Essays on Demands and Attributes in Property Markets of Republic of Korea

By

Taehyung Kim

DISSERTATION

Submitted to
KDI School of Public Policy and Management
in partial fullfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY
IN PUBLIC POLICY

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Abstract

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The three chapters in this dissertation paper tackle the questions of how demands for various properties respond to the changes of attributes of properties in the market. Though all three theses are related to the topics related to the real estate market, the objects of study are different. While the first and the second papers deal with markets of residential and commercial properties, the third one inquires the mechanism as to how supplying urban-use lands are determined.

In the first chapter, the value for safe access to schools is estimated in the residential apartment complexes. It is well known that proximity to schools has distinct values in the housing market. Previous research finds that there are solid correlations between the academic performance of schools and housing prices. However, this study contributes to the literature by estimating the pure value of safety concerns of parents in housing prices. While most of the previous research has focused on the value of educational quality of schools or the value of time-saving on the way to schools with hedonic pricing models, this study finds the value of safe access to schools in housing price determination for the

first time with similar statistical methods. Addressing endogeneity, which is prevailing in the estimations of school effects, is possible with the unique circumstances of the target area, Sejong city in the Republic of Korea, which was designed and built by neutral public urban planners to have balanced accessibility to elementary schools. However, the results are not limited to the city but can be generalized to the other cities with similar settings.

The second paper explores reasons why vacancies seem to exist permanently in the commercial property market. Traditionally, academic papers have argued that vacancy level will converge to the natural rate through rent adjustment and the market-clearing. However, other scholars claimed the opposite, rent rigidity, can be true. This chapter is inclined to the latter argument with the data of 31 business districts of Seoul, the capital city of the Republic of Korea. Furthermore, it suggests a new hypothesis that can explain rent rigidity by behaviors of landlords who are likely to maximize total benefits from properties. The hypothesis is that landlords can be reluctant to adjust rents if adjusting behavior can cause the devaluation of their assets. The estimations with price-per-rent ratio (PRR) and state of vacancy of properties support the hypothesis.

The third paper estimates political influence on policy-making of land use. Mayors, elected by public votes, have strong wills to satisfy voters for the next election, and, for them, the conversion of land use to more valuable ones can be a good tool for vote purchasing purposes. With local mayoral election data from 2002 to 2014 and land use data of primary municipalities of the Republic of Korea, the author tests the hypothesis that mayors who faced more fierce competition in the last election are more willing to promote developments. However, unlike the prior expectation, strong evidence is not found in the estimations with the entire countries. However, significant statistical correlations are found in the boroughs of metropolitan cities, more densely populated

areas. The heterogeneity between the entire sample and the densely populated area seems to be caused by the scarcity of developable lands in the more urbanized municipalities. The argument is supported by the estimation result with the regressions with different quantiles of developable land area per capita.

Dedicated to my family

ACKNOWLEDGEMENTS

Looking back to the past seven years and the agonies of conducting research and writing dissertation papers, I would like to express my gratitude to Professor Baek, Jisun, my supervisor. Professor Baek has always inspired me with new ideas whenever I faced hurdles that looked impossible to overcome and encouraged me to push forwards to the road ahead. All my knowledge and skills regarding economics and public policy, if any, cannot be obtained without the instruction and guidance of Professor Baek. Taking the lectures on microeconomics and game theory of Professor Baek is one of the most precious experiences in my Ph.D. course.

I have encountered many great scholars through my seven years in KDI school, and I owed them valuable lectures and wisdom. The econometrics lectures of Professor Kim, Taejong, and Wang, Shun helped me construct building blocks of quantitative methods. Professor Cho, Man gave me a lot of uncomparable advice that can reinforce weaknesses of the papers with his experiences and specialty as a top-level urban economist. Professor Lee, Jongyearn, encouraged me by patting me on the back while providing clues to solve current obstacles. Professor Han, Baran, and Lee, Jongkwan suggested alternative methods to improve the quality of the papers with their sharp eyes during the final evaluation process.

Finally, I want to share my present pleasure with my family, who have sacrificed and endured the time with me. Without their affectionate support, I could not even start the doctoral course in the KDI School.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter 1

Mencius's Mothers in Korea: The Causal Effects of Proximity to Elementary Schools on Housing Prices

[1]

[1]This chapter is written with Jisun Baek, KDI School of Public Policy

1.1 Introduction

It is well known that housing prices are higher when the locations of houses have better accessibility to elementary schools. In the Republic of Korea, apartment complexes containing elementary schools in their territories are more valuable in the housing market. The higher valuation might be related to concerns of parents about the education and safety of their children. When other qualities of all schools are similar, there can be two potential mechanisms by which proximity to schools affects housing values: the value of time and the value of safety. The closer distance from an apartment to a school is, the more pupils can save time commuting and the safer school trips. Generally speaking, parents will prefer shorter routes to school because the possibility of traffic accidents and other misfortunes can be lower. Because most pupils in Korea walk to elementary schools, the safety concern of parents is more prominent in Korea than in other countries using cars or school bus systems to commute to school.

This paper tries to find that safety issues can be essential in choosing a residential area. We estimate the willingness to pay for safety in the routes to school, which is distinct from saving time. However, it is difficult to disentangle the value of safety and time because the two values move in the same direction when the distance from school changes. Moreover, it is challenging to calculate pure values of saving time and safety because many confounding factors can affect housing values, such as the quality of schools, in many circumstances.

In this research, we try to solve the issues regarding estimating the values of living proximity to schools by selecting a particular case of the newly developed city in the Republic of Korea. Firstly, by using data of Sejong city of the Republic of Korea in its early development stage, we can control the differences in the quality of schools.

Because Sejong city was planned and designed by a public entity, which is a subsidiary of the Korean government, the locations of schools were artificially determined by the state agency before the development of the city started to guarantee equal levels of accessibility to schools from different regions in the city. Furthermore, because the lands designated for residential units are solely prepared by the public enterprise and sold to private housing construction companies with the price same as the costs invested for developing lands, the initial supply prices of housing units are almost equal among different apartment complexes built in similar periods. The unique characteristics of Sejong city enable researchers to emulate settings where the locations of schools are independent of the housing price and other endogenous variables. Furthermore, the reputation of schools, in terms of quality of school facilities and level of pupils, are not formed in the early stage of the city because it takes time for schools to differentiate educational achievements and for parents to recognize them, and housing prices are not affected by the reputation of schools.

To disentangle the value of safety from the value of time, we include two explanatory variables, the number of crossing streets to reach schools and walking distances to schools, in the estimations jointly. Though the number of crossing roads and distance to schools is positively related typically, there can be cases that students living in the nearer area to school should cross streets more due to the structure of apartment blocks. For that reason, we can separate the effects of time from the ones of safety by examining the influence of crossing roads independently.

From estimations with data of Sejong city, we can identify a considerable amount of impacts of crossing numbers as well as the ones of distance on housing price. In conclusion, we find that the apartments that contain elementary schools within blocks tend to be more

expensive. Moreover, if children must cross one more street to reach elementary school, the value of apartments decreases by almost fifteen million won (equivalent to about thirteen thousand US dollars). The differences in housing value measure the influence by only the number of crossing roads because the effects of walking distance to school are controlled in the estimations. Therefore, we conclude that we can disentangle the value of safety from the one of saving time. The results are statistically significant and compatible with the predictions. Besides, when comparing the results of estimation of elementary schools with the ones with middle school data, the number of crossing roads is only statistically significant in elementary schools data. This result means that parents care about child safety on the routes to school more when their children are younger. These results support the hypothesis that there are values of safety in housing prices, separated from the value of geographical proximity to schools.

This study contributes to the literature by estimating the pure value of safety concerns of parents in housing prices. While most of the previous research has focused on the value of educational quality of schools or the accessibility to schools with hedonic pricing models, this study finds the value of safety in housing price determination for the first time with similar statistical methods.

The remainder of this chapter describes related literature and explains the estimation results and the meanings. Section 1.2 reviews academic literature that has studied the topics related to this research. Section 1.3 provides more detailed aspects of institutional backgrounds in the study, including the plans and implementations of Sejong city development and policies for allocating lands and units for housing in the Republic of Korea. Section 1.4 specifies the data analyzed in this paper. Section 1.5 describes empirical strategies for estimation, and Section 1.6 provides the main results and checks

for the robustness of analyses. Finally, Section 1.7 concludes the paper and discusses the meanings of policy.

1.2 Literature Review

1.2.1 Hedonic Approach for Estimating Housing Values

The theoretical frame of this study is based on the hedonic regression model, one of the most used methods for estimating house value when multiple attributes can affect the value for housing. The early models were derived by Alonso [1964], Mills [1967] and Muth [1969]. Like in other goods markets, prices are determined by supply and demand in the housing market. However, estimating supply and demand for housing is significantly difficult because of the unique characteristics of the housing market. Supplies in the housing sector are often determined by the government agents, such as urban planners, architects, and public-owned enterprises, in relatively exogenous ways. Moreover, there are countless factors to affect the demand for houses. Economists have developed models to figure out how demand for housing forms and changes when there are various attributes of housing properties and neighborhoods. Urban economists developed the hedonic regression method to estimate the partial effect of each attribute on the housing value (see Sheppard [1999].)

Among many attributes, the quality of amenities in the neighborhood, such as public facilities and services, is one of the most critical elements in determining housing values. The categories of amenities that can affect the value of housing are various. They range from environmental ones, such as clean air, tap water, and sewage system, to transportation systems and accessibility, to security such as crime rates and protection by police and firefighters, to entertaining facilities like parks, museums, sports facilities, and other amusement parks. Although many amenities influence housing value, a lot of economic

studies have focused on the impact of the educational environment, such as the quality of schools in the neighborhood and proximity to schools. Because education is regarded as one of the essential public services, providing equal opportunity of education is often one of the primary policy goals in most societies.

Researchers have studied about the positive influence of academic achievements of schools or accessibility to schools on preference for housing, based on the hedonic model-based approaches. However, because the hedonic model cannot include all the factors affecting housing prices in the estimations, biases from omitted variables can arise. Moreover, endogeneity issues caused by reverse causalities are also common in the hedonic analyses. In many cases, it is not evident whether housing prices are higher because there are good accessible schools in the neighborhood, or affluent regions tend to have good schools. Therefore, previous studies have developed a variant of methods to alleviate the limitations of the hedonic model.

1.2.2 School Quality and Housing Values

There have been abundant studies trying to estimate the impact of school quality on housing values without biases. Black [1999] pioneers a method based on boundary discontinuity design to solve the omitted variable problem of the hedonic model. The main idea is that narrow line-shaped areas on both sides adjacent to the boundary of two school attendance zones can be assumed to be identical in neighborhood characteristics except for school factors. The only difference is the school quality between the two attendance zones. She studies cases of Massachusetts and finds the marginal willingness to pay for housing increases by 2.1 percent when the statewide test score of a school increases by five percent.

The boundary discontinuity design methods are applied to other cities in the US and

countries outside the US. Gabriel et al. [2016] estimate data of Los Angeles, California, from 2000 to 2013 and find that school quality, measured by API (Academic Performance Index), affects housing price positively, and the premium of good school zone increases during periods of economic bust more. Weimer and Wolkoff [2001] choose data of Monroe County, New York state of the US, and find that there are significant impacts of good school on house sale price. Bayer et al. [2007] study data of the San Francisco Bay Area and conclude that the educational environment has a significant impact on housing prices. They find that lower preference to the neighborhood where black people live mostly is not caused by racial recognition directly but by the lower educational quality of the black community. Fack and Grenet [2010] find similar results from data of Paris, France, while Gibbons et al. [2013] apply the boundary discontinuity design approach to the data of UK schools and house prices, and conclude that school quality affects house values.

Other approaches are using external interventions to measure the impacts of school quality on housing prices while avoiding endogeneity. Bogart and Cromwell [1997] selects regions where municipalities are the same, but school districts are divided to decompose the impact of public school from other public services provided by local governments. They claim that different school zones can explain sixteen to one hundred percent of the difference in housing prices. Bogart and Cromwell [2000] choose Shaker Heights region of Ohio state in the US, where the local government closed several elementary schools and redistricted school zones. They apply the difference-in-difference estimator of before and after redistricting school zones in calculating the effect of school quality on price and find that house prices reduce by 9.9 percent after school zone disruption. Ries and Somerville [2010] study school rezoning case of Vancouver. They estimate the impact of rezoning school zones by the Vancouver School Board in September 2009. Because

the rezoning was exogenously implemented, researchers can simulate natural experiment settings. Unlike other studies, although they find significant impacts of the academic score of schools on housing price in the secondary schools and top-quartile housing price group, the positive effects of elementary school quality are not observed when controlling price trends. Kane et al. [2006] can disentangle the impact of school quality from other amenities, using data of desegregation plan implemented by court order in Mecklenburg County, North Carolina, in the United States. They find that effect of good schools on housing price is about one-quarter of estimated values in naive cross-sectional regression. Brehm et al. [2017] studies the impact of penetration of the charter schools into residential areas. Their identification strategy is using census-block fixed effect with varying rates of charter schools in blocks. Because students can enroll in charter schools even though they do not reside nearby, the increase of charter schools tends to weaken the connection between school quality and housing prices of the region.

