Specialization or Diversity?

Mixed Land Use in Commercial Districts

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Abstract

What determines the land use mix in a commercial area? Within the downtown area, various retail and business types are evenly distributed in some commercial districts. However, for the others, a single type of business dominates the area. Each commercial district in downtown has a different degree of mixed land use according to its characteristics. Physical factors such as the location or accessibility have a great influence on those, though the socioeconomic factors of customers also affect the land use mix in a commercial area. In this study, a micro-scale approach is used to define the key determinant of land use mix in a commercial district. In the past, research on the relationship between land use and human activity was often done, but the microscopic approach was rare. However, this study intends to overcome the limitations of existing studies through big data processing. For commercial districts in Seoul, the LUM (Land Use Mix) of each district is defined based on the entropy index using individual building data that show the main use of each building for more than 100,000 units. By examining which factor determines the difference in a heterogeneity of business categories in commercial districts, we define which socioeconomic factors greatly affect the types of agglomeration economies.

Keywords: Commercial Districts, Land Use, Mixed Use, Land Use Mix(LUM), Big data

1. Introduction

Commercial districts have various types: concentrated with similar businesses or composed of various compartments. Some commercial areas become a huge cluster with monotonous use, while others consists of a wide variety of land uses. The homogeneous commercial clusters chose to pursue localization economies among the stores of similar businesses, while the heterogeneous commercial clusters enable the multi-purpose shopping in one place for urbanization economies. These two strategies are both to maintain the vitality of the region.

The purpose of this study is to analyze what factors affect the mixed land use of each commercial area. By analyzing the socioeconomic conditions of the surrounding areas and the physical characteristics of the commercial districts, we aim to find out what influence the diversity strategies adopted by the commercial districts in Seoul. Data for individual buildings located in commercial areas in Seoul were used to define the degree of mixed use in a commercial area. This study attempts to define the mixed land use at the micro level and examines how it affects the characteristics of the commercial area.

2. Review of Literature

2.1 Specialization vs. Diversity

The neo-regionalism, which emphasizes the role of regions in regional development and economic revitalization, advocates the benefits of the agglomeration of industries of the same industry in a region(Macleod, 2001). According to Markusen et al (1986), a cluster of small and medium-sized businesses form a new industrial district, thereby enhancing regional competitiveness. In addition, the concentration of interconnected businesses in a region forms an industry cluster, and spatial proximity increases the potential for innovation and regional development through a network(Krugman, 1991; Porter, 1996; 2002).

Commercial districts in a city are also considered as retail and service industry clusters, but there is much debate about whether the new regionalism theory can be applied to commercial areas as well. Conversely, a business mix is intended to provide convenient multi-purpose shopping to visitors in one place(Arentze et al., 2005; Teller et al., 2012; 2016).

This study aims to examine how the socioeconomic characteristics of a commercial area affects the choice of two opposing development strategies: specialization vs. diversity.

2.2 Mixed land use in commercial area

There has been a controversy over the effect of mixed land use that it really increases the vitality of space. A number of studies on mixed use in commercial districts focus on how mixed use affects the commuting pattern or choice of visitors(Cerin et al., 2007; Forsyth et al., 2007; McCormack et al., 2012). In order to examine the impact of commercial mix, Cervero and Duncan (2003) demonstrate that the proper degree of land use mix with commercial use and other use would increase the number of visitors. Also, Cervero(1996) analyze that commute through walking and bicycles has a positive correlation with high-density development and mixed use in a US metropolitan area. It has been confirmed that the commercial use mix within the business district located in the suburbs has a positive impact on pedestrian or bicycle traffic volume. In addition, Frank et al. (2008) demonstrate that mixed land use increases both commuting and non-commuting traffic (Ewing·Cervero, 2010).

In South Korea, there has been some research on the factors that affect the mixed use in commercial areas over the last decade (Seo et al., 2008; Hong et al., 2010). Yoon and Choi (2013) used the floating population data of Seoul (2009) combined with building ledger data and business survey data in 100m radius boundaries to verify the relationship between the number of maximum visitors, land use, and LUM (Land Use Mix, an entropy index indicating the degree of mixture of land use) in downtown commercial districts. As a result of analyzing the environmental factors affecting walking volume, it is confirmed that the higher the land use mix (degree between 0 and 1) of the lower floors of the building, the more the walking amount increases. However, the number of floating populations decreases as more residential use is included in commercial areas (Sung et al., 2014).

