Evolution of Spatial Structure of Commerce Center in Global City-Region: A Dynamic Agent-based Simulation*

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Abstract:

This paper presents an economic model of spatial structure of metropolitan commerce in city-region scenario based on monopolistic competition, scale economy, spatial cost, preference for variety, and product/service differentiations. However, this kind of traditional mathematic model is based on over-simplifying assumptions. Meanwhile, the equilibrium analysis is not suitable for dynamic research. To overcome the weakness of traditional deductive model and equilibrium analysis, the paper puts forward a new research approach to integrate economic deductive model with agent-based computational experiments for better understanding the evolutional process of metropolitan commerce. By using agent-based modeling and simulation, the spatial structure of metropolitan commerce can be observed dynamically indifferent scenarios. Therefore, instead of making nonlinear systems tractable by modeling complex building blocks with few interactions, we can make them understandable by modeling simple building blocks with many interactions among different agents in different districts based on our deductive economic model. Dynamic simulations show that: (1) The greater the gap of commercial fixed input between the new and old city zone is, the more imbalanced commercial space distribution would be, and more easy to form the core-periphery structure. (2) Due to diversified consumption preferences, inter-regional differences can change the business market share between the two region. (3) Commerce tends to gather in the place with location, population and fixed cost advantages, and improvements in traffic condition will accelerate the commercial spatial concentration. The related methodological issue such as integrating traditional economic model with agent-based geographical computation as well as empirical analysis and econometric test is also discussed.

1. Introduction

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Since the 1990s, cities in China have experienced a period of rapid development. In face of the increasing complexity of the development, Beijing, Shanghai, Tianjin, Guangzhou, Nanjing and other cities have made development strategies and planning to build new towns to avoid over-intensive population and infrastructure construction and to ease the pressure on urban centers. With the gradual evolve of spatial structure of these cities, multi-center pattern develops progressively, urban groups are strengthened, and combined cities are increasing. The expansion of metropolitan residential space has transformed the cities’ spatial structure and commerce structure, while commerce tends to concentrate in agglomerations. Commerce is one of the most important functions of a city, which have a both-way choice process with urban residential space, and the interaction of the two is the foundation of the multi-center structure of metropolitan area. Then, with the expansion of the metropolis, what are the main features of the commerce size, format and market share in new and old city zones? For government planning, what's the influence of the growth in new city zone population and income on commerce space of the new and old city zones? For commercial enterprises, whether to adopt different investment mode, to develop diverse commerce patterns, and to make different product strategy in new and old city zones? These are the main contents of this paper.

Commercial activities and commerce spatial structure have always been main issue of urban geography and urban economics. Since 1980s, with the gradual rising trend of research on urban commercial spatial structure in China, a fair number of works on geographical structure, network scale and hierarchical system of urban commerce based on central place theory come up[1-6]. Later some scholars carried out empirical research, layout analysis and planning discussion on some metropolis with the help of some measure indicators, distribution pattern and GIS method [7-14]. In recent years, issues on city's new commerce space, new commerce formats and centrifugal phenomenon begun to attract attention [15-17]. However, from an overall point of view, research on urban commercial activities and urban spatial structure are confined to description, measurement and classification, and the research methods are relatively static. Although some scholars began to discuss the issue of commerce location and urban business district on the basis of agglomeration economies and industrial cluster theory, these researches are mainly qualitative discussions without strict logic reasoning, let alone dynamic study on the issue.

The analytical framework of New Economic Geography (NEG) is undoubtedly the most advantageous tool in analyzing the spatial structure of economic activity[21-23]. However, the spatial structure in NEG model is the equilibrium result of transportation costs and economies of scale, and is not enough to explain the formation and evolution of the spatial structure of commerce. This paper puts forward a spatial structure model of commerce in two-region scenario based on monopolistic competition on the basis of NEG theory, and integrate the economies of scale, spatial transaction costs, preference for variety, and product / service differentiations into a unified analytical framework. This paper transcend the static and comparative static analysis of traditional economics, using the agent-based modeling methods, “dynamically” observe and study the impact of the product elasticity of substitution, fixed investment of the commercial facilities, spatial transaction costs between new and old city zones on the spatial structure of metropolitan commerce through the interaction among numerous micro-agent of shops and consumers. In this way, we can not only understand the evolution results in different scenarios, but also clearly see the dynamic process of different states and equilibriums.