Some papers apply the Instrument Variables (IV) approach. Gibbons and Machin [2003] introduce primary school entering age and types of schools (church school, community school, and controlled school) as IVs. Because these factors affect academic performance but are not related to students' socioeconomic status or amenities of neighborhoods, they can be regarded as good IVs by the researchers. They find that a one percentage point increase in grades is estimated to raise housing prices by 0.67 percent. Caetano [2012] applies proxy-IV estimation to estimate willingness to pay for increasing scores of their children. Because the utilities of groups who have no kids or grown-up children are not related to public school quality, he categorizes groups of parents and non-parents and segments them into small sub-groups by their socioeconomic characteristics. He calculates marginal willingness to pay for parents by comparing rents of different

groups and finding that parents who have pupils are willing to pay from 1,400USD to 2,700USD to improve test scores by one standard deviation (16 percent).

1.2.3 Proximity to Schools and Housing Values

While most research in this field is interested in the effects of school quality, measured by academic test scores, on housing valuation, the impacts of geographical proximity to schools, which is the main interest of this paper, are not explored much in-depth. Chin and Foong [2006] measure accessibility to thirty prestigious schools in entire Singapore and variations of housing valuation. They define accessibility index for each zone as a function of the number of schools in an area and travel time to prestigious schools and find that access to good schools affects the valuation of residential properties statistically significantly though the size of effects is less than other attributes, such as neighborhood prestige and building tenure. Guntermann and Colwell [1983] and Day et al. [2003] study the influence of transport accessibility on house values, and they conclude that there are positive impacts of accessibility on values.

While some papers find that proximity or accessibility to schools positively affects housing prices, they focus on the influences of geographical proximity based on travel time. That means that the value of proximity is derived from saving time for commuting to schools. However, the value of proximity to school need not be in only saving time. Values of living in the area close to schools can be more prominent in elementary schools than in the secondary or tertiary level of education, considering elementary school students usually walk to schools. In contrast, high school students or university students can commute by bus or subway. Therefore, we can infer that the value of proximity observed in elementary school can be from mixed demands of parents to save time and secure their children's safety. In this paper, we try to decompose the value of safety from saving time

by introducing a new variable, the number of crossing roads to reach school, along with walking distance jointly in the analysis.

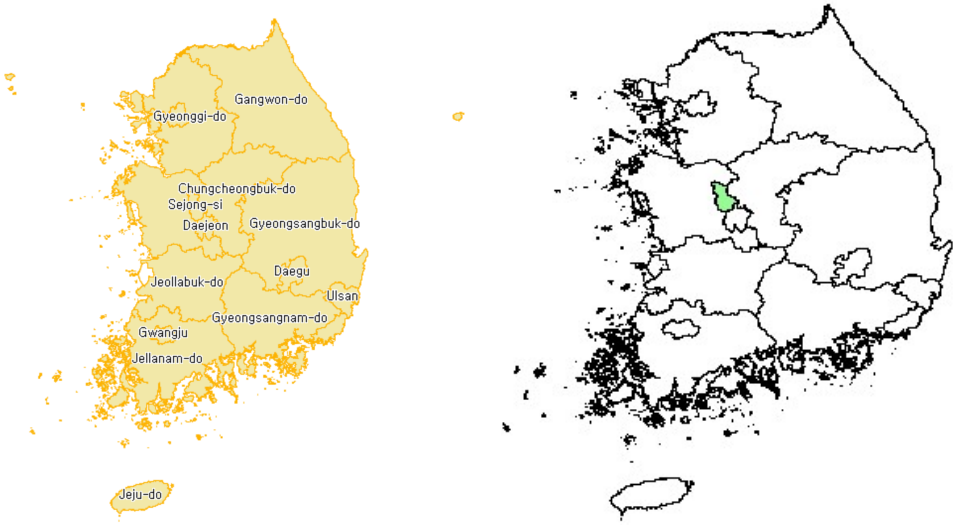
1.3 Institutional Background

1.3.1 Area of Study: Sejong City, the New Administrative Center

One of the contributions of this paper, in methodical aspects, is that we can handle endogeneity issues, often occurred in the hedonic estimation, by using data of Sejong city as the target area. Because target areas in most of the previous studies are already urbanized and developed, lots of factors affecting housing prices coexist with the factors related to schools. Researchers applied various empirical techniques ranging from boundary discontinuity to instrument variable approach to address the endogeneity issue. However, because Sejong city, the target area of this paper, was artificially planned and developed by the central government from scratch, and the analysis period is selected so that the city is in the early development stage, there is no preexisted class segregation by wealth or reputation about schools. Moreover, due to regulations of Korean governments, the initial supply price of an apartment is predetermined with cost-based standards, not related to the willingness of customers to pay for public amenities in the neighborhoods. The planners of the city set the schools' locations when they envisioned the entire city plans according to regulations and legal provisions to guarantee equal access to schools across the whole region of the city. Furthermore, because living environments are similar across the entire city, it has nothing to do with potential endogeneities arising from differences in neighborhood characteristics.

Sejong City is a new city that has been developed by the government of the Republic of Korea since 2003. In 2003, the administration of Noh Moo-hyun, then the president

Figure 1.1: The location of Sejong city



(a) national map of Republic of Korea (b) the location of Sejong city

Note: In (a), The Republic of Korea is located in the south part of Korea peninsular and the capital city region (Seoul city and Gyeonggi-do) is located in the northwestern part of territory of the nation. In (b), the location of Sejong city is colored in green. The Noh Moo-Hyun government determined to build a new city in the central region to reallocate part of the administrative functions of government from the capital region.

of the Republic of Korea, envisioned creating new administrative capital in Chungcheong area, the central region of the country, to pursue balanced development around the whole country and to alleviate the concentration of wealth and population in the metropolitan region of Seoul, the capital city of Korea. At first, the plan was to relocate all the administrative, legislative, and judicial functions of Seoul to the new city. However, the plan was revised to move parts of administrative ministries only after Constitutional Court ruled that relocating capital was unconstitutional in 2004. As a result of the Constitutional Court ruling, while the presidential office and some ministries like foreign affairs and defense still stay in the Seoul area, the prime minister's office and most ministerial agencies have been relocated to Sejong city step by step since December 2012.

To legitimize creating the new city for an administrative center, the Korean government drafted the "Special Act on the Construction of Administrative City in YEONGI-GONGJU Area for Follow-up Measures for New Administrative Capital" (hereafter "Spe-

cial Act"), and the Special Act was enacted at May 2005 by voting in the National Assembly. According to the special act, the special agency for developing the new city (National Agency for Administrative City Construction, hereafter "the Administrator") was founded in 2006. The Administrator has duties of planning cities, developing lands and basic infrastructures, and managing the newly built city. Since 2006, the Administrator has converted rural villages and mountainous areas in south Chungchong province to the newly modernized city. The construction of Sejong city is not finished at the time of writing this paper and is on the way, and the target year of completion is 2030. As of 2016, at the end of this study's analysis period, developments of only parts of the planned area are completed.

Sejong city consists of two different regions. One is the new administrative city region, which is urban planned zones, and the other is the buffer zone between the new administrative city and outer areas, in which most of the areas are farmlands, mountains, and forests, outside the urban zone. In this paper, we refer to Sejong city as the former urban one. New roads and infrastructures have been built, and zoning codes for land uses have been designated to every parcel of land in the city. Zoning codes define the primary use of lands and the legal standards for how densely and highly buildings can be constructed. According to the zoning system in Korea, all the lands are categorized as one of the zones among a residential area, a commercial area, or an industrial area. And, among residential areas, there are sub-categories: an exclusive residential area (class I and II), a general residential area (class I, II, and III), and a quasi-residential area. In the newly planned Sejong city, there is no quasi-residential area. Class I residential areas are for low-floor houses, and class II and III are for mid-floor and high-floor housing units, i.e., apartments complexes, which are the primary architectural type of this study.

In the Republic of Korea, each apartment complex consists of hundreds to thousands of residential units. Each apartment complex is normally constructed in one block, enclosed by roads, and separated from other blocks.

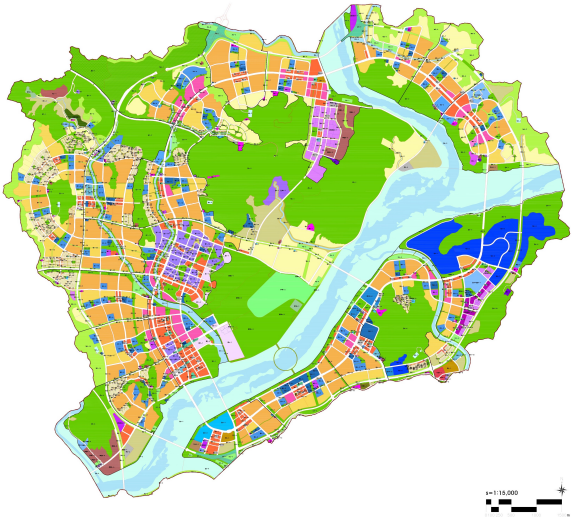
Sejong City consists of many sub-regions or district units, so-called "basic living areas." In Sejong City, the territory for each basic living area coincides with the basic unit of the municipality of the Republic of Korea, "Dong." Each basic living area or Dong includes three to five apartment complexes in its territory. Because basic living areas are the basic units for detailed urban planning and buildings in the same basic living area are developed during similar time periods, each basic living area has a strong identity, distinct from other basic living areas. The apartment complexes within the same basic living area have similar tenures and initial prices when supplied to the customers, and they share the same public amenities.

1.3.2 Determination of Locations for Schools

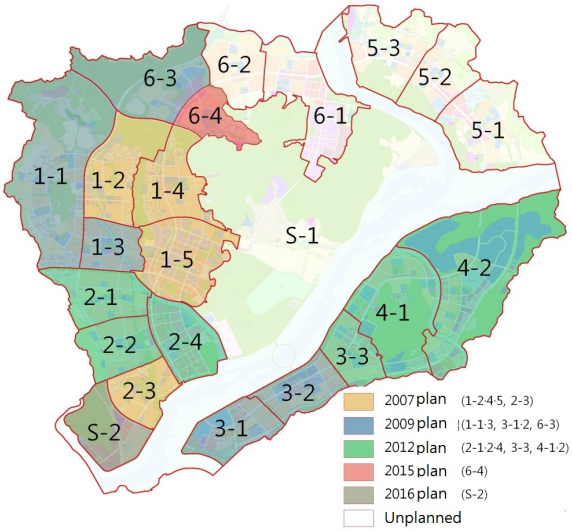
According to the Special Act, the Administrator is obliged to formulate the master plan and the development plan for constructing the new city. The master plan shall include the "[o]utline of the administrative city construction project," "[b]asic plan for population placement and land use," "[d]irection-setting for placement of central administrative agencies, subject to relocation," and other basic direction-setting for the necessary compartments of the city construction project. Among the direction settings which should be in the master plan, there is an outline "for the installation of *educational*, cultural, and welfare facilities." The master plan, formulated in 2006, has contents that provide standards for locating educational facilities. According to the master plan, the target number of students per class and school should be about 20 and 600, respectively. Two elementary schools, one middle school, and one high school would be installed in each

Figure 1.2: The territory of Sejong city and urban development plan

(a) The territory of Entire Sejong city



(b) the urban planning of new city region



(c) basic living areas or Dongs

(d) locations for schools

Note: In (a), The red line is the boundary of entire Sejong city, and the region inside red line is new planned city for administrative function relocation and the same territory displayed in (b). In (b), the yellow regions are residential zones, the red ones are commercial zones, and the purple ones are designated for industrial use or governmental agencies. And the sky-blue dots scattered are sites for schools. The locations of schools are also displayed in (d). In (c), the boundaries of basic living areas, the basic unit for detailed planning, are demonstrated. The basic living areas coincide with the basic administrative district, "Dong". *source:* National Agency for Administrative City Construction [2019], http://www.naacc.go.kr, Sejong city, http://sejong.go.kr

basic living area to meet the guideline of the master plan. The master plan also directs that the Administrator should plan to locate elementary schools within walking distances.

