoint of profit and the start of new retail store operations.

3. MARKET EQUILIBRIUM AND SOCIAL OPTIMUM

Market boundary under market equilibrium

Let b^m be the market boundary under market equilibrium. If $0 < b^m < \overline{N}$, then consumers at $n \in (0, b^m)$ go shopping in region 1, whereas consumers at $n \in (b^m, \overline{N})$ go shopping to region 2. If $b^m = 0$ or $b^m = \overline{N}$, then all consumers go to one region for shopping, region 1 ($b^m = \overline{N}$) or region 2 ($b^m = 0$). We define the description of these market equilibria in this paper as the following.

Definition: Interior equilibrium (*IE*): market boundary is $0 < b^m < \overline{N}$

[9] The derivation is explained in Appendix A.

Corner equilibrium (*CE*): market boundary is $b^m = \bar{N}$ or $b^m = 0$

Under *IE*, the consumer on a market boundary is indifferent to visiting either region. If the utility obtained from visiting one region is higher than that of another region for all consumers, then the *IE* does not exist and all consumers go to one region for shopping, which corresponds to *CE*. The condition of *IE* and *CE* is expressed as the following.

IE: $b^m \in (0, \bar{N})$ and $V_1(n = b^m, b^m) = V_2(n = b^m, b^m)$ [10] (7a)

CE: $b^m = 0$ and $V_1(n = 0,0) < V_2(n = 0,0)$,

or $b^m = \bar{N}$ and $V_1(n = \bar{N}, \bar{N}) > V_2(n = \bar{N}, \bar{N})$ (7b)

A stability condition is necessary for the *IE* ($b^m \in (0, \bar{N})$). It is shown as

$$\partial\left(V_1(n = b,b) - V_2(n = b,b)\right)/\partial b < 0, \quad (8)$$

which expresses that any consumer's change in a region for shopping decreases their own utility level. In this situation, no consumer has an incentive to change the shopping destination.

To capture the configuration of $V_i(n = b,b)$ with respect to market boundary, differentiating $V_1(n = b,b)$ and $V_2(n = b,b)$ with respect to their own market area b and $\bar{N} - b$ yields

$$\frac{\partial V_1(n = b,b)}{\partial b} = -\frac{1}{Y - b - t_1} + \frac{\mu}{\sigma - 1}\frac{\partial f_1}{\partial b}\frac{1}{f_1} \text{ and} \quad (9a)$$

$$\frac{\partial V_2(n = b,b)}{\partial(\bar{N} - b)} = -\frac{1}{Y - (\bar{N} - b) - t_2} + \frac{\mu}{\sigma - 1}\frac{\partial f_2}{\partial(\bar{N} - b)}\frac{1}{f_2}. \quad (9b)$$

The first terms in eqs. (9a) and (9b) are negative, whereas the second terms are positive. We can derive the following properties:

$\partial V_1(n = b,b)/\partial b \to +\infty$ when $b \to 0$, $\partial V_2(n = b,b)/\partial(\bar{N} - b) \to +\infty$ when $\bar{N} - b \to 0$,
$\partial^2 V_1(n = b,b)/\partial b^2 < 0$, and $\partial^2 V_2(n = b,b)/\partial(\bar{N} - b)^2 < 0$.

Therefore, $V_i(n = b,b)$ is concave with respect to b.

Figure 2 shows examples of the configuration of $V_i(n = b,b)$ derived by numerical simulation. In Fig. 2, the horizontal axis expresses the market area of each region: b, starting from the left, is the market area of region 1, equivalent to the number of consumers who visit region 1, and $\bar{N} - b$, starting from the right, is the market area of region 2, equivalent to the number of consumers who visit region 2. The difference in shape between $V_1(n = b,b)$ and $V_2(n = b,b)$ arises only from the difference of t_i, transport cost for transportation facility, which is included in the second and third terms in eq. (4)[11].