2. Spatial structure of commerce based on monopoly competition framework
Spatial structure of urban commerce is the spatial reflection of dynamic balance of the interaction between sale and consumption factors in aspects of commerce format and its hierarchy, scale and organization. The commerce discussed here is in a broad sense, which represents varieties of urban service function for the residents to do shopping, enjoy catering and entertainment, and is not limited to the everyday consumer goods business. This type of market has a monopolistic competition structure: on one hand, the input of commerce infrastructure and marketing show significant economies of scale that only a substantial quantity of consumption can support the large scale of fixed investment, while the improvement of commerce infrastructure and the further strengthening of marketing will attract more consumers. In such a cycle of cumulative mechanism, urban commercial activities appear to show a high degree of spatial concentration. On the other hand, with preferences for varieties, consumers also tend to consume in different places to achieve utility maximization, such as hunt for a different restaurant to eat, go to different places for leisure and shopping. The residents go to new and old city zones for consumption, which is the centrifugal force for the commercial activities to disperse. To the consumers, to consume in different places requires more spatial cost and thus the cost savings received from economies of scale is canceled out. Therefore, the residents have to make trade-offs between varieties of products and quantity of the same products. Thus, under these two opposing forces, there will be a balance of spatial structure of urban commerce.

2.1. Urban spatial structure and market structure of commerce

Supposing there are two city zones in a metropolis, that is, the old city zone and new city zone, and the two city zones are different in urban construction, commerce services, product characteristics and location. Set transport cost coefficient as \( t_a, t_b \) and \( t_{ab} \), all feature monotone increases. Variant \( t_a \) represent the transport cost coefficient of the residents in old city zone to consume in old city zone, and variant \( t_b \) represent the transport cost coefficient of the residents in new city zone to consume in new city zone, variant \( t_{ab} \) represent the transport cost coefficient of the residents in one city zone to consume in another city zone. Here assume that the cross-regional consumption are required to pay higher transaction costs, that is, \( t_{ab} > t_a \) and \( t_{ab} > t_b \). In addition, the population in old and new city is \( P_a \) and \( P_b \) respectively, and consumption level of the two city zones are \( Y_a \) and \( Y_b \).

Supposing market structure is monopoly competition, so there are a large number of shops in the market with intense competition. The products and services have a certain degree of monopoly force in the market because of their uniqueness in location, service courtesy, consume environment and brand reputation. Meanwhile, the commercial products / service are substitutes, when there is enough number of substitutes, a shop will gain break even.

<table>
<thead>
<tr>
<th>Old city zone</th>
<th>New city zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large number of commercial products ( X_a )</td>
<td>Large number of commercial products ( X_b )</td>
</tr>
<tr>
<td>the price is ( P_{ai} )</td>
<td>the price is ( P_{bi} )</td>
</tr>
<tr>
<td>( i = 1, 2 )</td>
<td>( i = 1, 2 )</td>
</tr>
<tr>
<td>Fixed cost: ( \alpha_a ), marginal cost: ( \beta_a )</td>
<td>Fixed cost: ( \alpha_b ), marginal cost: ( \beta_b )</td>
</tr>
<tr>
<td>Elasticity of substitution of the goods: ( \sigma_a )</td>
<td>Elasticity of substitution of the goods: ( \sigma_b )</td>
</tr>
<tr>
<td>Population: ( P_a ), consumption level: ( Y_a )</td>
<td>Population: ( P_b ), consumption level: ( Y_b )</td>
</tr>
<tr>
<td>Transport cost coefficient in the region: ( t_a )</td>
<td>Transport cost coefficient in the region: ( t_b )</td>
</tr>
</tbody>
</table>

| \( Q_{ab} \) |
2.2. **Consumer behavior**

### 2.2.1 Utilization function comprised of two tiers of CES functions

In the model of NEG, every product is included in utilization function symmetrically and the consumption volume of each product is the same. This is a highly simplified condition. However, the commercial products and services have specific spatial features, preference for variety and product differentiation are key dispersing forces, so when it comes to the research on the spatial structure of urban commerce, it is necessary to loosen the symmetry supposition in the model of NEG, and introduce parameters to control the degree of asymmetry in the new and old city zones, that is, to control the strength of dispersive force. Set a utilization function comprised of two tiers of CES functions. The detailed forms are as following:

\[
U = \left( \frac{U_a^{(\sigma-1)/\sigma} + U_b^{(\sigma-1)/\sigma}}{\sigma-1} \right)^{1/(\sigma-1)}
\]  