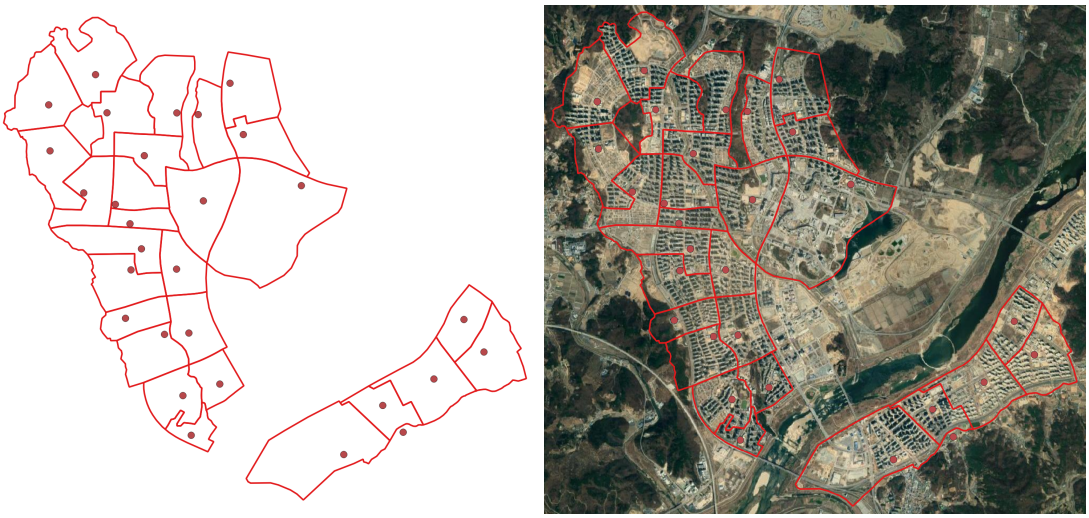
In accordance with the master plan, the Administrator formulates the development plan for Sejong city. While the master plan provides direction-setting for planning, the development plan designates uses of all the parcels of lands and allocates geographic locations of various facilities. The development plan can be revised to reflect changes of circumstances afterward, but the revision should not be incompatible with the master plan. The first development plan was formulated in 2006, and, at that time, school locations were also designated in the development plan, and the allocations of schools were done with respect to the guidelines in the master plans. After the first development plan was formulated, many revisions were made. However, the school locations were not changed though some lands, designated for class-I residential areas for lower-floor housing before, were additionally converted to lands for schools to fulfill increased demand.

Because the development plan was formulated by the Administrator, the National Agency for Administrative City Construction, no consideration related to the financial profitability of the developer was considered at this stage. At the stage of formulating the development plan, the locations of schools were determined with the consultation of the Ministry of Education. Moreover, the actual determination and adjustment of school zones were made by the regional educational authority later. The developer, LH corporation, does not have any authority to change the locations of schools designated by the development plan.

As it can be seen in Figure 1.3, the schools tended to be located at the center areas of school zones. The red dots are elementary schools, and the red lines display the boundaries of the school zones in Sejong City. In spite of exceptions, the school locations tend to be at the centers of school zones. The exceptions are caused by the inevitable conditions; for example, in the biggest school zones at the center of the map, the school

location is tilted to north area of the zone because there is a huge governmental complex at the center area of the zone, and the residential blocks are located in the northern part of the zone.

Figure 1.3: The locations of schools and school zones



(a) locations of elementary schools (b) locations of elementary schools (map)

Note: Since all the blocks in new city area are not constructed, people reside in west parts and south of river only and the elementary schools in those regions open as of January 2016. In the figure, each zone is designated to each elementary school. In (a) and (b), the red dots stand for the locations of elementary schools and the red lines are boundaries for school zones. *source:* School Zone Information Service System, Korea National Education University [2019], https://schoolzone.edumac.kr.

1.3.3 Assignments of School Zones and Student Allocations

In the Republic of Korea, elementary school district zones are generally allocated by regional educational authorities. Allocation of pupils is based on the residence of students. Pupils in the same school zones are assigned to the same schools. Regional educational authorities define and adjust school zones with considerations of various factors, such as the distance to schools, the number of classrooms, and school capacity. Because Sejong city is a new planned city, the locations of schools and school zones are predetermined at its development planning stages. Therefore, the residents already know which elementary school is assigned to their housing units before purchasing housing.

1.3.4 Supply System of New Apartments in Korea

Apartment housing complexes consisting of several apartment units are the most common type of residence in the Republic of Korea, and about sixty percent of south Korean people live in apartment housing units. Unlike other countries, where apartment complexes are regarded for relatively lower-income classes, apartment complexes in Korea are highly preferred by the middle and upper classes. Apartment complexes in Korea are unique in several aspects. The first noticeable characteristic is the size of apartment complexes. They are mainly composed of dozens of high-rising buildings on average. The stories of buildings vary from four to more than fifty. In some complexes, the number of buildings in one block exceeds fifty to sixty, and the number of households in one complex sometimes reach five thousand or more. Secondly, complexes are usually neighbored by another similar type of apartment complexes. In the new towns, which have been built in suburban areas of metropolitan cities since the 1990s, most residential blocks are filled with apartment complexes, and the blocks are located adjacently one another. Moreover, usually, three or four adjacent apartment complexes share the same elementary school. Apartment complexes that belong to the same elementary school districts have common traits in many aspects, such as the socioeconomic levels of residents. Thirdly, each complex is separated by motorways or streets from other complexes. Therefore, each apartment complex has unique spatial, demographic, and cultural characteristics, which are different from other blocks because of the spatial segregation.

New cities like Sejong are constructed according to the laws of new cities development. Because, in the Republic of Korea, development projects of new cities are considered to have public purposes, state-owned enterprises like LH Corporation (Korea Land and Housing Corporation) develop lands and sell blocks of land to private construction

companies that will build apartment complexes. The public developers, such as LH Corporation, often build public rental apartment complexes by themselves because public rental apartments are often regarded as unprofitable in viewpoints of private companies. When LH Corporation sells lands to private companies, the price should be the same as the development costs and the determination of buyers is through a lottery-like bidding process. Therefore, getting lands depends on the luck of companies. Because the housing prices are tied to development costs of public development companies by regulation, the initial supply prices of houses are similar if they are constructed in similar periods.

The initial selling process of houses from construction companies to final consumers is also a draw-based system. Applicants for housing, who are qualified and have a particular bank account for apartment application, need to apply for the units they want to purchase. Acquiring the right to purchase a house is determined by draw. There is a credit system, too. People can earn more credits if they have more children or live with parents, or have not owned houses for a long time. Applicants with more credits can have more probability of being chosen. When there are draws for housing, applicants can choose the area and type of housing they want. However, they cannot choose the exact unit they want. Furthermore, there are regulations prohibiting reselling during certain periods (generally from one year to three years). When people resell their units after the prohibition period, there is no regulation about the resale price.

People who purchased new apartments can live in the units for themselves or rent them out to other people who want to live in. In the Republic of Korea, there is a unique rent system called "Jeon-Se," in which only lump-sum deposit is traded instead of monthly rent. Tenants give a lump-sum deposit, called "Jeon-se Geum," to landlords for some period, at least two years by the law, and landlords can utilize the money for

the contract periods and must give the deposit back to tenants at the completion date of rental contracts.

1.4 Data

1.4.1 Data about Prices in Sale and Rent Contracts

All the data of housing resale prices and rental prices are acquired from The Real Trade Open Data System, constructed by the Ministry of Land, Infrastructure, and Transport (MOLIT) of the Republic of Korea. Whenever contracts for sale and rent are signed, real estate agents are obliged to report the data of contracts to the system within two months after the deal by law. The false reports of agents are legally banned and punished. The data are collected, analyzed, and opened to the public through the Internet by LH corporation, the public-owned enterprise for land development and public housing supply, on behalf of the MOLIT.

The data can be viewed at the Real Trade Open Data System, *rt.molit.go.kr*. The Real Trade Open Data System contains a variety of data about sold or rented housing units and lands. The data of sold ones have been collected since January 2006, while the rental data have been constructed since January 2011. The data cover all kinds of housing, from low-story single houses to villas to high-rise apartments. In the Republic of Korea, residential buildings with four or more stories are categorized as apartments by law. In analyses of this study, only data of apartments are used. That means that data of single-detached houses and housing units mixed with commercial facilities, which are called *Officetel* in Korea, are all excluded. The time span of data used in this study is from 2014 to 2016. The number of contracts during this period is 10,066 (2,774 sale contracts and 7,092 rental contracts).

The data contains only resale contracts signed between people and reported by agents.

Therefore, the data do not include the initial supply contracts between construction companies and people though it has information about the initial price by the construction companies. As explained above, because the initial price level is regulated by law and government and tied to the development cost of LH Corporation, prices of apartments built in similar periods tend to be similar. However, because the resale prices are formed by private demands and supply, they reflect the real preference of people.

During the study period, the average resale price is about 300 million won (about USD 250,000), and the average price per square meter is 3.8 million won (about USD 3,500). The cheapest one is only 155 million won (about USD 140,000), but the luxurious one reaches more than 1 billion won (about USD 1,000,000). The standard error is 77 million won. The price per square meter varies from 2.6 million won to 9.8 million won.

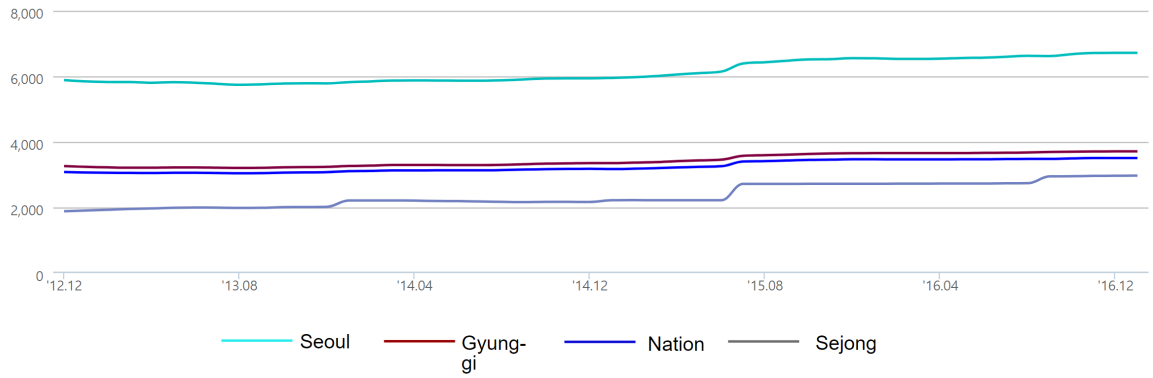
In the Republic of Korea, rental contracts have roughly two types: a lump-sum deposit-based system ("Jeon-se") and a monthly rent system. Because the deposit-based system is more dominant in the Korean housing market, we only use "Jeon-se" data in analyzing rental contract cases. The average lump-sum deposit is about 150 million won (about USD 125,000) in rental contract data, close to half of the average price. The lowest value of the rental deposit is 40 million won (about USD 36 thousand), and the highest one is 450 million won (about USD 410,000). The detailed data of prices are demonstrated in the table 1.1

The housing price level during this period in the Sejong area displays a trend of gradual increase. This trend is compatible with the trend of the whole real-estate market in Korea. During the early period of this study until July 2015, the sale prices of apartments were relatively stable. However, the price level soared in mid-2015 nationwide. In Seoul and Gyeong-gi, the capital region, the housing market moves in the same direction as the

national trend. In Sejong, the trend of the market is similar to the national one. Though prices per square meter in Sejong are lower than the national level, the trend line similarly moves to the upper right side.

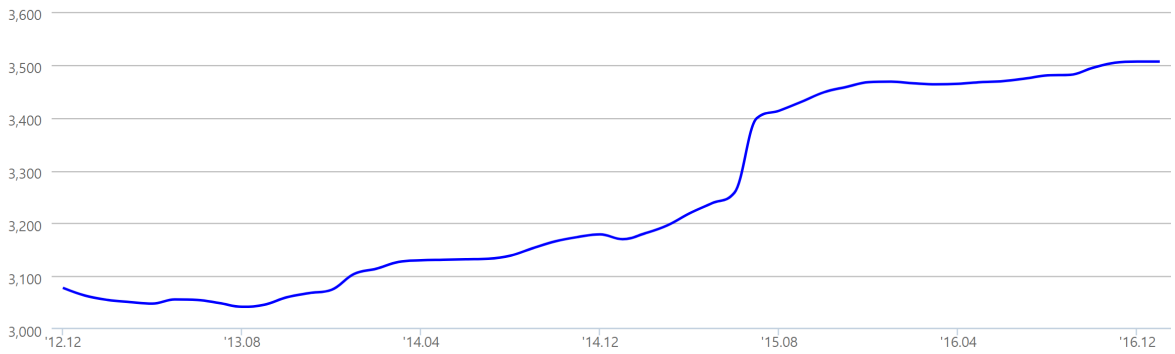
There is a noticeable trait in the Sejong apartments market, slightly different from other regions. The price sometimes jumps from time to time. The abrupt price rises occurred in January 2014, July 2015, and September 2016. Because the housing market in Sejong is relatively small, a little volatility in the market affects the Sejong housing market more than in other regions. There is another reason for abrupt price changes. Because the government banned the selling of apartment units during a specific period, usually one to three years after the initial purchase contract, the resale trades of apartments suddenly increase after the banning period finishes. Therefore, in the month when trade bans are lifted, higher-price trades abruptly appear in the data. However, even though there are slight differences in detail, the market trends are pretty similar in both Sejong city and the entire nation.