The left side in Fig. 2 shows the case in which the difference between t_1 and t_2 is not so large ($t_1 = 25$, $t_2 = 30$), whereas the right one is the case in which the difference between t_1

[10] $V_i(n = b^m, b^m)$ shows the utility of a consumer on market boundary when he or she visits region i.

[11] The second and third terms in eq. (4) include f_i, which is a function of t_i, as shown in Appendix A.

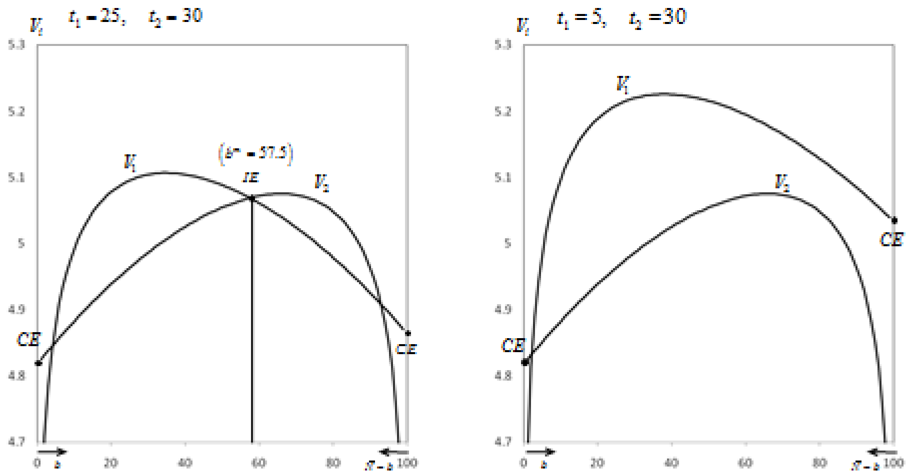

FIGURE 2 *– Configuration of* $V_i(n=b,b)$ *and market boundary with market equilibrium.*

and t_2 is large ($t_1=5, t_2=30$). The remaining exogenous variables and parameters are fixed through the numerical simulations in this paper ($\mu=0.2$, $\sigma=2$, $Y=250$, $F=20$, $c=3$, and $\bar{N}=100$). The left one has three intersections of $V_1(n=b,b)$ and $V_2(n=b,b)$ whereas the right one has one intersection.

Among the three intersections in the left one in Fig. 2, only $b^m=57.5$ satisfies the stability condition (8). In the right one, the intersection does not satisfy the stability condition (8), which yields the following.

Proposition 1. *If the difference between* t_1 *and* t_2 *is small, then both CEs and IE exist, whereas only CEs exist if the difference is large.*

If the difference between t_1 and t_2 is not so large, then both *CE*s and *IE* exist, which means that retail stores locate in both regions. However, all retail stores locate in one region if the difference between t_1 and t_2 is large.

Market boundary under social optimum

We define social welfare SW as the sum of individuals' utility level shown as

$$SW=\int_0^b V_1(n,b)\,dn+\int_{\bar{N}-b}^{\bar{N}} V_2(n,b)\,dn\,,$$

in which the first term is the sum of consumers' utility who visit region 1, whereas the second term is the sum of the utility of consumers who visit region 2.

Let b^s be the market boundary under social optimum. SW is not concave with respect to b. Moreover, it is not obvious whether SW is a monotonic increase or monotonic decrease.

