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[Field Research]

Analysis on Preceding Study of Consumer's Store-Choice Model: Focusing on Commercial Sphere Analysis Theories*

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Abstract

Purpose – There are numerous theories for retail trade area analysis which are designed to select candidate locations for new stores. In this study, comparative analysis on the characteristics from those of the theories are shown, and the explanation for the power in consumers' store-choice behaviors and their limitations are examined. Also, plans for improving commercial sphere analysis are explored.

Research design, data, and methodology – This study is based on literature reviews with normative research methodology. Among many researches regarding the analysis on the location and commercial sphere for launching a new store, researches relying on statistics are excluded in this study since they belong to the marketing research area,.

Results – In the Law of retail gravitation, Huff's model multinomial logit model and etc. are mutual complementary mathematical techniques for analyzing commercial spheres and each of them has its own characteristics. These theories rely on the same hypothesis in which consumers are all believed to be behaving rationally under a similar behavioral system. However, the trial in explaining or estimating behavior of choosing a store with only a select size of the population that is objectively estimated by some major properties has limits in its credibility.

Conclusion – Research on consumer's spatial behaviors can be fully illustrative and explainable when it has both quantitative approaches such as 'law of retail gravitation', 'logit model' and etc., and qualitative approaches like consumer's 'cognitive structure', 'learning status', 'image formation', 'attitude' and etc.

Keywords: Commercial Sphere Analysis Theory, Consumer's Store Choice, Retail Store, Space Travel.

JEL Classifications: D30, M31, M39, L81.

1. Introduction

Generally, research on analysis of location and commercial sphere have been carried out in the fields like distribution and real estate. In our country, there are many research that have been carried in the fields of real estate, but not much in the fields of distribution. Typical researches of location and commercial sphere theory based on distribution include Park et al. (2006), An et al. (2009), Kim and Youn (2010), Kim et al. (2011), Su and Youn (2011), Youn et al. (2012) and Youn et al. (2013). Although there are numerous theories existing as techniques in retail trade area analysis to select candidate locations for launching a new store, in this study, ones that are more related to the field of distribution are more focused and analyzed. The characteristics of those theories, explanation power of theories on consumer's choice over store and their limits are compared and analyzed. Among many research regarding to the analysis of location and commercial sphere for launching a new store, research relying on statistics are excluded in this study since they belong to marketing research areas, and therefore, research that only focuses on analysis of locating and commercial sphere are selected and compared in this study.

Research regarding analysis of location and retail trade areas can be divided into two categories: theory of customer's spatial demand and location selection for a store (Bacon, 1984). And also, existing theories for location selection and retail trade area can be divided into

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consumer's 'store-choice models' and store's 'retail location models'. In this study, consumer's store-choice model is mainly examined.

2. Literature review on store-choice models

2.1. Theory through normative assumption

'Among many techniques for commercial sphere analysis, theory through normative assumption is valid for selection of ideal store location. Therefore, commercial sphere analysis model are mainly from theories through normative assumptions. Among many normative models, CPT (Central Place Theory) by Christaller (1933) and Lösch (1940), Law of Retail Gravitation by Reilly (1931) and New Law of Retail Gravitation by Converse (1949) are the most popular ones.

2.1.1. Central Place Theory

The theory was originated by a German researcher called Christaller in his book "Die zentalen Orte in Suddeutschland" published in 1933. Over 30 years of research, Christaller completed a framework for consistent theories. In particular, in 1950, he presented a revised model of the previous one and thus he could achieve more perfection over his theories. In the revised model, instead of the assumption in which consumers are believed to travel freely in any direction and to any places, he believed that consumers travel differently when they have different traffic system, administrative district and etc. and therefore have different structures of central places (Craig et al., 1984).

In the revised model, Christaller presented 'Transportation Principle' and 'Administrative Principle' in addition to Market Principle. He stated that central places are determined through mutual interactions between the three principles. There have been many trials to make the theory more realistic and practical, and among them, there is the revised central place theories respectively by Lösch and Berry and Garrison (1958).

2.1.2 Law of Retail Gravitation by Reilly

The lack of empirical evidence for central place theory lead many researchers to recognize the problem in 'nearest-center hypothesis' which was the basis of central place theory. Therefore, numerous research was carried out actively to claim that consumer's traveling behaviors are decided by the attraction power (retailing gravity) of the store instead of the distance to the store described in central place theory.