Figure 1.4: The trend of housing resale prices per square meter

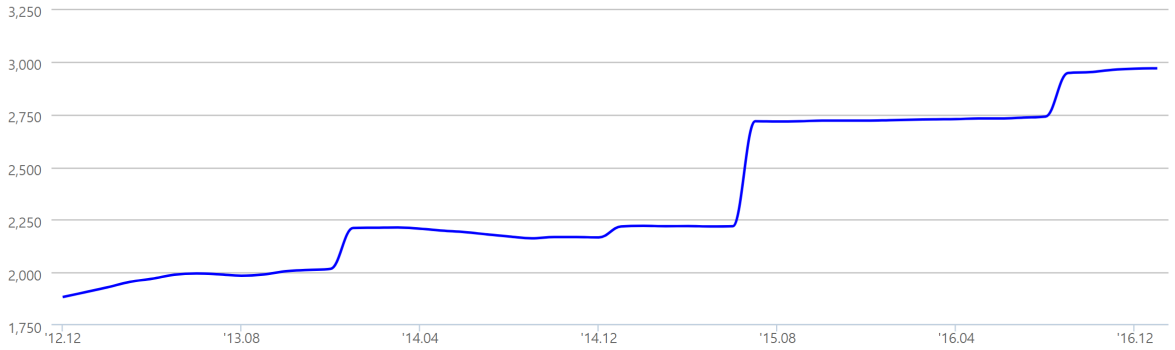


Note: The data is from Housing Resale Price Survey implemented by Korea Appraisal Board (KAB) and the Ministry o f Land, Infrastructure and Transport (MOLIT). The price is mean value of monthly data, and the unit is thousand won per square meter. *source:* Korea Appraisal Board [2019].

Figure 1.5: The trend of housing resale prices in Sejong and the entire nation



(a) entire nation



(b) Sejong city

Note: In (a), the trend of housing resale price is very smooth in the entire nation. However, in (b), resale prices of Sejong city sometimes jump from time to time. This irregularity may be related to small size of data and regulation to prohibit selling for certain periods. *Source:* Korea Appraisal Board [2019]

1.4.2 Characteristics of Apartment Units and Complexes

Real Trade Data, built by the Korean government, provides many other attributes about housing units and prices at the contract. Though they do not include information of the exact address of units, they provide information of apartment complex that units belong to and characteristics of units such as areas of units and floors in which units are located. The data contains information about the apartment complexes, such as the age of the apartment complex, floor-to-area ratio (summation of areas of all the floors

divided by land area), and parking slots per unit. Because we know the geographic locations of apartment complexes, we can assess neighborhood factors like transportation and accessibility to major facilities in the city, including elementary schools, the main theme of this study. The detailed data is in the table 1.1.

There is little difference in attributes of housing units between sale contracts and rental contracts. Average unit areas for sale contracts and rent ones are 81.97 m^2 and 82.24 m^2, respectively, and the average number of rooms and bathrooms are about three and two, respectively, in both sales and rental ones. Data of the average unit area, number of rooms, and bathrooms show that housing units in Sejong city have been supplied to accommodate governmental housing policy because the National Standard housing unit set by the government has an area of under 85 m^2 with typically three rooms and two bathroom, which is similar to the average size of Sejong city samples.

The age of Apartment complexes is older in sale contracts, and it is reasonable considering the selling ban regulation for specific periods after the initial purchase. The average age of apartment complexes in the sales group is 26.6 months after completion, while apartments in rent contracts have 13.9 months age on average. Floor Area Ratio, the ratio of summation of all floor areas to the land area, is about 160 percent. Considering that floors of apartment buildings reach more than thirty stories, the density of complexes is not high. Parking slots per unit are 1.28 on average.

There are data about neighborhood amenities, such as transportation and accessibility to the city's employment center and natural attractions (in the case of Sejong city, lake and river). The central arterial transportation system in Sejong city is a bus system, dubbed Bus Rapid Transit (BRT). BRT runs on the main roads, which are ring-shaped inner roads and highways connected to the neighboring cities, Daejeon and Cheongju.

Table 1.1: Summary Statistics

	(1)	(2)	(3)	(4)
Sample	Sale		Rent	
Variable	Mean	SD	Mean	SD
Price	30733.217	7715.831		
Price/sqm	376.978	54.16		
Deposit			15232.153	4755.431
Deposit/sqm			187.357	54.485
Number of Crossing Roads to Elem. Sch.	0.978	0.761	0.982	0.704
Elem. Sch. in the Same Block	0.234	0.424	0.215	0.411
Width of Cross Roads to Elem. Sch. (m)	18.51	14.731	19.259	13.753
Distance to Elem. Scho. (km)	0.476	0.172	0.503	0.183
Unit Area (sqm)	81.97	17.15	82.235	15.769
Number of Bedrooms	3.092	0.413	3.106	0.352
Number of Bathrooms	1.988	0.113	1.998	0.047
Age of APT complex (month)	26.558	15.338	13.87	16.016
Floor Area Ratio (%)	160.036	18.904	163.918	18.366
Parking Slots per Unit	1.274	0.083	1.28	0.089
Distance to BRT Station (km)	1.933	0.918	1.863	0.91
Government Nearby	0.221	0.415	0.111	0.314
River Nearby	0.053	0.223	0.07	0.255
Lake Nearby	0.026	0.159	0.018	0.132
Floor				
$1 \sim 5$	0.283	0.45	0.233	0.423
$6 \sim 10$	0.268	0.443	0.26	0.439
$11 \sim 15$	0.214	0.41	0.238	0.426
$16 \sim 20$	0.131	0.337	0.147	0.354
$21 \sim 25$	0.064	0.245	0.078	0.268
$25 \sim$	0.04	0.195	0.045	0.207
N	2,779		7,092	

Note. Columns (1) and (2) summarize the samples of sale contracts, and columns (3) and (4) summarize the samples of rental contracts between 2014 and 2016. The number of observations for sales contracts and rental contracts is reported in the bottom row of the table. The numbers in Columns (1) and (3) show the average of continuous, discrete and indicator variables. The numbers in columns (2) and (4) report the standard deviation. All monetary values are in current ten thousand KRW.

One of BRT operates a route from Osong station, high-speed railway (KTX) station connected to Seoul, in Cheongju city to Bansuk station, the metro railway station in

Daejeon city. The other BRT route stops the government complex, the central function of Sejong city, and the city hall, and it is connected to another KTX station in Daejeon city. Because BRT stations are critical in the transportation system of Sejong city, the distance to BRT affects housing values significantly. The average distance to the nearest BRT station from centroids of apartment complexes is 1.9 kilometers.

Because Sejong city was planned to relocate most central government functions to this area, the government complex is the most critical employment center. For the government employees residing in Sejong city, the housing units within walking distance to the government complex are regarded as more valuable.

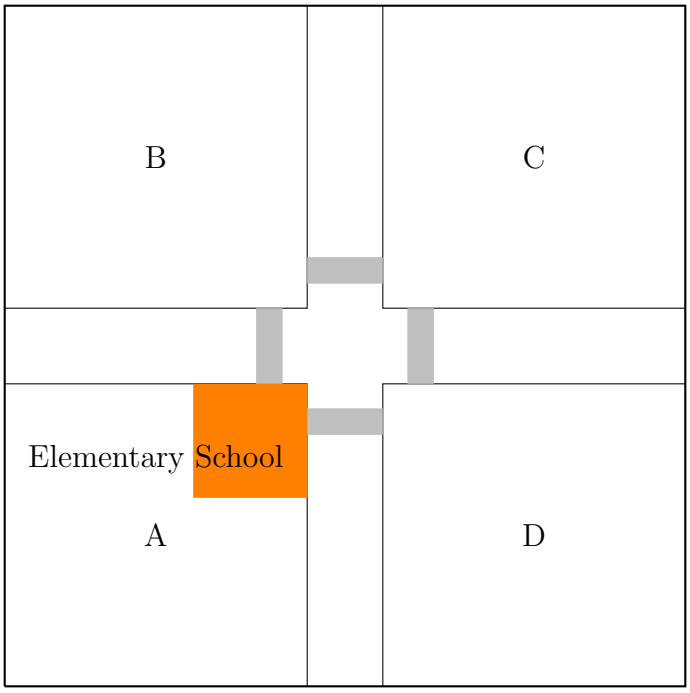
Sejong city has two distinctive natural attractions, the Geumgang river and an artificially created lake located in the center of the city. The apartment complexes nearby the river and lake are traded at much higher prices. To control the effects of the river and the lake, we include the distances to the river and the lake.

1.4.3 Data about Accessibility to School and Safety Measures

As stated above, we try to separate time-saving factors from safe access factors of proximity to schools. The walking distance from apartments to schools is an index for measuring time to schools, and the number of crossing roads to school can be a safe access measurement. In Figure 1.6, which displays a hypothetical residence block with an elementary school, apartments in sub-blocks A, B, C, and D may have similar walking distances to the elementary school. This hypothetical residence block can be regarded as a school district sharing one elementary school. However, while the students in sub-block A can commute to school without crossing any road, pupils living in sub-block B and D have to cross roads once to reach the school, and those in sub-block C have to cross roads twice. In this case, if we measure walking distances to school and the number of crossing roads

simultaneously, the effects of safety concerns on housing value can be estimated. Because Sejong city consists of school districts with several sub-blocks of apartment complexes, this hypothetical setting accurately reflects real situations.

Figure 1.6: A hypothetical residence block with an elementary school



notes: Sub-block A includes a elementary school within the territory, while sub-blocks B, C, D are not. Pupils living in sub-block B or D must cross street once to get to school, while the ones living in C have to cross twice.

The average walking distance to elementary school is about 500 meters, and the standard error is only about 180m. The average number of crossing roads to elementary school is 0.98, slightly less than once. These numbers show that the location plan for schools in Sejong city is quite balanced, and accessibility to elementary schools is well considered in the planning stage.

There is another measure for assessing safety on the road to schools. Safe accessibility depends on the width of roads when students cross. Generally, the wider roads are, the riskier crossing roads will be. Therefore, the summation of widths of roads on the routes to schools can be an alternative measure for the safety index.

Considering the characteristics of the two variables, the number of crossings is a discrete variable, while the width of crossing is a continuous one. Therefore, the effects of the number of crossings will jump with one more crossing. The riskiness of one more crossing road can be more intuitive to the minds of people. People cannot recognize the difference between one or two meters of distances without measuring with rulers even though they can differentiate between two-lane streets and four-lane roads. That is the reason we choose the number of crossings as the explanatory variable in the main estimation.

If we know the exact address of each sample, we can measure the exact walking distance to school. Because we cannot specify the exact starting points of trips, we measure the walking distances from centroids of apartment complexes to school. However, there is no need for the exact address in the case of measuring safety measures because we only have to measure the number of crossings between apartment complexes or the width of roads. According to the master plan and development plans, there are no roads inside the apartment complexes on the ground, and all parking spaces are built underground in Sejong city.

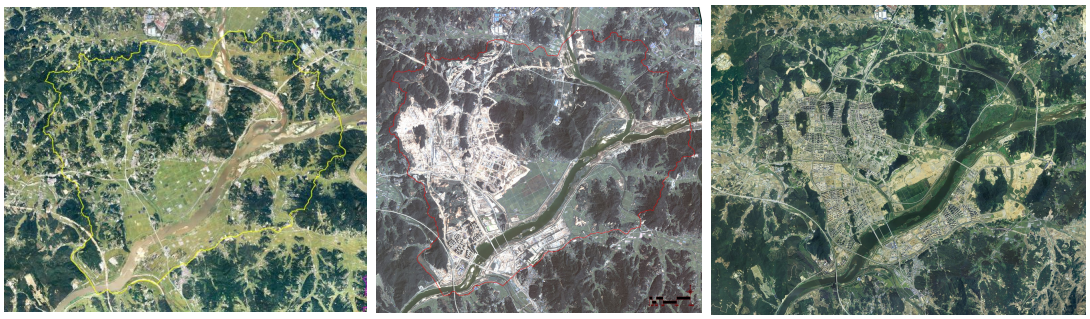
The data about elementary school districts are found in the data in *School Zone Information Service System*, schoolzone.edumac.kr. In School Zone Information System, the locations of elementary schools and the boundary of each school district can be found conveniently. The data of walking distance to school from an apartment complex and the number of crossing roads to school can be calculated with GIS data and school zone districts data.

1.5 Empirical Strategy

1.5.1 Ideal Setting for Alleviating Endogeneities

Sejong city during the period from 2014 to 2016 has several advantages to solve the endogeneity issue, which often arises in research to estimate causality between school factors and housing values. The most important advantage is that Sejong city was planned and built by the government artificially from scratch, and the locations of schools are predetermined before people move into the city. As seen in the Figure 1.7, before the development, the region of present Sejong city was a typical rural area of Korea. Out of nowhere, the city was planned, and buildings and infrastructures were developed according to the plans. The number of schools was determined according to population plans, and the locations of schools are positioned to create equal accessibility across the entire region and allocate a similar number of pupils per class. Therefore, there can be no reverse causality because good accessibility to schools in the Sejong area was not created to fulfill the demands of rich and affluent neighborhoods in this case. Locations of schools are determined by only considerations of geographic and demographic factors.

Figure 1.7: Change by Developments: Aerial photos



(a) 2006 (b) 2012 (c) 2016

Note: In (a), Sejong area was typical rural villages and mountains before the development started in 2006. In 2012, the first residents of Sejong move to the city. In (b), most of regions are being constructed. In (c), development of several sub-regions have been completed though many other areas are still being constructed. *source:* National Agency for Administrative City Construction [2019]

The second advantage is the time span of data. Because we gather data of early development stages, there is no difference in school quality in terms of academic performance. In most cases in related literature, not only the distance to schools but also the academic performance of schools really matter in the valuation of housing units. However, from 2014 to 2016, there was no indication of difference among schools in Sejong city because people had just started to move in the city during this period. In the Republic of Korea, the reputation of schools for academic performance is affected by university entrance results. In early development periods, families with high school students facing university entrance applications hesitated to move to the new city because moving might cause much uncertainty in terms of educational environments like the quality of teachers. For those reasons, Sejong city, in early-stage, is a city of younger demographic distribution (the average age was 31.1 years old at the end of April 2015). [1] Therefore, we can measure the effect of physical distance to schools only without concerns about the influence of academic quality of schools.