Therefore we cannot derive the condition which b^s satisfies. However, if we assume $0 < b^s < \bar{N}$, then b^s satisfies first-order condition $\partial SW/\partial b = 0$, shown as

$$V_1\left(n,b^s\right) + EX_1\left(n,b^s\right) = V_2\left(n,b^s\right) + EX_2\left(n,b^s\right), \text{ where} \tag{10}$$

$$EX_1\left(b\right) = \int_0^b \frac{\partial V_1\left(n,b\right)}{\partial b} dn = \frac{\mu}{\sigma - 1} \frac{Y - t_1 - b}{Y - t_1 - \frac{b}{2}} \text{ and} \tag{11a}$$

$$EX_2\left(b\right) = \int_b^{\bar{N}} \frac{\partial V_2\left(n,b\right)}{\partial\left(\bar{N} - b\right)} dn = \frac{\mu}{\sigma - 1} \frac{Y - t_2 - \left(\bar{N} - b\right)}{Y - t_2 - \frac{\left(\bar{N} - b\right)}{2}}. \tag{11b}$$

Comparing eq. (7a) to eq. (10), the difference of the condition between market equilibrium and social optimum is the second term in eq. (10), represented as EX_1 and EX_2. They express that technical externality arises from multipurpose shopping and monopolistic competition. Equations (11a) and (11b) show that the change in utility caused by the infinitesimal change in market area $\partial V_i\left(n,b\right)/\partial b$ applies to all consumers who visit region i. Put differently, if consumers switch their own personal destination from a marketplace to the other marketplace, then it changes not only their own utility but also that of all other consumers through the change in the number of goods in the region.

4. COMPARING MARKET EQUILIBRIUM TO SOCIAL OPTIMUM

We quantitatively explore the relation between b^m, the market boundary with the market equilibrium, and b^s, that with social optimum. b^m can be *IE* and *CE*, therefore we determine it individually.

Market equilibrium and social optimum

To capture the configuration of $V_i\left(n = b,b\right) + EX_i\left(b\right)$ with respect to market boundary, we must capture the configuration of $EX_i\left(b\right)$. We can derive the following properties from eq. (11a) and (11b): $EX_1\left(b\right) \to \mu/\left(\sigma - 1\right)$ when $b \to 0$, $EX_2\left(b\right) \to \mu/\left(\sigma - 1\right)$ when $\bar{N} - b \to 0$, $\partial EX_1/\partial b < 0$, and $\partial EX_2/\partial\left(\bar{N} - b\right) < 0$. From these properties, we can draw the shape of $V_i\left(n = b,b\right)$ and $V_i\left(n = b,b\right) + EX_i\left(b\right)$ and corresponding SW as Fig. 3, which is derived through numerical simulation. In Fig. 3, $V_i\left(n = b,b\right)$ is drawn as a solid line, $V_i\left(n = b,b\right) + EX_i\left(b\right)$ is drawn as broken line, and the corresponding SW is drawn as a chain line.

In Fig. 3, three stable market boundaries with market equilibrium are shown. One is b^m which corresponds to intersection of $V_1\left(n = b,b\right)$ and $V_2\left(n = b,b\right)$ (interior equilibrium, *IE*); the

