The Visualization and Analysis of Spatial Distribution of Foreign Restaurants: A Case Study of Tokyo Wards Area

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1 Introduction

Food culture is an important part of each regional culture throughout human history. Japanese cuisine has a long history of being affected by foreign culture. With the process of globalization, various foreign food culture could be enjoyed in Tokyo. Foreign restaurants have developed into kinds of spatial agglomeration phenomena.

In order to understand the different distribution phenomenon among these various foreign restaurants in Tokyo, to clarify how they have changed in recent years, and to find out the factors that affect the spatial distribution of foreign restaurants, this research was designed to achieve the following objectives. First, the study aims to visualize the spatial distribution of foreign restaurants and explores the characteristics among different foreign restaurants. Secondly, analysis of spatial distribution evolution is conducted to reveal the opening and increase phenomenon of foreign restaurants in recent years. Finally, the regressions are conducted to analyze the correlation between the influencing factors and foreign restaurants. This study help to gain a basic understanding of location preference of foreign restaurants.

2 Methodology

2.1 Study Area

In view of the fact that most restaurants and foreign populations are concentrated in the 23 wards, it is decided to regard the Tokyo wards area as the main research area to study the spatial distribution characteristics of foreign restaurants.

2.2 Data

The restaurants data are the POI (Point of Interest) data collected from Telepoint Pack, which is telephone directories (Yellow pages) database "Teledata". It is divided into Chinese, Korean, Indian, French and Italian restaurants. The foreign population data from 2009 to 2017 are downloaded from the website of Tokyo Metropolitan Government. The business land prices of Tokyo are collected from Tokyo Metropolitan Government Bureau of Finance.

2.3 Research Methods

Gini coefficient is utilized to calculate the distribution of various foreign restaurants which could reflect the agglomeration degree. The research utilizes Global Moran’s I to analyze the spatial auto correlated phenomenon of restaurants. Kernel Density Estimation is used to visualize the spatial distribution of POI data. To identify the factors that influence the

distribution of foreign restaurants and analyze their correlation, multiple linear regression analysis is conducted through the OLS model and GWR model

3 Spatial Distribution of Restaurants

3.1 Gini Coefficient

Table 1 Gini Coefficients of Foreign Restaurants

Restaurants	All	Chinese	Korean	Indian	French	Italian
Gini coefficient	0.29	0.25	0.42	0.22	0.57	0.41

Table 1 shows the Gini coefficients of foreign restaurants. Chinese cuisine and Indian cuisine are considered as the civilian cuisine, which the business thresholds are not high, so it could present a lot in non-commercial districts. The Gini coefficient of Korean, French and Italian restaurants shows that the distributions of these restaurants are more equal.

3.2 Global Moran's I

Table 2 Global Moran's I for Restaurants

Restaurants	Moran's I value	z-score	p-value
All restaurants	0.314478	3.087089	0.002021
Chinese	0.284232	2.765214	0.005689
Korean	0.133742	1.767173	0.077199
Indian	0.094274	1.165983	0.243621
French	0.360331	3.647836	0.000264
Italian	0.407113	3.851927	0.000117

Table 2 shows results of the Global Moran's I for Restaurants. Moran's I value of foreign restaurants is arranged from large to small: Italian, French, Chinese, Korean and Indian restaurants. For Chinese, French, and Italian restaurants, there is a less than 1% likelihood that these clustered patterns could be the result of random chance. Based on the results, there is a less than 10% likelihood that this clustered pattern of Korean restaurants could be the result of random chance. As for Indian restaurants, the clustered pattern does not appear to be significantly different than random.

3.3 Kernel Density Estimation

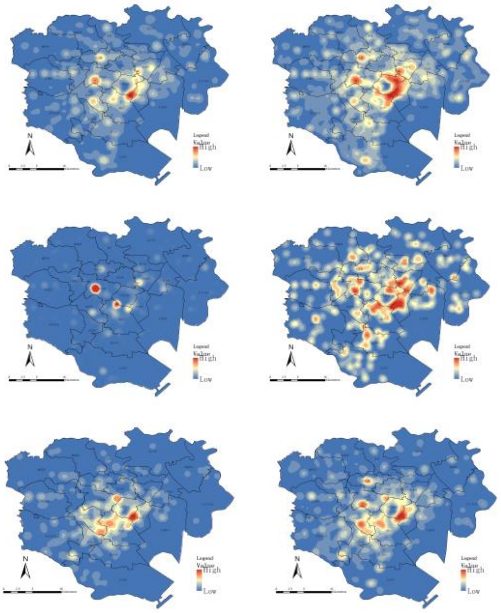

Figure 1 Distribution of Foreign Restaurants in 2017
(In turn: all restaurants, Chinese restaurants, Korean restaurants, Indian restaurants, French restaurants, Italian restaurants)