The third advantage of Sejong city data is the homogeneity of housing units. Sejong city was composed of an agglomeration of huge apartment complexes, and the complexes are pretty similar in shape, size, and design. There was little difference in the neighborhood environment. Each basic living area (Dong) has three to five apartment complexes and one community center. The basic amenities, such as parks, fire stations, police sub-stations, commercial areas, etc., are similarly dispersed to the entire city. Crucially, because the main goal of the city development is to create a balanced city as the policy objective of the city is to pursue balanced development of the whole country, basic living standards of the city are not significantly different regardless of wherever people live.

[1] The age data is from the resident registration statistics of the Ministry of Interior and Safety, and the average age of the whole country is 39.8 at the same time.

1.5.2 Estimation Equation

Due to the advantages stated above, we can construct an estimation equation based on the hedonic model approach without concerns of reverse causality and omitting confounding factors.

The estimation equation considers factors that can measure accessibility to school and walking distance to schools as main explanatory variables. There are other explanatory variables about characteristics of individual housing units and apartment complexes where the housing unit sample is located. The time (year and quarter of contract) fixed effect, and the municipality (herein "Dong" level) fixed effect, and the school zone fixed effect are included to control any difference caused by the different time of contracts and regional differences.

The form of estimation equation is:

$$y_i = \beta_0 + \beta_1 SA_i + \beta_2 d_i + \boldsymbol{A_i}\boldsymbol{\beta_3} + \boldsymbol{U_i}\boldsymbol{\beta_4} + SD_i + DONG_i + t_i. \tag{1.1}$$

SA_i is the explanatory variable which can be related to safe access to schools, which are the number of crossing roads or the sum of width of crossing roads here, and d_i is walking distance to a school from the centroid of the apartment complex where a housing unit is located. Vectors $\boldsymbol{A_i}$ and $\boldsymbol{U_i}$ are attributes related to the apartment complex and individual units of apartment, respectively. $\boldsymbol{A_i}$ includes the age of the apartment complex and its squared terms, the distance to the nearest middle and high schools and the nearest BRT station, dummy variables that tell whether government complex, river, and lake exist nearby the apartment complex, average parking slot per unit, and floors-to-area ratio (ratio of summation of floor area to the land area of an apartment complex). $\boldsymbol{U_i}$ contains the number of bedrooms and bathrooms, the floor of the unit, and the unit

area. SD_i and $DONG_i$ are variables to control the fixed effects of school districts and municipalities, while t_i is time dummy to control influence by market volatility.

For the dependent variable y_i, we apply five types of variables: prices and prices per square meter and logarithmic values of those, and the price changes between the price traded at the contract and the initial price supplied at the completion of construction. We estimated two types of contracts (sale and rental contracts) separately.

1.6 Results

1.6.1 Main Results

We estimate the impacts of safety accessibility to elementary schools on housing valuation. The main explanatory variable for safety accessibility is the number of crossing roads to reach a school from an apartment complex. By including walking distance to a school and the number of crossing roads simultaneously, we can estimate distinctive effects of safety concerns, separated by time-saving effects.

A. Effect on apartment prices

In all estimations, as expected, crossing roads have significant adverse effects on housing values. One more crossing road decreases housing value and price per square meter by about 14.95 million Korean won (about USD 140,000) and about 145,000 KRW (about USD 130). Moreover, the effects are statistically significant at a one percent level. The walking distance to elementary school, the measure for time-saving effect, also negatively impacts housing values. If an apartment complex is one kilometer farther from an elementary school, its housing price is about 35.6 million KRW (about USD 31,000) lower, and its unit price (price per square meter) would decrease by about 388,000 KRW (USD 350). Their statistically significant levels are less than 10 and 1 percent, respectively.

Table 1.2: Effects of Safe Accessibility to Elementary School on Housing Price

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Price	ln(Price)	Price/m^2	ln(Price/m^2)	Price change
Number of Cross Roads	-1495.0234***	-0.0439***	-14.4520***	-0.0378***	-616.8424**
to Elementary Schoool	(403.5806)	(0.0107)	(3.5623)	(0.0094)	(260.2465)
Distance	-3562.7145*	-0.0795*	-38.81385***	-0.0875***	-2037.9209*
to Elementary school	(1701.3329)	(0.0463)	(12.4488)	(0.0312)	(1106.0253)
adj. R2	0.811	0.881	0.711	0.739	0.609
Nobs.	2779	2779	2779	2779	2779

Note. All the regressions include district fixed effects. They also include a set of dummy variables for time (year-quarter) of contract and a set of dummy variables for each administrative district unit (Dong.) All the regressions control for characteristics of apartment complexes such as age of apartment complex and its squared term, distance to the nearest middle and high schools, the nearest BRT station, the government complex, lake and river, average parking slots per unit and floor to area ratio as well as characteristics of each unit such as number of bedrooms, number of bathrooms, floor of unit and unit area. Standard errors in parentheses are clustered at apartment complex level. *Statistically significant at the 10% level; ** at the 5% level, *** at the 1% level.

The effects on log values of dependent variables are also statistically significant. Estimation values of the log of dependent variables indicate the rate of change. One more crossing road on the way to an elementary school would bring down housing values by about 4.4 percent and the unit area price by about 3.8 percent when other attributes are in the same conditions. The effects of distance to an elementary school on log values display similar results. If the distance from an apartment complex to a school is one kilometer away, apartment values in the complex will decrease by about 8.0 percent, and their unit prices will be 8.8 percent lower.

The effects on price change, the difference between the traded price at the contract and the initial price supplied by the construction company at the completion of construction, are also estimated to control the potential influence from the anchor effect of the initial price. The estimated effect on price change is 6.2 million KRW. The statistical significance still remains after controlling the initial prices of apartments.

As a result of estimations, we can estimate the pure effects of the number of crossings to school, separated from time-saving aspects of proximity to schools. Considering the mean value of housing price in Sejong city is 307 million KRW, and its standard error is 77 million KRW during the study period, the effect of one more crossing road (14.9 million KRW) is not negligible (about 0.19σ). When Compared with the median value of sale prices in January 2017, 222 million won, reported by Korea Appraisal Board data, the estimated effects of crossing roads are considerable.

B. Effect on apartment rental deposits

Table 1.3: Effects of Safe Accessibility to Elementary School on Rental Price

	(1)	(2)	(3)	(4)
Dependent Variables	Deposit	ln(Deposit)	Deposit per m^2	ln(Deposit per m^2)
Number of Cross Roads	-252.5633**	-0.0232**	-3.5475**	-0.0204**
to Elementary School	(111.9147)	(0.0091)	(1.5539)	(0.0090)
Distance to Elementary school	-1303.9718**	-0.1184***	-21.8864***	-0.1233***
	(507.0552)	(0.0376)	(5.8564)	(0.0355)
adj. R2	0.826	0.825	0.813	0.792
Nobs.	7084	7084	7084	7084

Note. All the regressions include district fixed effects. They also include a set of dummy variables for time (year-quarter) of contract and a set of dummy variables for each administrative district unit (Dong.) All the regressions control for characteristics of apartment complexes such as age of apartment complex and its squared term, distance to the nearest middle and high schools, the nearest BRT station, the government complex, lake and river, average parking slots per unit and floor to area ratio as well as characteristics of each unit such as number of bedrooms, number of bathrooms, floor of unit and unit area. Standard errors are in parentheses are clustered at apartment complex level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

The effects of crossing roads are also significant on the amount of rental deposit. However, the magnitudes of effects on rental prices are less than sale prices. One more crossing decreases rental deposit by 2.5 million KRW (about USD 2,300). The deposit per unit area (m^2) is about 35,000 KRW (about USD 32) lower when the number of crossing increases one more. While the value of the average deposit (about 152 million

KRW) is half of the sale price mean value (307 million KRW), the effects of crossing roads on rental deposit are one-sixth of the ones on sale price.

The estimation with the log of dependent variables, which indicates the rate of change, also shows similar trends. The rate of changes on deposit is 2.32 percent, and this value is 53 percent of estimation with sales contract data. The rate of change in deposit per square meter is estimated as 2.04 percent, and it is about 54 percent of the coefficient in estimation with sale contract data.

C. The difference of effects on price and rental deposit

The reasons for differences in effects on the sale price and rental deposit cases are ambiguous. Theorizing the actual mechanisms of how demand for proximity to school is reflected in the selling market and rental market is beyond the scope of this study. However, we can provide possible hypotheses for future research as below.

The first hypothesis is that the compositions of market participants (samples) are different between the selling market and rental market. Many socioeconomic factors, such as income, wealth, ages, family members, and other things, can be different in the two groups. However, to figure out how they are different exactly, we need detailed survey data, which includes the personal information of tenants and landlords. Furthermore, this information should be linked with the real estate trade data. In this regard, constructing the data is highly challenging due to a lack of data.

The second potential cause is the difference in the number of stocks in the market. Because the analysis period is from 2014 to 2016, the early period after completion of apartment complexes, the houses for rent are more than the ones for selling in the market. It is often observed that the ratio of rental deposit of "Jeon-Se" to the price of an apartment is lower in the newly built apartment complexes in other new cities.

Because the apartment units for rent can be more easily found in the early period, the willingness to pay to the rental apartment unit near the school can be observed lower than the later period when time passes, and rental units are scarce.

The third and final possibility is the heterogeneity of motives. The motives at the moments of contracts can be different between the landlord group and the tenants. People purchasing the units will consider not only the value for a living but also the value for investment, while tenants renting units are more likely to be interested in the value for living. Therefore, in some cases, the higher selling prices in apartments near schools may be the reflection of investors' expectation of appreciation of the price in the future. In this regard, the effects on rental price can be closer to the fundamental values of proximity to a school than the effects on housing prices. However, without the data about the compositions of residents, we cannot conclude that this is the case.

1.6.2 Robustness Checks

For checking the robustness of estimations on effects of safe access to an elementary school, we devise other dependent variables which can represent safe accessibility to schools, displayed in Table 1.4.

The first explanatory variable estimated in Panel A is a dummy variable that indicates elementary school existence in the same apartment block. When an apartment complex contains an elementary school in its territory, the price of housing increases by 20.4 million KRW (about USD 18,500), and the unit price is 194,000 KRW (about USD 180) higher. The coefficients are statistically significant at a 1 percent level. The estimated values on logarithmic prices, which indicate the rates of change, are also statistically significant at a 1 percent level. The price of housing units in an apartment complex with an elementary school is 6.3 percent higher than the one without a school if they are in

Table 1.4: Robustness Check

	(1)	(2)	(3)	(4)	(5)
Dependent Variable	Price	ln(Price)	Price per m^2	ln(Price per m^2)	Price change
Panel A					
Elementary School	2041.2332***	0.0629***	19.4297***	0.0522***	882.5709**
in the Same Block	(536.2325)	(0.0141)	(4.6878)	(0.0125)	(333.9298)
Distance	-5771.8587***	-0.1436***	-59.5648***	-0.1432***	-2939.9248***
to Elementary school	(1410.8300)	(0.0380)	(10.6501)	(0.0264)	(1032.6289)
adj. R2	0.811	0.882	0.711	0.739	0.609
Nobs.	2779	2779	2779	2779	2779
Panel B					
Width of Cross Roads	-65.6084***	-0.0019***	-0.6221***	-0.0017***	-24.4525**
to Elementary School (m)	(16.4981)	(0.0004)	(0.1515)	(0.0004)	(10.6646)
Distance	-3459.8897*	-0.0766	-37.6591***	-0.0842**	-2106.8596*
to Elementary school	(1746.5221)	(0.0474)	(13.0523)	(0.0324)	(1112.4659)
adj. R2	0.811	0.881	0.710	0.739	0.608
Nobs.	2779	2779	2779	2779	2779
Panel C					
Number of Cross Roads	-9.9253	-0.0057	-1.7670	-0.0089	76.9951
to Middle School	(400.2483)	(0.0115)	(4.7016)	(0.0122)	(315.0484)
Distance	-6250.4189***	-0.1579***	-63.9531***	-0.1546***	-3154.9517***
to Elementary School	(1584.2805)	(0.0443)	(12.9765)	(0.0328)	(1060.0701)
adj. R2	0.808	0.879	0.706	0.734	0.607
Nobs.	2779	2779	2779	2779	2779

Note. Panel A through C adopt various measures for safe accessibility to elementary school. Regression in Panel A use an indicator variable taking one if an apartment unit belongs to an apartment complex located in he same block as the elementary school so that people residing in the unit do not have to cross any roads. Regression reported in Panel B adopts the sum of the width of cross roads to elementary school. Panel C employs a pseudo safe-accessibility, which is the number of cross roads to the nearest middle school. All the regressions include school district fixed effects. They also include a set of dummy variables for time (year-quarter) of contract and a set of dummy variables for each administrative district unit (Dong). All the regressions control for characteristics of apartment complex such as age of apartment complex and its squared term, distance to the nearest middle and high schools, the nearest BRT station, the government complex, lake and river, average parking slots per unit and floor to area ratio as well as characteristics of each unit such as number of bedrooms, number of bathrooms, floor of unit and unit area. Standard errors in parentheses are clustered at apartment complex level. *Statistically significant at the 10% level; ** at the 5% level, *** at the 1% level.

the same school district and other conditions are equal. The effects of containing schools within the complex on price change are also statistically significant, and its magnitude is 8.8 million KRW.

