ESTIMATION OF COMMERCIAL AREA CHANGING WITH TENANT AGENT MODEL

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ABSTRACT: Currently, many local governments in Japan has been forced to respond to changes in commercial area, such as rapid decline of cities and suburban commercial areas. Therefore, it is important to understand actual and detail changes in the commercial areas. In Japan, there are many detail information of city areas accumulated, such as phone dictionaries and residential maps, and it is possible to grasp the detail changes about tenant behaviors with using these information. In this study, tenant behaviors from phone directories were modeled by disaggregate demand model, and agent-based simulation model was developed. Using this model, we could estimate detail changes of commercial area. In addition, method of estimating future commercial area was developed by capturing the dynamic interaction of the tenant behavior.

1. INTRODUCTION

1.1 Background

Currently, Japan has become an aging society. Many cities, especially local cities, are facing problems, such as suburban expansion of the decline of the central business district. In addition, local governments are required to respond to these changes by policies or using urban planning. It is necessary to control and induce appropriately the development with analyses of commercial integrated factors. Therefore it is very important to understand the detailed changes in commercial areas. In Japan, there are many detail information of city areas accumulated, such as phone dictionaries and residential maps, and it is possible to grasp the detail changes about tenant behaviors with using these information.

Nagata et al. (2000) has estimated and discussed the changes of the business district in Fukuoka, many studies about detail commercial areas like this are limited to regional area, it is necessary field survey to analyze in smaller cities with less information. In addition, Matsui (2003) have analyzed retailer's strategy by type of shop with national statistics, however, the change in real commercial area with disaggregated data, such as the regional distribution of commercial, are not considered.

On the other hand, Akiyama et al. (2009) developed time-series change data of the tenant in national wide, by comparing name and address from town page (telephone dictionary by NTT Directory Services Co.), and observed the changes in commercial area. With historical information of tenant behavior like Akiyama's data, it is possible to develop the simulation model from micro perspective, estimation of tenant agent behavior, and observe detail changes of commercial area. In addition, it is possible future estimation by simulation and accumulation agent behavior from situation of the current commercial areas.

1.2 Purpose

The purpose of this study is to develop an national wide simulation model, it is able to estimate detail changes of commercial areas with information of tenant behaviors.

In the model, tenant behavior from tenant and building data, i.e. open and close, are modeled by the disaggregate demand model. In addition, for verifying the model, a multi-agent simulation are developed with the tenant as actors (agents), and represent changes in commercial areas dynamic, we compare simulation results with actual data.

2. METHOD OF MODELING AND SIMULATION

2.1 Modeling Tenant Behavior

In this study, retail tenant were selected to modeling, these tenant were used by many local residents, and represent the characteristics of the commercial area. In modeling, we use Akiyama's (2009) time series change information telephone dictionary (town page) , the residential map data (by ZENRIN CO., LTD.) and the census.
Tenant behavior has some pattern that are new tenant opening, business continue and shop closing, and individual tenant choice next action by their circumstances, unless some chain stores. If there is a tenant, it can choice next action as continue or close. On the other hand, the building owner, he have vacant room for tenant, can choice as open or not open, with considering the demand (Figure 1). In this study, tenant was modeling two model by situation, as exist of vacant, and each of them has two selection, as continue or close, and open or not.

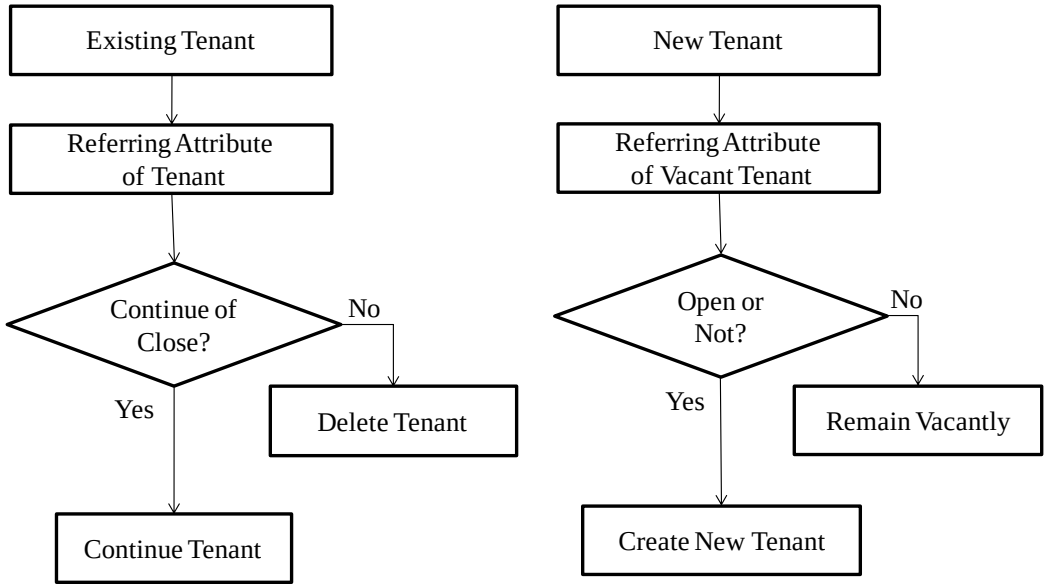

Figure 1 Two Situations and Two Selected Models

In this model, the two selection problems were modeled such formula (1) by Binomial Logit Model (a typical model of disaggregate demand model),

$$P = \frac{\exp(V)}{\sum \exp(V)} \qquad (1)$$

P: probability of selection, V: fixed term selection utility

and the parameters of the factors were estimated by the Maximum Likelihood Estimation. In addition, selection factors was introduced these in Table1 by the data sources.