Kernel density estimation is conducted to visualize the spatial distribution of foreign restaurants as Figure 1. It could be found out that the spatial distribution pattern of Chinese restaurants is basically the same as that of all restaurants. The culture of Chinese cuisine has been fully integrated into the Japanese society, so it does not show the characteristics of exotic food culture by the spatial distribution. The agglomeration phenomenon of Korean restaurants shows a strong relationship between Korean town and Korean restaurants. Indian restaurants are scattered throughout 23 wards, forming many small clusters. French cuisine and Italian cuisine belong to the western

cuisine. In addition to the Ginza and Yūrakuchō area, it is also concentrated in Roppongi, where has more foreigners. Besides, there are various fashionable areas and some of these places, like Kagurazaka, have European style streets, where French and Italian restaurants prefer to locate at.

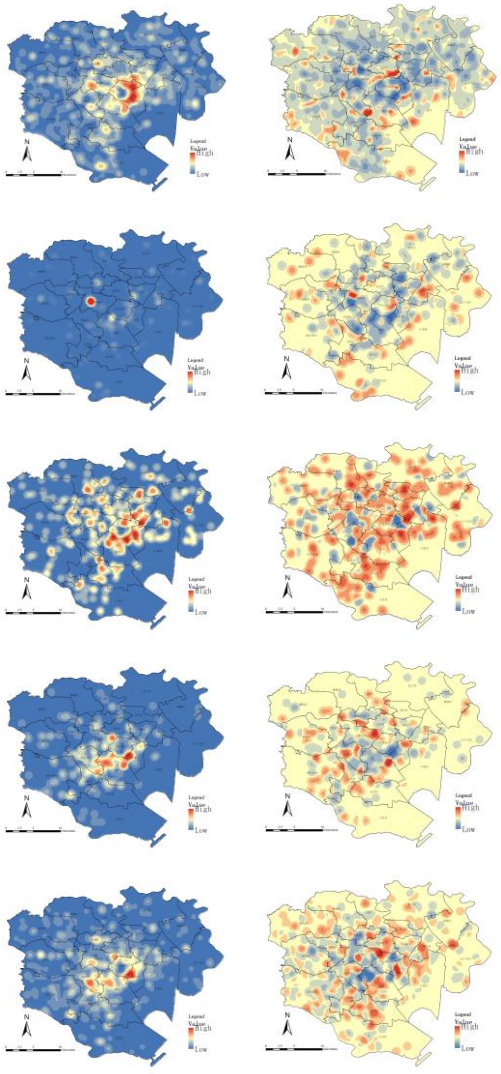

Figure 2 Evolution of Distribution from 2009 to 2017
(Left: newly opened restaurants
Right: change of number
In turn: Chinese, Korean, Indian, French and Italian)

Table 3 Changed Areas of Foreign Restaurants

	Openings Distribution	Increasing Distribution
Chinese	Ginza and Kanda	Hongō and Ebisu
Korean	Shin-Ōkubo and Akasaka	Shin-Ōkubo
Indian	Ginza, Akasaka and Asakusabashi	Ginza, Asakusabashi, Machiya, Naka-Itabashi, Kameido, Shin-Koiwa and Gotanda
French	Ginza, Kagurazaka, Roppongi and Hamamatsucho	Kagurazaka and Hamamatsucho
Italian	Ginza, Shibuya, Roppongi and Kagurazaka	Ginza and Kagurazaka

Appearance data of foreign restaurants from 2009 to 2017 are extracted to make the kernel density estimation of newly opened restaurants. The disappearance data of foreign restaurants from 2009 to 2017, have also been extracted by the same bandwidth. The value of output raster can be calculated to show the change of number of foreign restaurants. The clusters of openings districts and increasing districts are summarized in Table 3.