In Panel B, we estimate the effect of the width of roads to reach an elementary school. Because roads have different numbers of lanes and risks of crossing roads would increase with the width of roads, the degree of riskiness can be different even among the groups of the same number of crossing roads to a school. If we can find significant differences depending on the width of roads, it is reasonable to assume a strong preference for safe access to schools. Estimation results support the claim that safety concerns can differentiate housing prices. When the sum of width of roads on the way to a school increases by one meter, about 650,000 KRW (equivalent to USD 600) of housing value is lost. In case of price change, one meter of width affects about 245,000 KRW of price change between the traded price and the initial price negatively.

Finally, we try to estimate the effect of crossing roads to middle schools. As children grow, parents are less likely to worry about the safe access of their children on the way to school. If our hypothesis is correct, the effects of the number of crossing roads to middle schools would be less than the ones to elementary schools. The results of estimation about middle schools are strikingly different from the ones about elementary schools. The number of crossing roads to a middle school does not affect housing values.

With various estimations with several measures, we can conclude that the effects of safety concerns on housing prices are distinct and statistically significant.

1.7 Conclusions

We study the effects of physical distance and accessibility to schools from the housing units on the prices. We find that there are positive impacts of living close to schools with the data of Sejong city region and that there are distinct effects of safe access to school, separated from time-saving factors of proximity. In various estimations, parental demands for proximity to school seem to be considerable, and the demands are caused by not only physical closeness but also safe accessibility on the way to schools.

Moreover, we think that the results in Sejong city can be generalized beyond the region to the entire area of Korea if the compositions of the population and physical environment are similar. Since the early 1990s, the Korean government has built many new towns to supply decent housing units to the emerging middle-classes and lower-income classes. The structures and population compositions of apartment complexes in new towns are almost similar. Usually, when new towns are built, many young couples with children move to the city, and, thus, the average age of the towns grows older with the aging of apartment complexes. Because Sejong city is the metropolitan municipality with the youngest age compositions in Korea as of 2021, the preference of proximity to school can be more prominent. However, similar trends can be observed in other towns and cities, although estimating the effects can be more challenging than in Sejong City.

However, because all the residents are not parents who have elementary school students, the effects of estimation should be analyzed with caution. If people without children at the ages of elementary schools do not care about the proximity to schools, the effects of estimation can be the lowest bound for parental preference. However, parental preference for living nearby elementary schools is widely known in Korean society through viral opinions or media. Therefore, general people, who are not concerned about edu-

cation or do not have children at school ages, may also like the apartment complexes containing elementary schools because they know the asset values would be higher in apartment complexes with better access to schools. In that case, the pure demand of parents for safe accessibility will be mixed with the expectation for better investments of general people in the values of estimations.

Moreover, we should consider the unique circumstances of Sejong city. Urban planners and government agencies meticulously plan the districts and locations of essential facilities of Sejong city, and the safety of children is also considered in the planning process. Most of the roads inside apartment complexes are installed underground, and parking lots are also located on underground floors. All the blocks are squared away with lattice-shape compartments. Therefore, the impact of safe accessibility will be more considerable in other cities such as Seoul, which have complex road networks and disordered urban structures.

There are a few challenges left in the analysis. Though Sejong city provides an ideal setting to exclude effects of any other preexisting confounding factors, there can still be possibilities of biases by omitting essential variables that should not be excluded.

Finally, we conclude with discussions of the policy implications of the study. With the estimation results, we confidently can claim that there is abundant evidence for parental demand for safe access to school. Provided that parental demands on the safety of children exist, governmental agencies that take charge in educational policy and urban planning should consider ways to fulfill those demands. When drawing the districts of school zones or improving transportation systems and safety facilities, the implications of this study can be utilized.

Recently, in Sejong city, over-bridges crossing roads have been built to guarantee safe

routes to schools for pupils. Besides, these days, the Korean government has adopted some measures related to this issue. The speed limits in school zones and inner regions of cities have been lowered, and the law that aims to put more burden on drivers by raising the level of punishment was legalized. Moreover, many local municipalities are trying to convert the structures of cities to more passengers-friendly by introducing many urban-planning techniques. Generally, urban planning affects housing markets with significant impacts. In urban planning, because elementary schools are often centers of districts, the location of elementary schools should be chosen with caution and considerations.

One last thing we want to point out is that the preferences on close areas to school can change with demographic change. The population structure of the Republic of Korea is experiencing drastic aging, and the older the demographic profile becomes, the less the concerns on the safety of elementary school students might be. To figure out the impacts of aging on the housing markets and tackle urban planning issues in an aging society will be left for further research.

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Chapter 2

The Factors Affecting Incidence of Vacancy in Commercial Properties

2.1 Introduction

In many studies about real-estate markets, vacancies are often ignored even though vacant properties are commonly observed in real markets. In ideal efficient markets, where demands and supplies perfectly match, vacancies only can exist in a very short period, and they would evaporate through market-clearing processes. However, contrary to the expectations based on assumptions of efficient markets, vacant units seem to stay in property markets permanently. For example, the vacancy rates in business districts of Seoul, the target area of this paper, often record at close to twenty percent.

According to the assumptions of the price adjustment process, if the vacancy rate soars in a particular area due to whatever reasons, such as increasing stocks of properties or decreasing demands, rents would change to adjust the mismatch of supply and demand, and the vacancy rate of this specific area would converge to the natural level. However, in the data of rents of commercial properties in Seoul analyzed in this paper, the rental price adjustments and the convergence to the natural vacancy level do not seem to be observed. Conversely, rent levels are relatively stable while vacancy rates change in a volatile pattern for two years from 2017 to 2018.

In this study, the main argument is that the dual characteristics of real-estate markets can cause the discrepancy between expectations based on theory and actual data. Because real-estates are not only goods for the use of the owners or for renting to others, but also capital assets for investment for capital gains, the behaviors of landlords are highly affected by the prospect of asset values of their properties. If properties are expected to generate capital gains much more than the expected loss due to vacancy in the future, landlords can take less care of lost rental incomes caused by the vacancy. Moreover, if adjusting rents to dissolve vacancy affects the future value of properties,

maintaining the rent level can be a reasonable option for property owners. In this study, the author revises the Dipasquale-Wheaton-Colwell four-quadrant model to interlink the two markets: the asset market and the rental property market, and show that the vacancy can increase when the landlords are concerned about the depreciation of asset price more. The estimations of price, rent, and vacancy rates of 31 Seoul commercial districts in this study are supporting evidence for the existence of those behaviors of landlords. The estimation results in the study display a significant relationship between price per rent ratio (PRR) and the probability of being vacant of commercial properties. When the price of a property is relatively high compared to its rent, the property is likely to be vacant more.

Unlike previous studies, which mostly have focused on relationships between rent and vacancy, this paper shed light on the roles of asset value changes on the behaviors of landlords and its impact on creating vacancies. The following sections will explain the hypotheses for mechanisms of how price and rent can affect vacancy incidences and derive supporting evidence for the hypotheses from estimations with actual data. Section 2.2 reviews papers that attempt to figure out reasons for vacancy incidence and the relationship between vacancy and rent. Section 2.3 displays that the observations of 31 commercial districts in the capital city of the Republic of Korea contradict the prior expectations based on the rent-vacancy adjustment process. And it introduces models to explain the discrepancies. Section 2.4 provides a description of data and the empirical strategy. Section 2.5 will show results of estimations and sub-group analyses of different regions and categories of samples. Finally, 2.6 concludes the chapter.

2.2 Literature Review

Since the early 1950s, researchers have studied why vacancy occurs in property markets and how vacancies affect rent levels in the market. Blank and Winnick [1953] argues that vacancy rates are pivotal in explaining rental prices. Smith [1974] also claim that rent is a function of vacancy with estimations of housing markets of five Canadian cities. Some researchers explain vacancy in property markets by using an analogy with unemployment in labor markets. They define the concept of *natural vacancy rate*, similar to the natural unemployment rate in labor market models. They argue that the natural vacancy is an inevitable regularity, which occurs when searching tenants by landlords and finding units by tenants are not matched simultaneously. In their models, vacancies created by excess supply or lack of demand eventually converge to the natural level through rent adjustment processes. Shilling et al. [1987], Shilling et al. [1992], Gabriel and Nothaft [1988] and Gabriel and Nothaft [2001] estimate the natural vacancy rates with similar approach. Wheaton [1990] develops a more sophisticated model about causes of vacancies in housing markets by borrowing an idea of searching and matching model of unemployment. In the model, housing prices are determined by the costs of managing vacant stocks and searching for new tenants. Small changes in supply and demand affect vacancy rates in the market, and the changes in vacancy rates determine searching and matching costs. The changes in costs of buyers and sellers finally decide the range of traded prices, and, in this model, vacancies are structurally unavoidable due to the characteristics of the competitive process of searching and matching. Colwell [2002] explains the vacancy with the revision of the Dipasquale-Wheaton model, originally devised in DiPasquale and Wheaton [1992]. In his model, the vacancy can be created by the speculative demand of landlords that expect the change in rent level in the future and adjust the stocks in

the market. Miceli and Sirmans [2013] propose the efficient rent hypothesis, named after the efficient wage model in labor economics. They argue that positive vacancy rates incentivize landlords to invest more in the maintenance of rental units to keep them filled with tenants.

In the models using an analogy with labor markets, vacancies are the results of searching and matching. They assume that real-estate markets are kinds of goods markets where potential buyers and sellers try to make the best deals with their reservation prices. When the vacancy increases, the rent and price levels will change, and the changed rental price eventually drives the actual vacancy level to the natural rate. Rosen and Smith [1983] estimates the effect of vacancy rates on the rental price, and they argued that "actual vacancy rate[s] were shown to be significant in determining the percentage change in rents." They estimate natural vacancy rates of American cities, ranging from 5.6 percent in Cleveland to 23.2 percent in Milwaukee. Wheaton and Torto [1988] and Voith and Crone [1988] adopt similar approach with Rosen and Smith [1983] though the estimation strategies are more sophisticated. Gabriel and Nothaft [2001] also estimates the natural vacancy rates of the residential properties in metropolitan areas of the United States with the housing rental data from CPI housing samples surveyed by the U.S. Bureau of Labor Statistics. The estimated natural vacancy rates range from 3.9 percent (Anchorage in Alaska) to 4.3 percent (Atlanta, Baltimore, Boston, and others). There are studies in the office market in Seoul, the Republic of Korea. Son and Lee [2014] estimate the natural vacancy rates in the office market in Seoul from 6.7 to 8.7 percent, given the assumption of invariable natural vacancy rate with time. Lim and Seo [2011] also estimated the rates; however, their values are much lower, from 1.75 to 5.37 percent, because they estimate the data based on the time-varying natural vacancy rate model.

Meanwhile, there also have been studies against claims of the rental price adjustment process to clear vacancies in the market. De Leeuw and Ekanem [1971], Fair [1972], and Eubank Jr and Sirmans [1979] cast doubts about the significance of rental price adjustment when vacancy occurs. According to De Leeuw and Ekanem [1971], the impact of vacancy on rental price is insignificant when including income, price, and cost variables in estimations. Since the early 2000s, some researchers have focused on the conspicuous phenomenon called *rent rigidity*. In many data across the world, stable rent levels are observed for long periods while vacancy rates change. Genesove [2003] estimates that 29 percent of nominal housing rents do not change in the U.S. from 1974 to 1981. Shimizu et al. [2010] find similar phenomena in Japan during its bubble period in the 1980s. Rents in residential units were stable for the period when asset prices skyrocketed. Ninety percent of housing rents did not change for the period. Hoffmann and Kurz-Kim [2006] observe similar rigidity in rents in Germany.

Though there are various explanations for rent rigidity depending on researchers, most of the explanations are related to the pricing behaviors of landlords. John [1996] suggest changes in natural vacancy rates, changes in rental price-setting behaviors of landlords, changes in nominal and real rents measurement in CPI, etc., as candidates for causes of rigid rents in the 1980s in the U.S. market. Genesove [2003] cites tendencies of landlords to stick to the old nominal rents when contracts are renewed and the grid pricing, which means that rents would increase by some fixed values like \$5 or \$10, for the reason of rigidity. Tsai [2020] suggest a theory that argues that the different responses of landlords to expected inflation in the future contribute to the patterns of rental contracts and rigidity of rents. During a period of high inflation, landlords expect rent raises in the near future and would try to make short-term rental contracts. Short-term rental

contracts create high transaction volumes and higher frequencies of price adjustments. However, landlords would make the longer-term contracts in a low inflation period, and rent levels do not adjust quickly while vacant units are accumulated.