Reilly had research on how consumer's perception on selecting cities or stores in different locations differs and he found out that there is no difference in how consumers perceive it and consumers take a point of difference as a breaking point. In other words, consumers at the break point between two cities take both of cities as suitable places for their purchasing behaviors with no differentiations in viewing each of them.

Law of retail gravitation defines that the attraction power or ratio of big cities over purchasing power of small cities close to break points in between them is positively proportional to population of big cities and negatively proportional to square of distance to each of big cities under the condition in which the roads and geographical elements are same and the ability of merchants in two big cities are equal.

Law of retail gravitation by Reilly is as followings:

$$\frac{B_a}{B_b} = \left[\frac{P_a}{P_b}\right]\left[\frac{D_b}{D_a}\right]^2$$

where

- B_a: Retail amount absorbed by city A from small city C in between A and B
- B_b: Retail amount absorbed by city B from small city C in between A and B
- P_a: Population size of city A
- P_b: Population size of city B
- D_a: Distance between city A and C
- D_b: Distance between city B and C

Unlike central place theory, law of retail gravitation conceptualizes the boundaries of commercial spheres to show that agglomeration of stores and space of stores are the attraction factors to consumers in consideration of two variables: population size and distance.

2.1.3. Modified Law of Retail Gravitation by Converse

While original law of retail gravitation was designed to describe attraction power over purchasing power of two big cities, the modified law of retail gravitation was designed to describe attraction power of shopping malls in a city, and to do so, there were three major improvements made to the law (Davies, 1976):

First, factors like population size and distance that form boundaries of commercial spheres are more detailed, and the population size was considered to be the attraction factor to consumers' traveling and the distance mileage was considered to be the resisting factor.

Second, a symptom in which shopping trips are decreased as the distance increases was illustrated in the Distance-Decay Function and the relationship between the distance and purchasing frequency was understood in the Negative Exponential Curve.

Third, understanding of relationship between purchasing expenses and retail sales.

Such improvements of a theory are examined in detail in modified law of retail gravitation by Converse and probabilistic retail gravitation by Huff (1963).

Converse modified the law of retail gravitation by Reilly to

decide precise location of break point between two locations and derived the distance-decay function as followings:

$$D_a = \frac{D_{ab}}{1+\sqrt{\frac{P_b}{P_a}}} \quad \text{or} \quad D_a = \frac{D_{ab}}{1+\sqrt{\frac{P_a}{P_b}}}$$

where
D_a: Distance between city A to break point of commercial sphere
D_b: Distance between city B to break point of commercial sphere
D_{ab}: Distance between city A and city B
Pa: Population size of city A
P_b: Population size of city B

The formula shows the random boundary points to which consumers travel for purchasing behaviors. It is not applicable to the behaviors of purchasing entire products but it is better to understand when it comes to the shopping goods and specialized goods.

2.2. General Interaction Theory

2.2.1. Probability model by Huff

Probabilistic gravitation theory by Huff is a revision of retail gravitation theories by Reilly and Converse into a theory that is applicable to the real world. Huff (1963) paid attention to consumers to analyze spatial structure of the city, and considered the consumers as the element that has the influence on commercial spheres. Consumers at suburban areas where places to purchase goods are limited tend to visit store that is big-sized and located in the nearest city as described in law of retail gravitation by Reilly. However, in urban areas where there are a number of stores, purchasing behaviors of consumers at a certain store is considered to be occurring probabilistically, and the existence of commercial sphere is also considered to be probabilistic. Huff made law of city-centric commercial sphere into a law of retail-facility-centric commercial sphere, and made the law from the aspect of shopping goods into a law that can understand the commercial sphere for each of the goods.

$$p_{ij} = \frac{\frac{S_j}{T_{ij}}\lambda}{\sum_{i=1}^{n}\frac{S_j}{T_{ij}}\lambda}$$

where
P_{ij}: Probability of consumer at i goes to retail facility j
S_j: Size of retail facility
T_{ij}: Time takes or distance from location i to retail facility j
λ : Empirically estimated parameter to reflect time effect in various shopping behaviors
n : Number of stores

According to the formula, the number of consumers at i visits retail facility j can be derived as followings.

$$E_{ij} = P_{ij} \times C_i$$

where
E_{ij}: Number of consumers at location i visit retail facility j
C_i: Total number of consumers

2.2.2. Modified probability model

Despite advantages of the probability model by Huff, it has a limit that it is difficult to apply to real world. Especially, the parameter cannot be found until the market analysis is complete. To overcome such difficulties, modified probability model has been presented.