(1)

\[
U_a = \left( \sum_{i=1}^{n_a} x_{ai} \frac{\sigma_{ai}^{\sigma-1}}{\sigma_a} \right)^{1/(\sigma-1)}
\]

(2)

\[
U_b = \left( \sum_{i=1}^{n_b} x_{bi} \frac{\sigma_{bi}^{\sigma-1}}{\sigma_b} \right)^{1/(\sigma-1)}
\]

(3)

\(U_a\) is the quantitative index of commercial products in old city zone, \(U_b\) is that in the new city zone, and \(\sigma_{ab}, \sigma_a, \sigma_b\) represent elasticity of substitution of the products. \(\sigma\) as the elasticity of substitution between composite products \(U_a\) and \(U_b\), \(\sigma_a\) as the elasticity of substitution of local products \(x_{ai}\) and \(x_{aj}\) in old city zone, \(\sigma_b\) as the elasticity of substitution of local products \(x_{bi}\) and \(x_{bj}\) in new city zone, \(\sigma_{ab}\) as the elasticity of substitution between \(x_{ai}\) and \(x_{bi}\) in old and new city zone. The elasticity of substitution between products within a region is higher than that of the composite products, so \(\sigma_a > \sigma, \sigma_b > \sigma, \sigma_a > \sigma_{ab}, \sigma_b > \sigma_{ab}\).

### 2.2.2 Product expense distribution between two regions

With budget constraint \(I_a U_a + I_b U_b = Y\), from the first-order condition of utility maximization, the product expense distribution between new and old city zones is as following:

\[
I_a U_a = \frac{V}{1 + I^\sigma - 1}
\]

(4)

\[
I_b U_b = \frac{V}{1 + I^{1-\sigma}}
\]

(5)

In the formula above, \(I = \frac{I_a}{I_b}\) is the ratio of price index of products in old city zone to that of new city zone. \(I_a\) and \(I_b\) are price indexes. Calculate and arrive at the below results:

\[
I_a = t_a \left( \sum_{i=1}^{n_a} p_{ai}^{1-\sigma_a} \right)^{1-\sigma_a}
\]

(6)

\[
I_b = t_b \left( \sum_{i=1}^{n_b} p_{bi}^{1-\sigma_b} \right)^{1-\sigma_b}
\]

(7)
2.2.3 Demand function

Max $U_a \sum_{i=1}^{n_a} t_a P_{ai} X_{ai} = \frac{\sigma}{1+\sigma-1}$ (8)

Max $U_b \sum_{i=1}^{n_b} t_b P_{bi} X_{bi} = \frac{\sigma}{1+1-\sigma}$ (9)

Deduce the demand function for products in new and old city zones from the maximized first-order condition:

$$X_{ai} = \frac{\frac{\sigma}{1+\sigma-1}}{t_a a^\sigma \sum_{i=1}^{n_a} t_a^\sigma P_{ai} X_{ai} = \frac{\sigma}{1+\sigma-1}}$$ (10)

$$X_{bi} = \frac{\frac{\sigma}{1+\sigma-1}}{t_b b^\sigma \sum_{i=1}^{n_b} t_b^\sigma P_{bi} X_{bi} = \frac{\sigma}{1+\sigma-1}}$$ (11)

2.3. Producer behavior

Commercial production embodies the features of scale economy. Supposing there is only one production element—capital. Set $r$ as the common interest rates of the two regions, which is externally given. Cost functions of a produce in new and old city zones are as following:

$$k_{ai} = a_0 + \beta_a x_{ai}, \quad k_{bi} = b_0 + \beta_b x_{bi}$$ (12)