3. Methodology

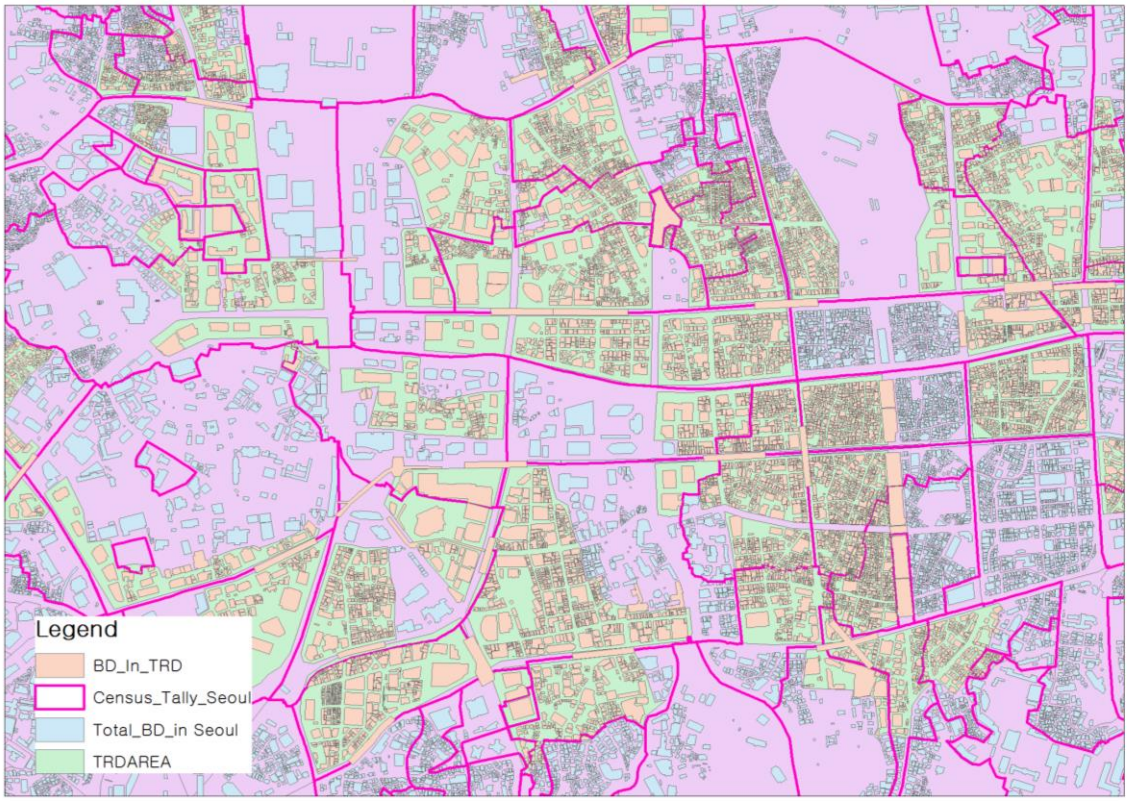
3.1 Data collection

The study area covers 232 Developmental Commercial Zones (DCZs) located in the Seoul Metropolitan City. The DCZ is identified by the Minstry of SMEs and Startups as an area where many restaurants, retail shops, and small offices concentrated with abundant jobs and traffic working in the surrounding areas.

Given the nature of this research, the default collection unit of data is a census tally district (CTD), which is a smaller spatial unit than the smallest administrative unit, Dong. Usually, several CTDs are included in a Dong. Since the boundaries of some commercial areas are not consistent with the boundaries

of census tally districts, all of the CTDs that include the boundaries of the commercial area are counted in as the scope of the study. Thus, data for 2,234 CTDs in total were aggregated into data for the 232 DCZs for analysis.

For each DCZ, by using GIS(ArcMap 10.3)'s Spatial Join feature, we extracted buildings whose centroid is located within each DCZ and assigned the ID of the DCZ to the extracted buildings. Likewise, the ID of each DCZ is assigned to the CTDs which contain the centers of those buildings.



[Figure 1] Boundaries of Census-tally Districts and Commercial Areas

3.2 Data Aggregation

3.2.1 Land uses of buildings

Building DB Korea provides a summary of the current land use of individual buildings in Seoul. The data used for the analysis(total 407,376 units) are accumulated until the first half of 2017, which was revised on July 14, 2017.

3.2.2 Census Data

Census data provides the number of residents, employees in each CTD.