Table 1 Factors of Behavior Selection

Factor	Data source	Data unit
Population	Census of Japan, 2005	Grid
Type of shop	Telephone book (Town page)	Per Tenant
Distribution of Type of shop	Telephone book (Town page)	Grid

2.2 Verification of Simulation Parameters

In order to verify the estimated parameters of the contribution of each factor, we simulate a model with the tenant as agent. At this step, to estimate future, the simulation model was developed by multi-agent system, that can take into the interaction between agents in a dynamic and changing conditions.
We run the simulation using the parameters selected by logit model, and verify the model parameters by comparing the results and actual data. In particular, we tried to set factors these can capture characteristics of the region and type of shop, and improve in the model.

2.3 Classification for Type of Business

Retail tenants to model, can be classified by products, was divided into two on, i.e., convenience product (commodities, food, etc.) and shopping products (clothing, books, etc.). In this study, referring The business statistics in Japan and Nagata (2000) , the classification of Retail Store determined as in Table 2.
Type of shop was considered as factors of tenant behavior by the distribution, and shopping products were classified more detail to distinguish positive and negative impacts. Method of Classification are not developed the same with Japan Standard Industrial Classification, However classified by material, such as frequency of shopping as well.

Table 2 Classification of Retail Store

Classification	Included type of shop
Convenience products	Grocery store, super market, convenience store, etc.
Shopping products	
Clothing, etc.	Clothing, Sporting Goods, etc.
Furniture, etc.	Furniture, Consumer Appliances, vehicles, etc.
Books, CD, etc.	Books, CDs, Florist, Drugstore, etc.
Glasses, Clocks	Glasses store, Clock store, Pet shop and others

3. EXAMPLE OF MODEL RUN

3.1 Example of Execution in the Sinjuku Area

In this study, the purpose is development a model that can be used nationwide, in this paper, first we select Shinjuku area, developed city and relatively low rate of change of tenant (Ito, 1998), from the southern Kanto area by detailed time series information (Akiyama, 2009).
In this paper, example of model run, modeled with time series change data at 2005 and 2000, are showed. this model is the existing tenants in the selection model. Agent-based simulation results are omitted.

Table 3 Parameter Estimation

Variable	Parameter	Values(±)
Variables of Integration	Population	-3.195
	Convenience products stores	0.524
	Clothing stores	0.996
Variables mean Type of shop	Convenience products shop	+1
	Clothing store	-3
	Florists	+1
	Drugstore	-3

3.2 Result

Table 3 shows some typical results of the parameter estimation of logit models. Shown in Table 3 as well, consumer electronics, furniture, sporting goods and accessories shops integration appeared to work positive effect in estimation. In addition, the type of shop was most working negative effect in the result of estimation.

3.3 Discussion

According to the estimated parameters in Table 3, it have shown tendency that the greater the probability of selecting closing under the larger the degree of integration population. That is opposite effect with our intuition, that tenant is likely to survive in high demand for more populous areas. It may appear different results by using the parameters with considering the distribution by age.
In addition, the clothing store has a strong tendency for close than continue, however the probability of survival raised under strong degree of integration of clothing stores. This suggest integration of clothing stores shows the commercial area has the steady demand, and this parameter might an alternative indicator.

4. CONCLUSION

4.1 Conclusion

In this paper, tenant behavior model was developed with disaggregate data from time-series tenant changes information by Logit model. Using The maximum likelihood parameter estimation with this logit model, we could observe the commercial area changes by considering the factors of tenant.
This estimation is more detailed estimation than statistical analysis, and this method is an effective method to capture changes in the commercial area. However, indicator for verifying estimation with agent simulation are not able to determined, we can't guarantee the accuracy of the model.

4.2 Future

In order to ensure the accuracy of data estimation, it is necessary to consider how to verify the actual commercial area and the tenant agent simulation results based on estimated parameters. Not only aggregate disaggregate data, we need suggest indicators to be capable of capturing the spatial structure.
In addition, about factors in the behavior model, there are some phenomena that the current factor can't expressed. It is necessary to use the data source other census and town page.
Moreover, we can apply a dynamic model by combination the agent-based parameter estimation and c multi-agent simulation. Accordingly, such model improve the estimated results in its own model, some generic model can be developed.

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