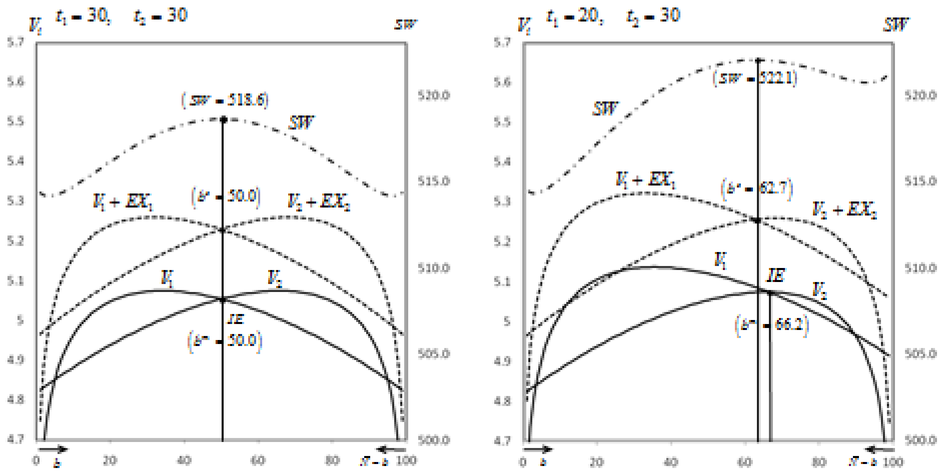

***FIGURE 3** – Configuration of* $V_i(n=b,b)+EX_i(b)$ *and corresponding* SW *(IE and CEs).*

others are $b^m=0$ and $b^m=\bar{N}$ (corner equilibrium, *CE*). Socially optimum market boundary b^s is the intersection of $V_1(n=b,b)+EX_1(b)$ and $V_2(n=b,b)+EX_2(b)$ [12]. The *CE*s ($b^m=0$ and $b^m=\bar{N}$) can be stable market equilibrium in Fig. 3. If one of the two *CEs* ($b^m=0$ or $b^m=\bar{N}$) comes into existence, then consumers are caught in a "utility trap". On each *CE*, an individual's change in the shopping region decreases that individual's utility level. Therefore none changes the shopping region, and SW is far from optimum level. However, if some large number of individuals change shopping regions simultaneously, then the utility level of each increases. They extricate themselves from a "utility trap" and the market boundary heads for *IE*.

The left side in Fig. 3 shows the case in which region 1 and region 2 are indifferent; $t_1=t_2$ ($t_1=t_2=30$). In this case, $V_1(n=b,b)$ and $V_2(n=b,b)$ are symmetric. Therefore b^m and b^s are just middle: $b^m=b^s=\bar{N}/2$. The right side in Fig. 3 shows the case in which $t_1<t_2$ ($t_1=20, t_2=30$). The decrease in t_1 affects the increase in budget for goods in consumers who visit region 1. Therefore $V_1(n=b,b)$ moves upward. In consequence, b^m and b^s are moved to the right.

In our model, the difference between b^m and b^s is determined by the difference between t_1 and t_2. It is summarized in the property:

Property 1 $b^m=b^s$ if $t_1=t_2$

Property 2 $b^m>b^s$ if $t_1<t_2$ and $b^m<b^s$ if $t_1>t_2$

Property 1 might be readily apparent as shown on the right side in Fig. 3. The derivation of **Property 2** is shown in appendix B. Therefore, we obtain following.

12 Numerical simulation confirms social optimum is interior solution.

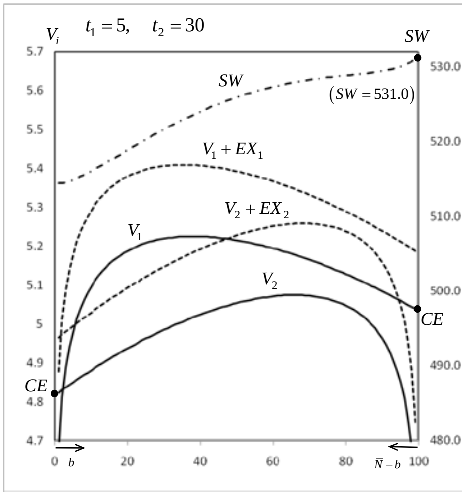

***FIGURE 4** – Configuration of* $V_i(n = b, b) + EX_i(b)$ *and corresponding* SW *(CEs).*

Proposition 2. *Market boundary in social optimum is the same as that in market equilibrium only if* $t_1 = t_2$*. They differ if* $t_1 \neq t_2$*.*

Because of monopolistic competition and shopping externality, socially optimal b^s differs from b^m if the transport cost to region 1 and region 2 differ ($t_1 \neq t_2$). Interpreting **Property 2**, a commercial area's retail stores are agglomerated excessively if the accessibility from the residential area is better than another commercial area.

No formation of *IE* and social optimum

If the difference between t_1 and t_2 is large, then stable *IE* does not exist and only *CE* ($b^m = 0$ and $b^m = \bar{N}$) exists. Figure 4 shows the case in which t_1 is much smaller than t_2 ($t_1 = 5$, $t_2 = 30$).