The modified probability model was proposed by Japanese ministry of international trade and industry and has been practiced in commercial adjustment under the law of large-scale stores management. Therefore it is also known as 'Japanese ministry of international trade and industry model'. The model shows that the probability of customers' purchase of goods at a certain commercial sphere is positively proportional to the size or scale of the stores and negatively proportional to square of the distance customers to the commercial spheres.

$$p_{ij} = \frac{\frac{S_j}{T_{ij}^2}}{\sum_{i=1}^{n}\frac{S_j}{T_{ij}^2}}$$

where
P_{ij}: Probability of customer's visit to retail facility j
S_j: Scale of retail facility
T_{ij}: Time takes to retail facility j from location i
n : Number of stores

2.2.3. Multiplicative competitive interaction model

In Huff's probability model, there might be specification bias in process of estimation of commercial sphere analysis and behavior of selecting store due to exclusion of numerous important variables. If a variable that is excluded from the model is not independent of travel time, there must be a problem in parameter estimation. In other words, it leads to a conclusion that commercial sphere is more limited by the travel time than it really is due to its reinforced effect of absolute value of travel time parameter. The reason is that variables like comfort, satisfaction and etc. are collateral to travel time. To provide solution to such a problem, characteristics such as assortment, cost, atmosphere, interior of store, travel cost, safety of travel, convenience of travel and etc. should be included in attraction variables (Gautschi, 1981). MCI (multiplicative competitive interaction model) (Jain & Mahajan, 1979) is one of the solutions to overcome such

shortages.

2.2.4. Multinomial logit model

Recently, commercial spheres are not viewed as a location or an area where real customers or potential customers are living in, rather it is being defined as an area where retail facilities can deploy their economic marketing activities. In other words, it is being defined as a place where retail facilities create new demands from customers with various sales strategies by targeting local people, and adopt local people as their continuous long-term customers. In such cases, Reilly's or Huff's models, which make surveys on collection range of customers, number of real and potential customers, are not enough in understanding customers and therefore investigation on what customers really expect from a retail facility and with what standards customers select a certain store among many competitive retail facilities is being issued.

Most of customers select a facility that satisfies their demands mostly which means they select a facility that gives them the most utilizations. The utilizations to customers is generated by properties that compose a retail facility. Under such premises, MLM (Multinomial Logit Model) can be shown as following formula (Gosh & McLafferty, 1987).

$$p_{ij} = \frac{e^{U_{ij}}}{\sum_{g=1}^{m} e^{U_{ij}}}$$

where
P_{ij}: Probability of a customer selects a retail facility
e: Natural number
U_{ij}: Customer utility
m: Number of properties

As aforementioned, the utilizations to customers is related to properties of retail facility, and if the relationship is linear, then the following is true.

$$U_i = \sum_{k=1}^{m} \beta_k X_{jk} + \epsilon_j$$

where
X_{jk}: Score of property k a retail facility j has
k : Weight to property k
j : Error term
m : Number of properties

To apply this model to real world, the main task to be done is estimation of weight k on the basis of customer's frequency of visits to retail facility Pijand the score of property of a retail facility X_{jk}.

2.2.5. Utility function direct estimation model

Utility function direct estimation model is a modified and improved version of MCI and MLM. It has changed the way data are collected from the basis. The model does not apply data collected from observation, communicative surveys and etc., instead it applies a method in which simulated data are collected from experiment circumstances and applied, and derives the benefic function directly by utilizing binding assay or logit methods. Especially, the advantage of collecting data from experiments is that it gives precise sensitivity analysis of relationship between customers and properties of stores, and the effect of properties of new stores can be estimated by important properties derived in the process of sensitivity analysis. Also, it is effective in estimation of market share of newly established retail stores with new form of business.

2.2.6. Cognitive-behavioral model

Garner (1967) is the first scholar who had interest in the process of consumer's psychological information processing which affects the behavior of customer's selection of retail stores, and he claims that there should be research on the level of customers' motivation in selection of a certain product or store and the mechanism of consumer's information processing. He estimated scale of commercial sphere with estimation of the image of customers over women's apparel retail store.

Also, Downs (1970) improved the Garner's method and estimated decisive variables regarding to the formation of image over retail stores. Aside from this, Horton and Reynolds (1971) had research on the effect of the level of consumer's knowledge in retail structure onto the consumer's behavior of space selection. They divided the space into 'Action Space' and 'Activity Space' according to how familiar people are to the spaces. They define action space as a place where a consumer has certain level of knowledge regarding the space due to their preferences and it is the space they can interact with; and activity space is a place or facility where a consumer visits to or stops by periodically.