From the results, it could be observed that there are both a lot of openings and increasing of restaurants from 2009 to 2017 in the districts, such as Korean restaurants in Shin-Ōkubo, Indian restaurants in Asakusabashi, as well as French and Italian restaurants in Kagurazaka. Some places represented by Ginza had already gathered many foreign restaurants in 2009 and continued to gather more foreign restaurants in 2017. The other places, such as Asakusabashi where Indian restaurants are gathering, have developed new concentrations through newly opened foreign restaurants. Although there is just a relatively low increase of Indian restaurants in some areas, the number has grown. It also happened in the case of Chinese restaurants in certain areas, such as Hongō and Ebisu. It also could be found out that even though there are plenty of newly opened foreign restaurants in the area, the total number of foreign restaurants maintains. It indicates that openings and closures of restaurants in these districts happened frequently.

4 Analysis of Influencing Factors

OLS model and GWR model are employed to examine the association between foreign restaurants and two characteristics: foreign population and land price.

Table 4 OLS Results of Foreign Restaurants

	sig. of F	coefficients		sig. of t-test	VIF
Chinese	0.048	population	0.201	0.386	1.001
		land price	-0.007	0.020	
Korean	0.000	population	0.427	0.000	1.022
		land price	-0.001	0.350	
Indian	0.022	population	-0.007	0.973	1.000
		land price	-0.002	0.006	
French	0.000	population	5.008	0.000	1.685
		land price	0.002	0.229	
Italian	0.009	population	31.422	0.018	1.500
		land price	0.001	0.383	

Table 5 Comparison of OLS and GWR

	OLS			GWR		
	R^2	Adjusted R^2	AICc	R^2	Adjusted R^2	AICc
Chinese	0.262	0.188	-133.28	0.262	0.188	-133.27
Korean	0.578	0.535	-205.53	0.607	0.549	-205.71
Indian	0.318	0.250	-194.75	0.319	0.250	-194.74
French	0.707	0.678	-185.73	0.795	0.739	-188.28
Italian	0.373	0.310	-138.67	0.504	0.394	-140.21

It is found out that the significance of foreign population and land price is different depending on the type of foreign restaurants. The test of significance shows that there is no significant correlation between population and restaurants for Chinse and Indian restaurants. It is considered that more detailed population data could conduct precisely regression. For Korean, French and Italian restaurants, foreign population is more important than land price. Furthermore, there is a positive correlation between land price and French, Italian restaurants, while for Chinese, Korean, Indian restaurants, coefficients of land price show the negative correlation.

From Table 5, it could be seen that results of Chinese and Indian restaurants are almost same. As for Korean, French and Italian restaurants, results of GWR are greater than those of OLS. The estimated coefficients of the GWR model are visually shown in Figure 3, which reflect the difference among 23 wards.

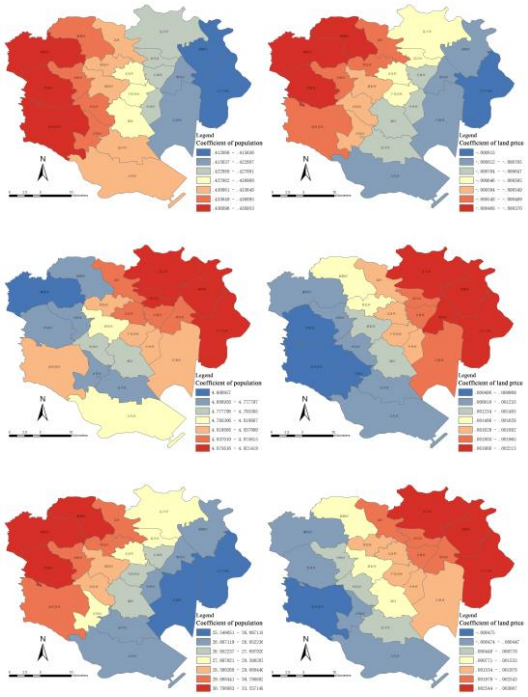

Figure 3 distribution of coefficients
(Left: population Right: land price
In turn: Korean, French and Italian restaurants)

5 Conclusion

This study explores the spatial distribution of five kinds of foreign restaurants in Tokyo wards area. It captures the characteristics of different foreign restaurants through the visualizations. This study also visualizes the spatial distribution of newly opened foreign restaurants and the areas where the number of foreign restaurants has grown from 2009 to 2017. It is found out that significance of foreign population and land price is different depending on the type of foreign restaurants. It also contributes to the further extension of geography research content.