3.2.3 De facto population

The Seoul Metropolitan Government provides GPS data collected for 19,153 CTDs in Seoul by dividing the number of populations located in the districts of each 24-hour unit by sex and age (5-year interval, all ages from 0 to 69 and over 70) on a daily basis. This is based on LTE(Long Term Evolution, a 4G mobile communications standard) signal data provided by KT(Korea Telecom).

4. Empirical Analysis

4.1 Variable descriptions

Independent Var.	LUM in a commercial district	Entropy index
Dependent Var.	The size of a commercial area	ln(size(m^2))
	Max visitors per hour	The maximum number of visitors per hour
	Resident population in adjacent area (100m rad)	The number of resident population
	Total employees in adjacent area (100m rad)	The number of employees
	LUM in adjacent area (100m rad)	Entropy index
	The ratio of office use in a commercial area	Ratio of office use buildings per total buildings
	The ratio of residential use in a commercial area	Ratio of residential use buildings per total buildings
	The number of subway lines near a commercial area	Total number of subway lines encompass a boundary

[Table 1] Variables

The maximum number of visitors in each commercial area is a value of each CTD of 24 months and 730 days from January 2017 to December 2018. The data are recorded hourly and aggregated by corresponding time zone.

In order to obtain the annual average as shown in Equation (2).

$$X_{at} = \frac{\sum_{n=1}^{k} X_n}{k} \quad \ldots(2)$$

X_{at}: Average value of CTD ‘a’ – time zone ‘t’

k : 730 (sum of total days, 2017.01.01~2018.12.31)

The Land Use Mix (LUM) is an Entropy Index indicating the degree of mixture of land use with a range of values from 0 to 1. The closer the LUM is to 1, the higher the complexity(Lee and Moundon, 2006).

$$LUM = -\sum P_U \ln(P_U)/\ln(n) \quad \text{...(3)}$$

P_U: The ratio of total floor area of land use type 'U'

(calculated based on the use classification above)

n: Number of land use in the unit (total: 12)

In equation (3), P_U represents the area ratio of each land use, and n represents the number of land use. The area ratio for each use was calculated based on Building DB Korea.

4.2 Results: Multinomial Regression

	Coef.		Beta
The size of a DCZ	-0.022		0.018
Max visitors per hour	0.000		0.000
Resident population in adjacent area (100m rad)	2.986	*	1.707
Total employees in adjacent area (100m rad)	-0.103		0.544
LUM in adjacent area (100m rad)	0.480	***	0.076
The ratio of office use in a DCZ	0.034		0.058
The ratio of residential use in a DCZ	0.102	*	0.060
The number of subway lines near a DCZ	-0.014		0.011
Constant	0.530		
Number of obs.	232		
R-squared	0.198		

*** p>0.001 ** p>0.05 * p>0.1

[Table 2] Estimation Result

According to the results, the mixed use of the commercial districts has a correlation with the resident population and LUM in the adjacent area(100 meter radius), and the ratio of residential buildings in the commercial district.

This suggests that the demand for housing in the commercial areas and adjacent areas affects the mixed land use within the area. Resident population has a positive correlation with the mixed use, while the number of visitors identified by the de facto population is insignificant.

In addition, the ratio of office buildings in the commercial area and the number of workers in the adjacent areas is also not significant.

On the other hand, physical factors of the commercial area, such as the number of subway lines or the size of the DCZ, do not affect the mixed use of the commercial area.

Also, it isconfirmed that the factors that determine the visit to aDCZare not limited to the inside of the DCZ, butare significantly affected by the surrounding area as well. This is because the mixed land use of the DCZ is influenced by the resident population and LUM of its catchment area.

5. Findings and Discussion

This study aims to analyze the socioeconomic factors affecting the mixed land use in commercial areas. According to the results of the study, housing in surrounding areas is a key factor that has a significant impact on mixed land use. The higher the ratio of residential buildings and the number of residents in its catchment area, the higher the degree of land use mix (LUM) in the commercial area. And the result shows that the LUM of adjacent area near a commercial district boundary also affect the LUM of the commercial area. In conclusion, significant presence of residential use and the mixed use of the surrounding area are the main factors that increase the diversityof the commercial area.

This study identified the basic factors affecting mixed use of commercial areas, but in order to identify more specific influential factors, it is necessary to examine key determinants of heterogenous use clusters in commercial districts. In order to produce more precise results, it is needed to measure the degree of retail mix in a commercial area in addition to defining a land use by building units.

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