3. Results

3.1. Comparison between Central Place Theory and Law of Retail Gravitation

Firstly, central place theory has contribution on selection of optimal location for stores by explaining process of growth of shopping center or commercial sphere while law of retail gravitation is a theory related to space travel of consumers and demand for locating stores in regard to consumers' store selection.

Secondly, law of retail gravitation is less clear in concept structure compared to central place theory and robustness in the underlying premise is low, and it is only a theory with a chain of loose mathematic formulas.

Thirdly, the difference between two theories is that central place theory only explains marketing activities like formation

of hierarchy of retail facilities while law of retail gravitation is applicable to various fields like consumer's purchasing behaviors, movement of population, forecast of traffic and etc.

<Table 1> Comparison between law of retail gravitation and central place theory

Item	Law of retail gravitation	Central place theory
Analysis direction	Explanation on consumers' space travel and demand for stores location in accordance to consumers' store choice	Explanation on selection of optimal store location and growth process of commercial sphere
Concept structure	Less clear concept structure and low robustness in the underlying premise	Clear concept structure high robustness in the underlying premise and
Application range	Consumers' purchasing behaviors, movement of population, forecast of traffic, etc. (Utilizable in the field of distribution)	Marketing activities in the field of distribution economy (Utilizable in the field of geography and urban planning)

3.2. Comparison between Law of Retail Gravitation and Huff's model

Law of retail gravitation overlooks followings (Huff, 1964).

First, consumers inside of the break point and outside of the break point have differences in purchasing attitude to a certain competitive city or store due to distance, but it is disregarded, and thus it is difficult to calculate the level of attraction of consumers.

Second, in case of applying the law of the break point in a purpose to establish a commercial sphere over more than 3 stores, there must be a chance of overlapping of commercial sphere. Since the break point means a point or a location where consumers feel no difference in between cities or stores that are close to each other and are mutually competitive, and therefore there should be no overlapping of conceptual commercial spheres.

Third, the population or parameter values estimated by Reilly is used equally to all kinds of purchasing behaviors. The population or parameters are theoretically changed by purchasing behaviors and the scale of commercial sphere is differed by types of products even though the stores are the same ones.

With such points to be criticized, Huff's model is classified differently from law of retail gravitation since it is deployed with introduction of the concept of 'Total Utility' with underlying premise which assumes that the reason consumers select a certain store is not only related to the distance but to both of elements: distance to the store and scale of the store. Since the ratio of customer attraction can be calculated with Huff's model, it can be said that Huff's model has high practicality. Especially, it has been useful for estimating possibility of customer attraction at the point of planning to launch a large-scale commercial facilities near to existing shopping streets.

3.3. Comparison between Huff's model and Multinomial Logit Model

The most problematic point of Huff's model is how to decide value for parameter λ. Huff states that this parameter differs by types of products, consumers' social / economical attributes and/or images over retail facilities. However, MLM is easily applicable to real world problems and is easy to calculate thus widely accepted. MLM has 2 advantages compared to Huff's model. First is that it can acquire the utilizations to customers which is level of attraction to consumers. Second is that it can derive factors, which generate utilizations to customer, from highly important to the low ones by weight β_k. These are essential information for marketing strategy planning of a retail facility.

3.4. Mathematical commercial sphere estimation model and non-mathematical one

Law of retail gravitation, Huff's model, multinomial logit model and etc. are typical mathematical commercial sphere estimation methods. However, variables included in these models are only a part of elements or factors that compose a real commercial sphere. These models and theories are deployed with a premise which assumes that consumers behave rationally in a similar behavioral structure. However, in real world, in addition to social and/or economical motivation of consumers, personalities, level of information they have, level of motivation and etc. are different from each other, and therefore the fact that trials to explain and estimate behaviors of store choice by estimated population or parameters surely have limitations should be noticed.

4. Conclusion and Research Limitations

In general, research on theories for locating stores and commercial sphere analysis are mainly conducted in the field of distribution and real estates. Although there are many techniques and theories regarding commercial sphere analysis for selecting store location, in this study, it is limited to theories for commercial sphere analysis related to the field of distribution, and they are examined and compared in terms of characteristics, explanation power over consumers' store choice behaviors and its limitations. As the result shows, each of theories has its own characteristics and advantages / disadvantages.