While many researchers attempt to figure out why, in property markets, rent and vacancy can be deviated from efficient levels by behaviors of landlords, they only regard landlords as seekers of rental incomes. However, because landlords pursue capital gains as well as regular incomes from rent when they decide to invest in specific commercial properties, we should consider how the behaviors of landlords can affect the capital values of assets. According to Archer and Ling [1997], there are three dimensions in real-estate markets, which are dimensions of the space market, capital market, and property market. Demands for space are for using the space, and they are affected by rent level and other socio-economic factors like GDP, growth of population in regions. However, due to the characteristics of real estate as assets for investment, they are also influenced by financial factors as interest rate changes and prediction for future property market conditions. Cheung et al. [1995] also points out that property markets are objects of investment as well as tools for use. They test if there is any spillover of sales market into the rental market, but they cannot find a significant relationship between the two markets.

In the remaining sections, rental income and expected future price gains, the two factors affecting demands for commercial properties, will be linked in the analysis of vacancy incidences. Moreover, supporting evidence will be provided to explain why landlords might choose not to adjust rents to the changed circumstances and leave their assets vacant if landlords guess that adjusting rents can negatively impact property prices in the future. In those cases, vacancy rates could stay higher than the natural level, and there would be minor rent adjustments.

2.3 Observations and Hypotheses

2.3.1 Stable Rents and Volatile Vacancies in Seoul Commercial Districts

The data I use in this paper are from the Survey of Commercial Property Rental Trends, which has been collected, processed, and produced since 2002 by Korea Appraisal Board (KAB)[1], the public agency for property price survey and appraisal. The survey has been conducted quarterly, four times a year, with selected samples. The survey area is the entire nation of the Republic of Korea, and 177 business districts are included. The total number of commercial buildings in the sample is 29,355, but the unit of samples is not a building but individual shops in buildings. The samples are added and revised from time to time, and the samples I use in the study are from the first quarter of 2017 to the fourth quarter of 2018. The reason for selecting this two-year window is because KAB revised samples at the start of 2017 and 2019, and the samples before and after this period cannot be regarded as identical.

To eliminate variations caused by regional differences, only samples in the Seoul area, the capital, are chosen for the study. In Seoul, the data of 42 business districts are surveyed, but the districts with less than one hundred samples are excluded from analyzing process. Therefore, only 31 business districts are used. The data of the area and boundary of each business district are constructed by GIS (Geographic Information System). The names and areas of 31 districts are described in Table 2.1 and Figure 2.1. The number of final samples is around 14,800 though there are some changes in samples quarterly. Unfortunately, because KAB did not tag any distinguishable identification number on

[1]Korea Appraisal Board was renamed to Korea Real Estate Board (REB) at December 10, 2020

each sample, the samples cannot be regarded as panel data.

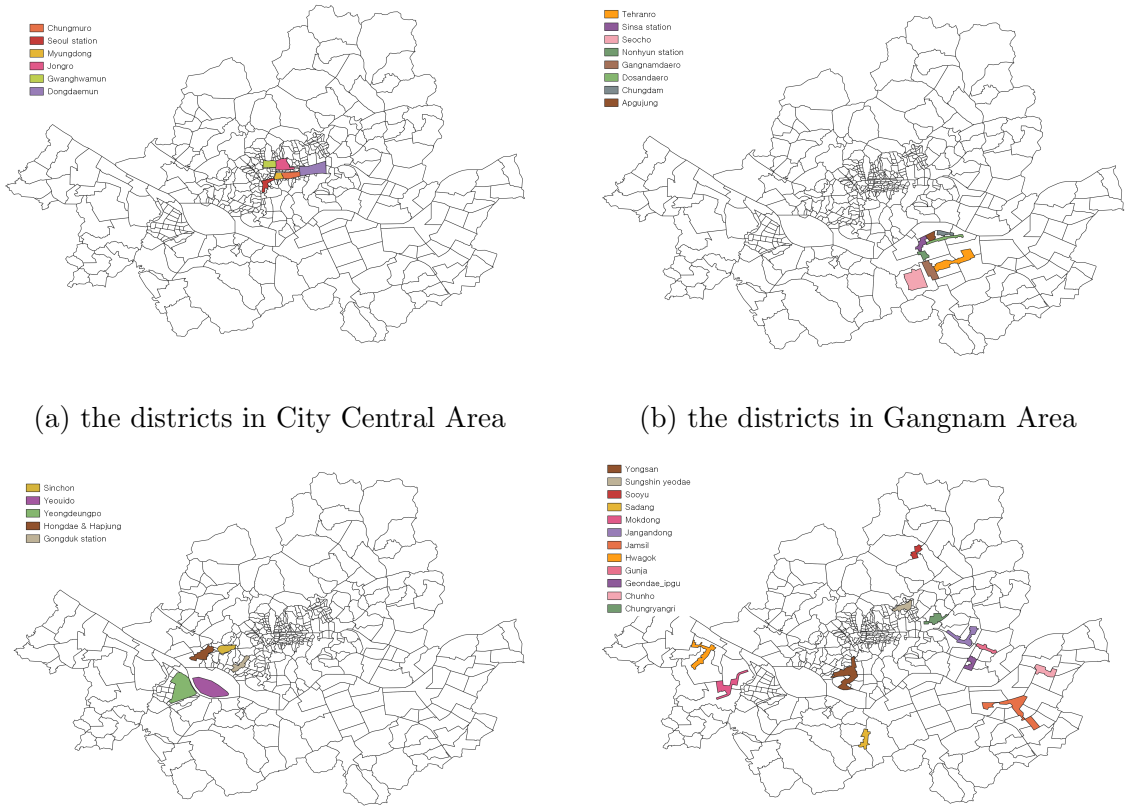
Table 2.1: Description of 31 Business Districts in Seoul

Business Districts		Area(m^2)	Buildings(no.)
City Central Area	Gwanghwamun	556,156	218
	Dongdaemun	1,616,967	2,245
	Myungdong	311,011	462
	Seoul station	470,421	501
	Jongro	906,043	1,726
	Chungmuro	644,373	1,593
Gangnam Area (Southeast Sub-center)	Gangnamdaero	1,027,884	613
	Nonhyun station	368,884	371
	Dosandaero	577,569	474
	Seocho	2,123,854	1,269
	Sinsa station	522,770	559
	Apgujeong	371,401	344
	Chungdam	350,692	488
	Tehranro	1,791,548	1,183
West Sub-Center	Gongduk station	680,719	913
	Sinchon	703,639	768
	Yeouido	2,740,902	205
	Yeongdeungpo	3,155,248	2,637
	Hongdae-Hapjung	1,086,699	770
Other Local Centers	Geondae-ipgu	618,644	356
	Gunja	494,866	188
	Mokdong	1,487,554	491
	Sadang	764,712	670
	Sungshin-yeodae	681,394	597
	Sooyu	530,182	546
	Yongsan	2,179,429	684
	Jamsil	2,569,798	1,003
	Jangandong	1,201,769	547
	Chunho	968,943	549
	Chungryangri	852,110	912
	Hwagok	1,342,686	554

Note. There are four groups in terms of categories of business districts depending on the locations and functions: City Central Area, Gangnam Area, West Sub-Center, and Other Local Centers. Areas of districts are calculated by the areas of polygons that match business districts in GIS program. And, for the number of buildings, only commercial buildings are counted in the polygons and buildings for residential and other uses are excluded.

Business districts in Seoul, where many commercial buildings and shops are concen-

Figure 2.1: Locations of business districts



(a) the districts in City Central Area

(b) the districts in Gangnam Area

(c) the districts in West Sub-Center

(d) the districts in Other Local Centers

Note. In (a) (d), 31 business districts are displayed. In (a), six districts (Chungmuro, Seoul station, Myongdong, Jongro, Gwanghwamun, Dongdaemun) are in City Central Area. In (b), eight districts (Tehranro, Sinsa station, Seocho, Nonhyun station, Gangnamdaero, Dosandaero, Chungdam, Apgujeong) are included in Gangnam Area group. In (c), five sub-districts (Sinchon, Yeouido, Yeongdeungpo, Hongdae-Hapjung, Gongduk station) are in West Sub-Center group. Finally, in (d), there are twelve Local Sub-Centers located across Seoul (Yongsan, Sungshin-yeodae, Sooyu, Sadang, Mokdong, Jangandong, Jamsil, Hwagok, Gunja, Geondae-ipgu, Chunho, Chungryangri).

trated, can be categorized into four groups depending on the locations and functions. The first group is City Central Area, and there are six districts in this group: Chungmuro, Seoul station, Myongdong, Jongro, Gwanghwamun, Dongdaemun. The districts in City Central Area have had functions of city centers since the beginning of the city for almost about six hundred years. Government offices, main branches of big companies and banks have been located in this region. Because there are old traditional shops, many tourist attractions like palaces of the Chosun Dynasty, and luxurious hotels, many foreign

tourists visit this area. Seoul station, the central high-speed railway station connected to most regions around the country, is in the area. The second group is Gangnam Area, which is the most affluent area, located in the Southeast part of the city. Gangnam Area has been developed since the 1970s through the expansion of the city. There are eight business districts in this group: Tehranro, Sinsa station, Seocho, Nonhyun station, Gangnamdaero, Dosandaero, Chungdam, and Apgujeong. Gangnam Area also has a lot of main branches of big companies. The prices of houses and commercial buildings of Gangnam Area are the highest in the country. There are many boutique shops, department stores, and high-quality dining restaurants in this group. The third group is West Sub-Center, and five sub-districts are included in the area: Sinchon, Yeouido, Yeongdeungpo, Hongdae-Hapjung, and Gongduk station. Yeouido district is a financial center, and many branches of commercial and investment banks, securities companies, and other financial institutions are concentrated in this district. Sinchon and Hongdae-Hapjung districts are places the young generation gather due to several universities in this region. The fourth group is a collection of relatively small business districts, and it is named Other Local Centers in the survey. Because Seoul is a huge city, there are scattered business districts that function as centers for shopping and commercial activities across the entire city area. In this group, there are twelve districts: Yongsan, Sungshin-yeodae, Sooyu, Sadang, Mokdong, Jangandong, Jamsil, Hwagok, Gunja, Geondae-ipgu, Chunho, Chungryangri. Districts in this group are more focused on commercial purpose shops, and the proportions of offices are lower than other groups.

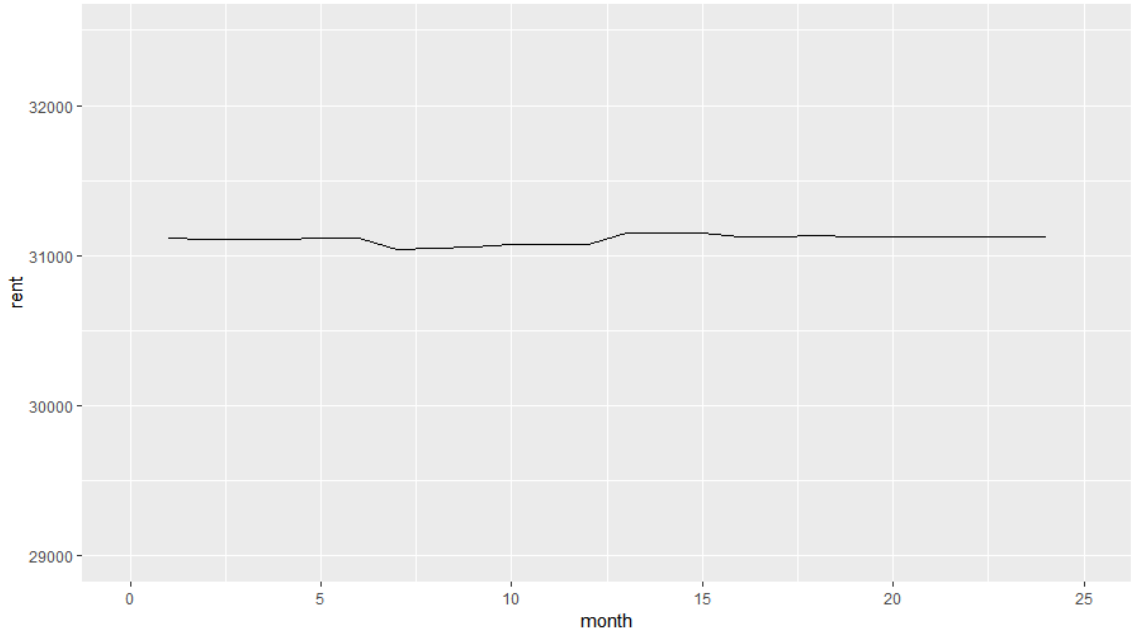
To observe patterns of movements of rents and vacancies in commercial properties in Seoul, the author compares average rents and vacancy rates of all 31 business districts in Seoul for two years, from January 2017 to December 2018. As it can be seen in Figure

2.2, the patterns of rents and vacancies are totally different. For two years, the rents have not changed much. However, the vacancy rate varies in a volatile fashion. While the average vacancy rate changes from 8.36 percent to 10.13 percent (rate of change is about 25 percent), the rental price level moves only slightly in the range from 31,040 KRW/m^2 to 31,153 KRW/m^2 (rate of changes is 0.36 percent). The same pattern also appears in the average rent and vacancy rate in data of each 31 districts. In the data of average rent and the average vacancy rate in each district, the imbalances of movements between rent and vacancy is displayed in a more distinct pattern (See Figure 2.3).