If the *CE* ($b^m = 0$) comes into existence in Fig. 4, then consumers are also caught in a "utility trap". On the *CE* ($b^m = 0$), SW is minimum. If consumers get out of a "utility trap", then by the same token, the market boundary heads for another *CE* ($b^m = \bar{N}$). Numerical simulation clarifies that $b^s = \bar{N}$.

5. TRANSPORTATION IMPROVEMENT AND RETAIL STORE LOCATION CHANGE

Regarding region 1 and region 2 as the urban center and outskirts of a city in our model, some fruitful remarks can be made which associate the outcome of the model with some issues of transportation improvement and retail store location.

Hollowing-out, suburbanization and its control

Transportation improvement in the outskirts in a city is a main cause of the hollowing-out of city centers and suburbanization of retail stores. In fact, our model demonstrates that a decrease in t_2 makes b^m smaller. Improving access to outskirts in a city expands the market area of retail stores in outskirts in a city.

Comparing the market boundary with the market equilibrium b^m and that with social optimum b^s, **Property 2** shows that $b^m > b^s$ if $t_1 < t_2$, and $b^m < b^s$ if $t_1 > t_2$. If the accessibility for outskirts is worse ($t_1 < t_2$), then the market area of outskirts under market equilibrium is smaller than that under social optimum ($b^m > b^s$). Therefore policies for regulation of suburbanization of retail stores or promotion and revitalization of retail stores in the city center decrease social welfare if the accessibility for outskirts is worse.

Such regulation or promotion improves the utility of consumers who visit city centers through a decrease in transport cost and increases the variety of retail stores in city centers. However, it simultaneously brings utility loss to consumers who visit the outskirts through a decrease in the variety of retail stores in the outskirts. Under the situation in which accessibility for outskirts is worse, the utility loss is superior to the improvement of utility.

Conversely, if the degree of suburbanization is large ($t_1 > t_2$), then the market boundary with market equilibrium is smaller than that with social optimum ($b^m < b^s$). Therefore policies for regulation of suburbanization of retail stores or promotion and revitalization of retail stores in city center increase social welfare if the accessibility for outskirts is better.

Hollowing-out of an urban center's commerce has been promoted during the past few decades in developed countries as described early in this paper. In such countries, road construction and improvement in outlying areas is well underway. Therefore we can regard suburbanization of retail stores as excessive and the regulation of suburbanization of retail stores or promotion and revitalization of retail stores in the city center as effective from the perspective of social welfare improvement.

Emergence of new marketplace

If transport costs to region 2 are sufficiently greater than those to region 1, then only *CE*s come into existence, as portrayed in Fig. 4. Although we do not know which *CE* is realized, we take it as given that all retail stores locate in region 1 ($b^m = \overline{N}$) as the initial state. As described above, we regard region 1 as the city center and region 2 as the outskirts. Therefore, the initial state is that all retail stores concentrate in the city center[14].

Transportation improvement to region 2 from initial state, t_2 becomes small and $V_2(n = b, b)$ moves upward in Fig. 4. Decreasing t_2 from the initial state eventually generates *IE*, intersection of $V_1(n = b, b)$ and $V_2(n = b, b)$. Therefore, transportation improvement to region 2 creates the potential by which collective retail stores can locate in region 2 with some other retail stores. If some retail stores locate simultaneously in region 2, then consumers living near region 2 can improve their utility by changing their shopping place

[14] Cities are historically formulated around one marketplace as a general rule. Therefore if the transport cost for outskirt is sufficiently large, corresponding *CE* is such that all retail stores are located in the city center.

from region 1 to region 2. Their utility losses occur by having fewer kinds of goods available in the outskirts, but they can obtain higher utility by saving transport costs.