$\alpha_a$ and $\alpha_b$ stand for fixed cost. $\beta_a$ and $\beta_b$ stand for marginal cost. Profit function is:

$$\pi_{ai} = P_{ai} X_{ai} - r(\alpha_a + \beta_x x_{ai}), \quad \pi_{bi} = P_{bi} X_{bi} - r(\alpha_b + \beta_b x_{bi})$$ (13)

Under the condition of profit maximization, we obtain the result below:

$$P_{ai} = \frac{r_a}{P_a}, \quad P_{bi} = \frac{r_b}{P_b}$$ (14)

Among the above, $P_a = 1 - \frac{1}{\sigma_a}$ and $P_b = 1 - \frac{1}{\sigma_b}$. From the formula, it can be seen that prices of all commodity in a city zone are the same, which exhibits the symmetric property within the region. However, prices of products/service in new and old city zones are different because of different elasticity of substitution and marginal cost in the two regions, which exhibits the asymmetric property. Enter the result of Eq. (14) into demand function and obtain the supply of each commodity through utility maximization and profit maximization.

$$X_{ai} = \frac{P_{ai}^\sigma}{n_a r_a t_a (1+n_a) t_a^\sigma 1-\sigma_a}$$ (15)

$$X_{bi} = \frac{P_{bi}^\sigma}{n_b r_b t_b (1+n_b) t_b^\sigma 1-\sigma_b}$$ (16)
3. Agent-Based Modeling and Dynamic Simulation

3.1. Agent-based modeling

In recent years, agent-based modeling has gained more attention in social science. Research on theories and the application of Agent-based Computational Economics and Artificial Society is just unfolding [24-26]. ABM is a bottom-up modeling strategy, which concerns about the interactions between large numbers of microscopic individuals. With ABM, we build micro behavior model and learning algorithm for individual decision-makers such as the residents and enterprises, and study the macro-spatial structure and process of the commerce in a region as a whole through analyzing the interactions of these numerous micro-agents [27]. In this paper, through the interactions of micro-agents we can dynamically observe the macro-structure and macro-processes such as dynamic changes of commodity price index, the number of shops, and the size of commodities in new and old city zones. This “dynamic” innovation transcends the static and comparative static analysis methods of traditional economic—we not only know the results of different states, but also clearly see the dynamic process during different states and equilibriums. More importantly, we can set a series of parameters in different scenarios, such as the elasticity of substitution, transport cost coefficient, population distribution, as well as consumption level and so on, and by way of computational experiments, we can study the structure and evolve law of the urban commerce under controllable conditions.

From the foregoing deductive derivation, we can get the consumption size of the resident agents and the supply of commodities of the shop agents in new and old city zones through maximizing the utility and profit. Then an endogenous agent-based model in two-regional scenario is built, and the production function of the shop agents has increasing returns to scale. Here we make use of Swarm software library [28] developed by Longdon, the author of Artificial Life, for secondary development. The standard GNU software simulation platform includes a number of reusable classes to support the process control, parameter adjustments, data analysis and graphical display of computer simulation experiment. In this paper, we build a simulation system Urban Swarm to simulate the evolution of metropolis spatial structure based on Swarm platform, in which Urban Observer and Urban Model is the core of the system.

Urban Observer input data and set simulation parameters into Urban Model, and various types of agent behavior and statistical data, including shop's quantity, commerce size and price index can be read from Urban Model. The time schedule of Urban Observer is to drive the system to read data continuously, and constantly refresh and draw two-dimensional graphs.

In the simulation system, shop agents are divided into old city shops and new city shops. The table below is the list of properties of shop agents (see Tab.1). The note of each table represents the corresponding variables in spatial model of the property.
Table 1 Property list of shop agent

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Note</th>
<th>Property</th>
<th>Description</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>fCost1</td>
<td>Fixed cost</td>
<td>a</td>
<td>fCost2</td>
<td>Fixed cost</td>
<td>b</td>
</tr>
<tr>
<td>mCost1</td>
<td>Marginal cost</td>
<td>a</td>
<td>mCost2</td>
<td>Marginal cost</td>
<td>b</td>
</tr>
<tr>
<td>sigmaR1</td>
<td>Elasticity of substitution of the goods in old city zones</td>
<td>a</td>
<td>sigmaR2</td>
<td>Elasticity of substitution of the goods in new city zones</td>
<td>b</td>
</tr>
<tr>
<td>priceR1</td>
<td>Price in old city zones</td>
<td>( P_i )</td>
<td>priceR2</td>
<td>Price in new city zones</td>
<td>( P_n )</td>
</tr>
</tbody>
</table>

The commercial behavior of the shops from new and old city zones are the same, see the table below (Tab. 2).