It is clear that it is not possible to completely explain

change of consumers' individual preference on spaces with mutual interacting theory or direct estimation theory with utilizations function. These theories have underlying premise that assumes customers behave rationally under a similar behavioral structure while they show big differences in their behaviors due to different level of information, level of motivation and etc. Therefore, there must be limits in trying to explain and/or estimate consumers' store choice behaviors by estimated population or parameters. Thus, consumers' behaviors of space demanding or store choice is differed by their level of knowledge and the scale of alternative stores is differed by their size of knowledge. It implies that consumers' demand for space is differed by the status of their learning.

In conclusion, research on consumers' space behaviors would have complete explanation structure when quantitative approaches (such as central place theory, law of retail gravitation, Huff's model, multiplicative competitive interaction model and multinomial logit model) and qualitative examinations (such as cognitive structure of consumers, learning status, formation of images) are combined and backed up by each other.

In this study, characteristics of existing theories and techniques for commercial sphere analysis for selecting a location of a newly launching store and explanation power over consumers' store choice behavior and limits of those theories/techniques are compared. Thus it has contributions in planning improvement for commercial sphere analysis. It could be said that there is a natural limit since the study is a comparison of existing studies and therefore more objective and empirical proof is needed in the future.

References

Ahn, S. W., Lee, S. Y., Kim, P. J., & Youn, M. K. (2009). A Practical Study on the New Revenue Estimate Model Of SSM. *Journal of Distribution Science*, 7(3), 5-24.

Bacon, Robert W. (1984). *Consumer Spatial Behavior.* Oxford, Oxfordshire : Clarendon Press

Berry, B. J. L., & Garrison W. L. (1958). The Functional Bases of the Central Place Hierarchy. *Economic Geography,* 34, 145-154.

Christaller, W. (1933). *Central Places in Southern Germany* (trans. C. W. Baskin, 1966). Englewood Cliffs, NJ: Prentice Hall

Converse, P. D. (1949). New Laws of Retail Gravitation. *Journal of Marketing,* 14, 339–344.

Craig, C. S., Ghosh, A., & McLafferty, S. (1984). Model of the retail location process: a review. *Journal of Retailing*, 60(1), 5–36.

Davies, R. L. (1976). *Marking Geography with Special Reference to Retailing.* London, UK: Methun Co.

Downs, R. M. (1970). The Cognitive Structure of an Urban Shopping Center. *Environment and Behavior*, 2(1), 13-39.

Garner, B. J. (1967). Some reflections on the notion of threshold in central place studies. *Annals of the Association of American Geographers*, 57(4), 788.

Gautschi, D. A. (1981). Specification of Patronage Models for Retail Center Choice. *Journal of Marketing Research,* 18, 163-166.

Gosh, A., and McLafferty, S. L. (1987). *Location Strategies for Retail and Service Firms.* Lexington, MA: Lexington Books

Horton, F. E., & Reynolds, D. R. (1971). Effects of Urban spatial structure on individual behavior. *Economic Geography*, 47(1), 36-48.

Huff, D. (1963). A Probability Analysis of Shopping Centers' Trade Areas. *Land Economics,* 39, 81–90.

Huff, D. (1964). Defining and Estimating a Trade Area. *Journal of Marketing,* 28, 34-38.

Jain, A. K., & Mahajan, V. (1979). Evaluating the Competitive Environment in Retailing using MCI Model. *Research in Marketing,* 2, 217–235.

Kim, P. J., & Youn, M. K. (2010). Retail Sales forecasting of agricultural products marts in a mid-sized city using the Huff Model. *Journal of Food. Agriculture & Environment,* 8(2), 945-948.

Lösch, A. (1940). *The Economics of Location* (translated By W. H. Woglom and W. R. Stolper in 1954). New Haven: Yale University Press

Reilly, W. J. (1931). *The Law of Retail Gravitation.* New York: Knickerbocker Press.

Su, Shuai, & Youn, M. K. (2011). Using Huff Model for Predicting potential Chinese Retail Market. *East Asian Journal of Business Management,* 1(1), 9-12.

Youn, M. K., Kim, W. K., Kim, P. J., Lee, S. Y., Shim, K. Y., & Kim, Y. O. (2012). Retail sales forecast analysis of general hospitals in Daejeon, Korea, using the Huff model. *African Journal of Business Management,* 6(3), 971-977.

Youn, M. K., Kim, J. J., Park, C. J., & Shim, G. Y. (2013). A research on set-up of turnover estimation model of domestic large department store. *Journal of Distribution Science*, 11(12), 5-11.