Entering some quantities of retail stores into region 2 is the formation of new marketplace in region 2. Formation of a new marketplace at the edge of a residential area is explored in Tabuchi (2009). The increasing number of consumers surrounding a central marketplace expands the residential area to the outskirts. Therefore, transport costs from the outskirts to central marketplace increase. Eventually, an increase in population causes the formation of an “edge city”, which is a new marketplace at the edge of a residential area. Our model fixes the population of consumers. However, expanding residential area to outskirts is equivalent to that of transportation improvement in region 2 in the sense that the transport cost for outskirts becomes low compared to that for city center for consumers living near the outskirts.

Complete suburbanization and hollowing-out

Under circumstances in which transport cost for region 1 and region 2 are not so different, the *IE* comes into existence by which retail stores locate in both regions. We assume that retail stores locate in both regions ($0 < b^m < \overline{N}$), giving the initial state shown on the left side in Fig. 2.

Promoting transportation improvement for region 2 from the initial state, t_2 becomes small and $V_2\left(n = b, b\right)$ moves upward in Fig. 2. Decreasing t_2 from initial state eventually eliminates *IE* and generates the *CEs*. If consumers cooperate to move in search of a better equilibrium, then the *CE* by which all retail stores locate in region 2 comes into existence. This change in equilibrium from the *IE* ($0 < b^m < \overline{N}$) to the *CE* ($b^m = 0$) by the decrease in t_2 engenders complete suburbanization and hollowing-out of retail stores.

Complete suburbanization and hollowing-out of retail stores brings improvement of social welfare because welfare improvement by facing more goods in region 2 and saving of transport cost to region 2 exceeds the welfare loss incurred by the increase in transport cost for consumers living near region 1.

Retail store concentration to the outskirts is often subject to control [15] because suburbanization and the hollowing-out of retail stores are believed to be inefficient from the conventional perspective of social welfare. However, our model shows that it is desirable given the existence of retail store monopolistic competition and shopping externality.

6. CONCLUSION

We have derived the mechanics generating a divergence of market boundary of retail stores between the market equilibrium and social optimum by constructing a model that introduces market failure. Although market failures of several kinds exist, we have specifically

[15] Some policies have been implemented to promote urban center revitalization: improving transportation accessibility of an urban center and compact city policy are typical policies. Compact city policy leads residents, retail stores, and public facilities such as schools and hospitals to locate in a city center against the unregulated suburbanization and hollowing-out of the city center.

described two of them: shopping externality for consumers and monopolistic competition of retail stores, which have greater influence on retail store location.

Depending on the difference in t_1 and t_2, stable multi-equilibria exist under the market equilibrium. If the difference is large, then only two *CEs* ($b^m = 0$ and $b^m = \bar{N}$) exist. One is equal to the social optimum. If the difference is small, then both *IE* and *CEs* exist. In this case, consumers can be caught in a “utility trap”[16]. If one of the two *CEs* ($b^m = 0$ or $b^m = \bar{N}$) comes into existence, then social welfare is less than *IE*.

Even if *IE* comes into existence under a market equilibrium, it is different from the social optimum except for the case in which both regions are indifferent ($t_1 = t_2$). **Property 2** shows that a commercial area’s market area is excessive if the accessibility from residential area is better than that of another commercial area.

We presented three remarks relating our theoretical conclusion with some issues of transport improvement and retail store location. The first result shows that if the transport cost to the city center is smaller than that to the suburb, the number of retail stores in the city center is greater than that in a social optimum, which implies that, in that case, “promotion of retail stores’ location in city center” such as subsidies to locate in city center or restrictions of location in suburbs, worsens social welfare. Instead, promotion of stores’ location in the suburbs is preferred.

The second result shows that, if the transport cost to city center is sufficiently smaller than that of suburb, then all retail stores concentrate in the city center. Given such a central agglomeration case, a decrease in transport cost to suburb can spur the emergence of suburban retail stores. This emergence invariably increases social welfare, which implies that an improvement in transport to suburb is desirable if it generates new suburban stores’ location. In that case, policy-makers should not restrict suburban locations.