Table 2 Behavior function of the shop agent

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-setMyPrice</td>
<td>Set the price of the goods</td>
</tr>
<tr>
<td>-getDemandToMe</td>
<td>Get the demand from a consumer agent for my goods</td>
</tr>
<tr>
<td>-sellGoods</td>
<td>Sell the goods to consumer agent</td>
</tr>
<tr>
<td>-getMyProfit</td>
<td>Get the sales profit</td>
</tr>
<tr>
<td>-getScale</td>
<td>Get information on market scale</td>
</tr>
</tbody>
</table>

In the system, residents are divided into old city residents and new city residents, and the population and consumption level in two regions can be controlled. The following is the property list of residents from new and old city zones (Table 3).

Table 3 Property list of resident agent and main behavior function

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Note</th>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>budget</td>
<td>Consumption budget of the residents</td>
<td>Y</td>
<td>-getDemandR1</td>
<td>Demand for a specific commodity in old city zone</td>
</tr>
<tr>
<td>sigma</td>
<td>Elasticity of substitution between goods from new and old city zones</td>
<td>( \sigma_{ab} )</td>
<td>-getDemandR2</td>
<td>Demand for a specific commodity in new city zone</td>
</tr>
<tr>
<td>sigmaR1</td>
<td>Elasticity of substitution of goods in old city zones</td>
<td>( \sigma_a )</td>
<td>-buyGoodsR1</td>
<td>Buy the commodities in old city zone</td>
</tr>
<tr>
<td>sigmaR2</td>
<td>Elasticity of substitution of goods in new city zones</td>
<td>( \sigma_b )</td>
<td>-buyGoodsR2</td>
<td>Buy the commodities in new city zone</td>
</tr>
<tr>
<td>tCostR</td>
<td>transport cost coefficient of shopping between new and old</td>
<td>( t_{ab} )</td>
<td>-getIndexR1</td>
<td>Get information of price index ( L ) in</td>
</tr>
</tbody>
</table>
Urban Model is the most important class in the simulation system. It not only create varieties of objects required for the computational experiments, but also control and coordinate the relationship between the instances in the simulation system, so Urban Model has a number of important properties (Table 4).

Table 4 Property list and main behavior function of Urban Model

<table>
<thead>
<tr>
<th>Property</th>
<th>Description</th>
<th>Note</th>
<th>Behavior</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>numPopR1</td>
<td>Population of old city zone</td>
<td>$P_a$</td>
<td>-sectorEnterQuitR1</td>
<td>Shops enter or exit old city zone</td>
</tr>
<tr>
<td>numPopR2</td>
<td>Population of new city zone</td>
<td>$P_b$</td>
<td>-sectorEnterQuitR2</td>
<td>Shops enter or exit new city zone</td>
</tr>
<tr>
<td>numSectorR1</td>
<td>Number of shops in old city zone</td>
<td>$n_a$</td>
<td>-getIndexR1</td>
<td>Get information of price index $I_a$ in old city zone</td>
</tr>
<tr>
<td>numSectorR2</td>
<td>Number of shops in new city zone</td>
<td>$n_b$</td>
<td>-getIndexR2</td>
<td>Get information of price index $I_b$ in old city zone</td>
</tr>
<tr>
<td>budgetR1</td>
<td>Consumption level of residents in old city zone</td>
<td>$Y_a$</td>
<td>-getScaleRatioR1</td>
<td>Get information of shop market share in old city zone</td>
</tr>
<tr>
<td>budgetR2</td>
<td>Consumption level of residents in new city zone</td>
<td>$Y_b$</td>
<td>-getScaleRatioR2</td>
<td>Get information of shop market share in new city zone</td>
</tr>
</tbody>
</table>

It should be noted that, as shops are free to enter or exit the market, the long-term profits of each shop is zero. If the shop in new or old city zone are still profitable, there would be new shops to enter, but if the new enterer gain negative profit, there would be shop quit from the market, when the system reach dynamic equilibrium.