Third, transport improvement for suburb eventually generates complete suburbanization and hollowing-out of retail stores, which is optimal from the perspective of social welfare. Complete suburbanization and hollowing-out of retail stores brings a greater variety of goods in suburbs and savings of transport to suburbs, with benefits exceeding the shortcomings of hollowing-out of retail stores.

Suburbanization and hollowing-out of retail stores is believed to be inefficient from the conventional perspective of social welfare. Therefore, some policies have been implemented against suburbanization in many developed countries. Nevertheless, it is desirable in our model because our model incorporates shopping externality and monopolistic competition among retail stores as factors exacerbating market failure: some other factors of market failure, such as agglomeration economy and congestion externality, are not addressed in the model. However, these factors, such as agglomeration economy and congestion externality, make little impact on retail stores’ location.

[16] If there are many commercial areas, the probability of a utility trap is low because consumers can extricate themselves from a utility trap with a small quantity of individuals changing their shopping region at the same time. They can exit a utility trap by cooperating in choosing where to shop. However, few actual commercial areas exist for consumers’ usual shopping behaviour and It seems unrealistic that consumers will cooperate even if the number of consumers is fairly small. Therefore it is possible that consumers are caught in a utility trap.

As described above, we presume two factors of market failure: shopping externality for consumers and monopolistic competition among retail stores. Public awareness that the hollowing-out of urban center is inefficient might encourage consideration of market failure of various sorts. However, our results are available for practical policy making for suburbanization or hollowing-out of retail store location. Our research is important in the sense that suburbanization or hollowing-out of the city center is not always inefficient from the perspective of social welfare.

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APPENDIX

A. Derivation of Differentials of f_1 and f_2

$p(j)m(j)$, the expenditure of a good of a consumer, is derived through formulation of consumer behavior as

$$p(j)m(j) = p(j)\left(\frac{p(j)}{G_i}\right)^{-\sigma} M_i, \qquad \text{(A1)}$$

where $M_i = \mu(Y - L_i)/G_i$ is the solution of consumers' utility maximization (2). Substituting $M_i = \mu(Y - L_i)/G_i$ and eq. (3) into (A1) yields $p(j)m(j) = \mu(Y - n - t_1)/f_1$ for a good supplied in region 1 and $p(j)m(j) = \mu\left(Y - \left(\bar{N} - n\right) - t_2\right)/f_2$ for a good supplied in region 2. The sum of the expenditure with respect to all consumers visiting each region is equal to the sales turnover amount of each retail store p^*q^* when the market boundary is b ($0 \le b \le \bar{N}$). This condition is shown as

$$p^*q^* = \int_0^b \frac{\mu}{f_1}(Y - n - t_1)\,dn \text{ in region 1 and } p^*q^* = \int_{\bar{N}-b}^{\bar{N}} \frac{\mu}{f_2}\left(Y - \left(\bar{N} - n\right) - t_2\right)dn \text{ in region 2.}$$

Substituting eq. (5) and (6) into this condition yields

$$f_1 = \frac{\mu}{F\sigma}\left((Y-t_1)b - \frac{b^2}{2} \right) \text{ and } f_2 = \frac{\mu}{F\sigma}\left((Y-t_2)(\bar{N}-b) - \frac{(\bar{N}-b)^2}{2} \right).$$

Therefore, differentials of f_1 and f_2 with respect to their own market area are

$$\frac{\partial f_1}{\partial b} = \frac{\mu}{F\sigma}(Y-b-t_1) > 0 \text{ and } \frac{\partial f_2}{\partial(\bar{N}-b)} = \frac{\mu}{F\sigma}\left(Y-(\bar{N}-b)-t_2\right) > 0 .$$

B. Derivation of Property 2.

If $EX_1(b)$ is larger/smaller than $EX_2(b)$ at b^m, then $V_1(n=b,b)+EX_1(b)$ is larger/smaller than $V_2(n=b,b)+EX_2(b)$ at b^m because $V_1(n=b,b)=V_2(n=b,b)$ therefore $V_1(n=b,b)+EX_1(b)$ and $V_2(n=b,b)+EX_2(b)$ intersect a point that is larger/smaller than b^m. Accordingly, whether b^m is larger than b^s or not depends on whether or not $EX_1(b)$ is greater than $EX_2(b)$ at b^m.

$\Delta EX(b^m) = EX_1(b^m) - EX_2(b^m)$ is derived from eqs. (11a) and (11b) as

$$\Delta EX(b^m) = \frac{\mu}{\sigma-1}\frac{(\bar{N}-b^m)(Y-t_1) - b^m(Y-t_2)}{2\left[Y-t_1-\frac{b^m}{2}\right]\left[Y-t_2-\frac{(\bar{N}-b^m)}{2}\right]}. \quad \text{(B1)}$$

The denominator of eq. (A1) is positive. Therefore the sign of the numerator dominates the sign of $\Delta EX(b^m)$.

To ascertain the sign of the numerator in eq. (B1), we use some related expressions. First, from $V_1(n=b^m,b^m)=V_2(n=b^m,b^m)$ and eq. (4), we derive

$$\ln\left(\frac{\mu}{p^*}\right)^{\mu}(1-\mu)^{1-\mu} + \ln(Y-L_1) + \frac{\mu}{\sigma-1}\ln f_1 = \ln\left(\frac{\mu}{p^*}\right)^{\mu}(1-\mu)^{1-\mu} + \ln(Y-L_2) + \frac{\mu}{\sigma-1}\ln f_2$$

$$\Rightarrow \frac{Y-t_1-b^m}{Y-t_2-(\bar{N}-b^m)} = \left(\frac{f_2}{f_1}\right)^{\frac{\mu}{\sigma-1}}. \quad \text{(B2)}$$

Second, as explained in the text, the decrease in t_1 affects the increase in budget for goods in consumers who visit the region. Therefore $V_1(n=b,b)$ moves upward. In consequence, b^m becomes large and f_1 becomes large because $\partial f_1/\partial b > 0$. Therefore, if $t_1 < t_2$, then $f_1 > f_2$.

If $t_1 < t_2$, then $f_1 > f_2$. Therefore $Y-t_2-(\bar{N}-b^m) > Y-t_1-b^m$ from eq. (A2). This is altered as $Y-t_1 > Y-t_2-(\bar{N}-2b^m)$. Substituting this relation in the numerator in eq. (A1), we obtain the following relation:

$$\left(\bar{N}-b^{m}\right)\left(Y-t_{1}\right)-b^{m}\left(Y-t_{2}\right)<\left(\bar{N}-b^{m}\right)\left[Y-t_{2}-\left(\bar{N}-2b^{m}\right)\right]-b^{m}\left(Y-t_{2}\right).$$

Altering the right hand side in this relation yields

$$\left(\bar{N}-b^{m}\right)\left(Y-t_{1}\right)-b^{m}\left(Y-t_{2}\right)<\left(\bar{N}-2b^{m}\right)\left[Y-t_{2}-\left(\bar{N}-b^{m}\right)\right],$$

of which the first term on the right side is negative because $b^{m}>\bar{N}/2$. The second term on the right side is positive. Therefore, we can derive the following relation:

$$\left(\bar{N}-b^{m}\right)\left(Y-t_{1}\right)-b^{m}\left(Y-t_{2}\right)<\left(\bar{N}-2b^{m}\right)\left[Y-t_{2}-\left(\bar{N}-b^{m}\right)\right]<0$$

Accordingly, $\Delta EX\left(b^{m}\right)<0$ if $t_{1}<t_{2}$. Therefore, we can obtain the following relation:

$$b^{m}>b^{s}\ \text{if}\ t_{1}<t_{2}.$$

In the same manner, the remaining property ($b^{m}<b^{s}$ if $t_{1}>t_{2}$) is also derived.