3.2. Scenario analysis and dynamic simulation

3.2.1 Dynamic simulation of spatial structure of commerce in general scenario
From the perspective of current development situation of Chinese urban commerce, the development of new urban commerce entails a greater fixed costs because changing the consumer behavior need greater efforts, such as to improve the accessibility of space (i.e. the construction of large scale parking lot), to invest in business infrastructure, to spend higher marketing expenses, and even to construct new commercial area. Meanwhile, commerce in old city zone benefit from the spillover effects of mature markets and shared intermediate inputs. The marketing cost and fixed investment is relatively lower in old city zone, and it is also easier to lease the business premises. In addition, old city zone has a larger population than the new city zone. Scenario setting of commerce development in two city zones in general case is as follows (Table 5).

Table 5 Settings of parameters and variables of the new and old city zones in general scenario

<table>
<thead>
<tr>
<th>Old city zone</th>
<th>New city zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>parameters and variables</td>
<td>setting</td>
</tr>
<tr>
<td>Population $P_a$</td>
<td>200</td>
</tr>
<tr>
<td>Consumption budget $Y_a$</td>
<td>50</td>
</tr>
<tr>
<td>Initial number of shops $n_a$</td>
<td>50</td>
</tr>
<tr>
<td>Fixed cost $\alpha_a$</td>
<td>5</td>
</tr>
<tr>
<td>Marginal cost $\beta_a$</td>
<td>1.1</td>
</tr>
<tr>
<td>Elasticity of substitution of the goods in old city zone $\sigma_a$</td>
<td>3.5</td>
</tr>
<tr>
<td>Transport cost coefficient in old city zone $t_a$</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Set the transport cost coefficient $t_{ab}$ between new and old city zones as 2.2, elasticity of substitution $\sigma_{ab}$ as 3.0, and set the income of the residents in two regions $Y_a$ and $Y_b$ the same. Through analysis on the number of shops, sales volume of a commodity and commerce size (number of shops X sale scale of individual shop) of the two regions, we can see the dynamic change of the clustering degree of commerce space in new and old city zones under different scenario (AA. 2).
Figure 2 Dynamic simulation of spatial structure of metropolitan commerce in general scenario

Figure 2 shows the number of shops in old city zone is larger, but the sales volume of each shop is small, while in new city zone there is less number of shops, the sales volume of each shop is relatively larger (because of high fixed investment, only shop with large sales volume can achieve a profit). Overall, commerce in old city zone occupies more than 80% of market share, while market share of commerce in new city zone is less than 20%. The simulation results cohere with Chinese metropolis commerce. We will take this as the control (Figure 2), and further simulate and analysis the impact of these parameters such as fixed costs, regional differences of commerce and transport cost on the spatial structure of metropolis commerce.

3.2.2 Impact of parameters change on spatial structure of commerce

1) Impact of the commerce fixed cost on spatial structure of commerce

Narrow the gap between the new and old city zone in commercial infrastructure and popularity (by narrowing the gap of fixed investment between the two regions, and economies of scale are similar in the two regions), then what the spatial structure of commerce would be? Here the fixed costs of commerce $\alpha_a$ and $\alpha_b$ in old and new city are set to 5.0, and simulation results are as follows (Figure 3).

![Figure 3 Simulation of spatial structure of metropolitan commerce with qual fixed cost in new and old city zone](image_url)
Figure 3 shows that as the fixed costs decrease, the number of shops in new city zone increase significantly, and the sales volume of a single shop in new and old city zone tend to be the same. The difference in commerce size of the two regions is caused by population differences, but the market share of commerce in new city zone has been greatly improved. Compare with the first scenario simulation (Figure 2), the greater visibility of the gap of commercial infrastructure and population between the two regions is (the greater the fixed cost is, the more importance of scale economy would be), the more imbalance of the commerce spatial structure would be, the distribution of commerce space will be more uneven, and commerce mainly concentrated in a region with relatively lower fixed cost. Therefore, for the government of new city zone, to promote the construction of commerce infrastructure vigorously, and increase marketing investment on the area can significantly reduce the fixed costs of local shops, and improve the commerce environment.

2) Impact of goods diversity between two regions on spatial structure of commerce

Shops in new and old city zones tend to differentiate their goods/service, for instance, to bring in new formats of commerce, including shopping mall, outlets, decoration market, textile market, leisure service, and theme service. While the commerce in old city zone is mature, shops in new city zone are more likely to introduce a new format of commerce, so the elasticity of substitution of goods/service $\sigma_{ab}$ between the two regions become the focus of the study, if we lower $\sigma_{ab}$ from 3.0 to 1.5, simulation results is as follows (Figure 4).
The decline of elasticity of substitution of the goods between the regions means the strengthening of diversity. Figure 4 shows that the strengthening of diversity has not change the sales volume of a single shop in new and old city zones, but change commerce size of the two regions with less number of shops in old city zones. It indicates that the commerce in new city zone is more attractive and has expanded its market share through competition. Conversely, given that no diversity exists in the commerce of two regions, if old city zone has enough advantage in fixed cost or transport cost, then the business will be entirely concentrated in the old city zone, forming the core-periphery structure. Therefore, for the new business district, to implement differentiated business strategy, actively promote format and service innovation, and develop a unique business culture and products, is the key to win the competitive advantage. Of course, the local marketing strategy of government in new city zone can not be ignored as well.

3) Impact of shopping transport cost on spatial structure
If the transport cost coefficient $t_{ab}$ between new and old city zones decline from 2.2 in general scenario (Figure 2) to 1.5, the simulation result is as follows:

![Simulation of spatial structure of metropolitan commerce with varying shopping traffic cost in new and old city zones](image)

The figure shows that if the old city zone has a larger population and lower fixed cost, the improvement in the traffic between new and old city zones is in favor of the expansion of old city's commerce and market share, which speed up the spatial concentration and core-periphery structure formation. In other words, commerce is often concentrated in a region with location advantage. To new city zone, if accessibility is improved significantly, to enlarge population, decrease the fixed cost of commercial development can also help to seize greater market share.

4. Conclusions
In this paper, fixed and marginal costs of commerce, spatial distribution of population and income levels, diversity of commerce within and between regions, as well as transport cost between two regions are viewed as key factors to dominate and influence the spatial structure of metropolis commerce. From the simulation results we can conclude that: (1) the greater visibility of the gap of commercial fixed cost between the two regions is, the more disparity of the importance of scale economy is, and the more imbalance of the commerce spatial structure would be. To promote commercial infrastructure improvements and make efforts to enhance the regional image in new city zone led by government can significantly reduce the fixed inputs of the commercial exploitation. (2) Because of the preferences for varieties, more intense preference for varieties means relative smaller elasticity of substitution. Therefore, for new city zone with poor location, scarce commerce infrastructure and less popularity, to strengthen features of commercial products and services and to innovate commercial formats can help to enhance the market share. (3) Traffic is a double-edged sword. Commerce often concentrated in a region with location, population and fixed cost advantage, and the improvement of traffic conditions will accelerate the concentration of commercial space. Therefore, the already formed commerce concentration and commerce status of old city zone is difficult to change, unless the new city increase its population size significantly and reduce the fixed costs of its commercial exploitation. Due to space limitations, this article will be to explore in new text, to discuss the issue of the influence of commerce diversity within new and old city zones, the consumption level of residents in different regions, and the collaborate transfer of population and commerce on spatial structure of metropolis commerce.

From the perspective of research method, the deductive reasoning of economics can effectively reduce the complexity of the problem, and the ABM can provide us with the details that deductive theory can hardly express or handle, making the deductive reasoning more applicable and able to “dynamically” reflect the characteristics of changing parameters in complex system. Therefore, this “dynamic” innovation transcends the static and comparative static analysis methods of traditional economic—we not only know the results of different states, but also clearly see the dynamic process during different states and equilibriums, which is an important foundation to discovery new laws and gain new knowledge. Therefore, the technical route through deductive model of economics and agent-based geographical computation, to empirical analysis and econometric test is worth exploring.

References