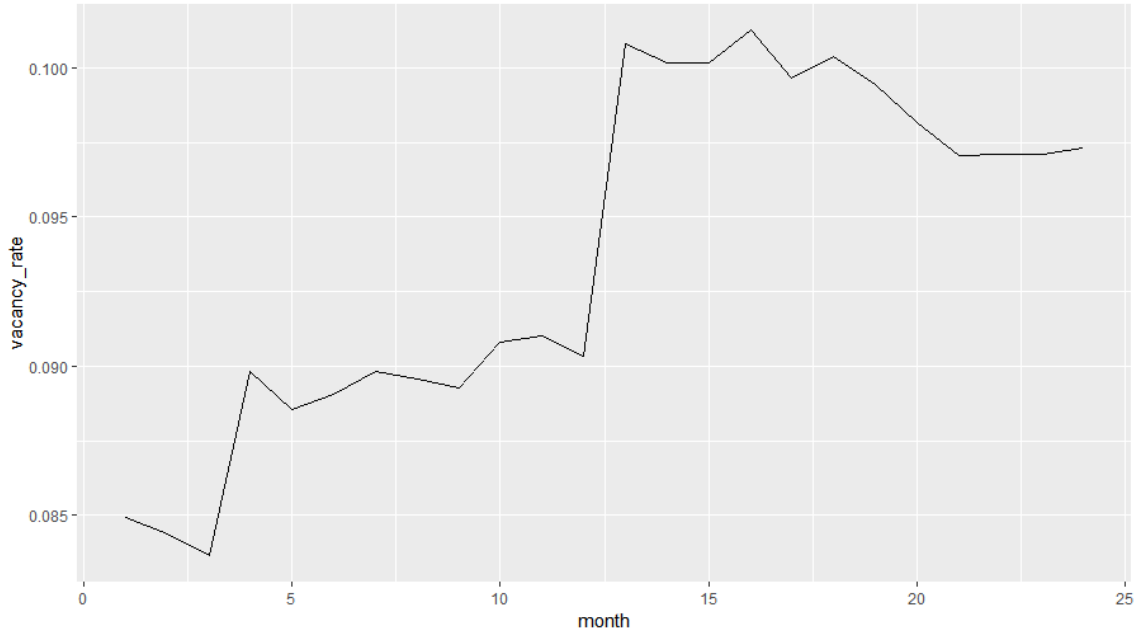
According to the predictions of Rosen and Smith [1983] and others, when vacancy deviates from the natural level, rents must change to adjust the excess demand or supply. However, in the data of Seoul, the opposite patterns are observed. Rent levels are relatively stable for two years of the observation period, but vacancy rates drastically change from quarter to quarter in all 31 districts.[2] The hypotheses explaining this irregularity will be suggested in the next section.

[2]The rent and price data of individual shops in this study are appraised by the Korea Appraisal Board (KAB, its name was changed to Real Estate Board in 2020) of the Republic of Korea. KAB provides the *market rent*, the level of rent that can be tradable at the moment of the survey. The market rent is the appraised value by the KAB with the appraisal method based on the market comparison approach. In case the rent and price are appraised, so-called appraisal smoothing is well-known. In the Republic of Korea, the official surveys of rental trends are in accordance with the rules by the government. The Korean government regulates the appraisal methods of appraisers, and article 22 of the Enforcement Rule of Appraisal, the executive rule of the Ministry of Land, Infrastructure, and Transportation (MOLIT), stipulate that the appraisal of rent should be conducted with the *market comparison approach*, the appraisal methods to estimate values by comparing with the rents of similar properties. In many previous literatures, such as Barkham and Geltner [1995], Clayton et al. [2001], Geltner et al. [2003], and McAllister et al. [2003], appraisal-based valuations have tendency to reduce volatile change in values and to show lagging (*appraisal smoothing*). Because the appraisers assess the values at present based on the previous values with the Bayesian improvement approach, the appraised values tend to be smoothed than the actual transaction data, including noises. While the data of vacancy is from the real state of individual shops, the data of rent and price have a possibility of deviations from the real values. Moreover, the appraisal smoothing has risks excluding the extreme values out of allowable ranges based on the previous observations. However, there is no other option to take the appraised values when we want to compare the rents of properties in different states, from the occupied stocks with existing contracts to the newly occupied stocks with the new contracts to the vacant stocks. Though the interpretation of rent data should be made with caution, this study deals with the data in the short run with many transaction data in Seoul metropolitan city, and, thus, the risks of distortion are expected to be small.

Figure 2.2: Trends of Average Rent and Vacancy Rates of 31 Business Districts



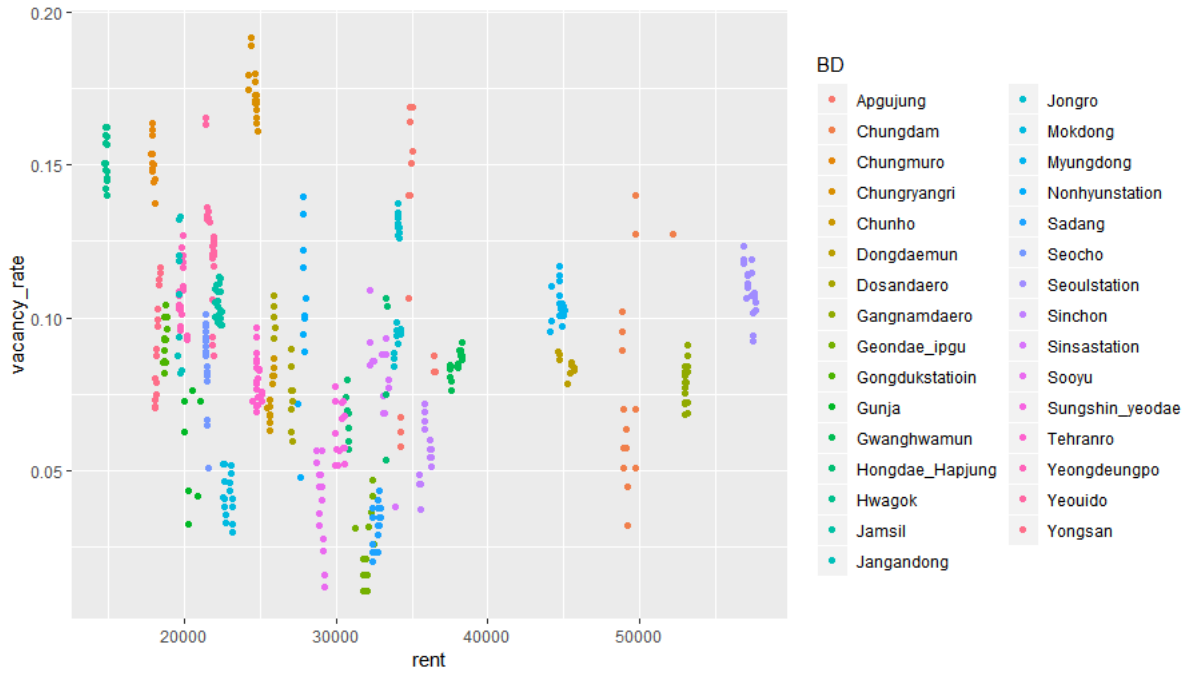
(a) average rent price



(b) average vacancy rate

Note. The number of horizontal axis from 1 to 24, in both diagrams, stand for each month of the analysis period from January of 2017 (1) to December of 2018 (24). The vertical axis in (a) is monthly rent per square meter and the unit is Korean Won (KRW). The vertical axis in (B) is vacancy rate, which is the proportion of vacant unit to all the units of business district. In (a), average rent level of all 31 districts moves only slightly in the range from 31,040 KRW/m^2 to 31,153 KRW/m^2 (rate of changes is 0.36 percent). In (b), average vacancy rate changes from 8.36 percent to 10.13 percent (rate of change is about 25 percent).

Figure 2.3: Scatter Plots of Rent and Vacancy Rate in 31 Business Districts



Note. The numbers of horizontal axis from 1 to 24, in both diagrams, stand for each month of the analysis period from January of 2017 (1) to December of 2018 (24). The vertical axis in (a) is monthly rent per square meter, and the unit is Korean Won (KRW). The vertical axis in (B) is the vacancy rate, which is the proportion of vacant units to all the units of the business district. Each dot stands for the average monthly rent and vacancy rate of each business district. Same colors mean same districts; that is, each business district has twenty-four same-colored dots. Horizontal variations in rent level are limited, and most of the variations occur in vertical directions.

2.3.2 The Hypotheses for Stable Rent and Volatile Vacancy

A. Regulation for rent

The first hypothesis for stable rent levels and volatile vacancy rates is that government rent control regulations can prevent rent levels from changing rapidly. In the Republic of Korea, there are regulations for protecting tenants of residential and commercial properties. According to the "Commercial Building Lease Protection Act," a tenant has the right for renewing contracts for *five years* from the starting date of entering the property, and the price of rent in a new contract cannot be increased by more than *nine percent* of the previous contract. (Since 2018.10.16., the maximum period of renewing the contract is extended to ten years). Due to this regulation, there can be arguments that rent levels

cannot abruptly increase. Moreover, because of control for rent level and contract period, the landlords might tend to be reluctant to lower rents when renewing contracts, even in a bad economic cycle, because they know they cannot quickly make prices back when the economic cycle recovers.

However, the rent control hypothesis is only half of the explanation for stable rent level. Because the rent regulation does not apply to the case of contracts with negative rent adjustment, landowners can choose to cut rents to clear vacancies if they think vacancy will persist for a long time. When a tenant leaves the property and the landowner of the property makes another contract with new tenants, the price regulation does not apply to the new rental contracts. The regulation is not applied when a landlord renews a contract with the same tenant after the legal protection period (five years before October 2018, ten years after that). Therefore, the rent regulation hypothesis cannot explain the entire picture even though it can partially explain the phenomenon.

B. Profit maximizing behavior of landlords

The second hypothesis is that vacancies are the results of reasonable choices of landlords who try to maximize their economic gains. This hypothesis is based on the two characteristics of commercial property: a capital asset for investment as well as an income-generating tool by renting the space. For a hypothetical landlord, who owns a commercial property for an investment purpose, the objective function is to maximize profits from the property. Economic gains from the property can roughly have two sources: net operational income (NOI, rental income – operating costs) and capital gains from the increased property value. When other factors, such as interest rates, inflation, and depreciation of assets, are ignored, the economic gains for a certain period from a property can be

expressed in the equation:

$$EG = RI + CG = f(R, V) \ + \Delta P, \tag{2.1}$$

where EG, RI, and CG are economic gains, rental income and, capital gains during the period, R is rent level set by the landlord, V is the probability of being vacant, and ΔP is change in asset value during the period. The main point of Equation 2.1 is that landowners are interested not only in rental income from properties (or revenues in case they use the spaces for themselves) but also in variations of financial values of assets.

When a property becomes vacant due to a lack of demands or excess supply in an area, the rent level must change in the negative direction to clear the vacancy. Facing the vacancy by market changes, a hypothetical individual landlord can have two options: to accept the changed rent level to fill the vacancy or to leave the asset in vacant states while observing the property market for a while. If we assume that V, the probability of being vacant is determined by market conditions exogenously, in 2.1, the choice of the hypothetical landlord depends on the relationship between R (rent) and ΔP. There are two scenarios regarding the relationship. The first one is that rent and price change of property are not related. In other words, R and ΔP are independent, and ΔP is also exogenously determined. The second scenario is that ΔP is affected by R; i.e., the future price of property can be influenced by the present rent level.

B-1. Case1: Rent and Price change are independent

When the price of a property is not affected by the current rent level set by the landlord, his or her rational choice is to accept the market-clearing rent to generate rental income. Because price changes are determined by exogenous factors other than vacancy and rent,

landlords try to fill the vacancies because earning rental income, no matter how small it is, is better than nothing. If units are in vacant states for longer terms, landlords are worse off due to continuously losing costs. Therefore, in this scenario, landlords respond to the changes in market demand and supply quickly. When the vacancy rate of a business district is distracted from the natural level once, for whatever reasons, the vacancy rates will converge back to the natural level in a short period through a rent adjustment mechanism.

B-2. Case2: Future prices are affected by current rent level

Unlike the first scenario, in this case, landlords consider the influence of the current rent level on future prices when they choose an option between filling the vacant spaces by lowering rents or leaving spaces vacant without adjusting rents. Because landlords are eager to maximize the economic gains, which are the summation of capital gains and rental incomes altogether, they may not accept the market-clearing level of rent if those choices negatively affect capital gains in the future. Also, in the results of those choices, vacancy rates may stay at a higher level than the natural vacancy rate of the market.

Then, how are future prices affected by the choice of current rent level? There can be two channels explaining how the current rent level influences future prices: the linkage between rent and price through the required rate of return ("capitalization rate," or "cap rate") and the behaviors of landlords to set efficiency rents for screening tenants, which will be described below in detail.

(1) Linkage between rent and price through cap rate

In equation 2.1, the economic gain of a hypothetical landlord can be decomposed to the ones from the two sources, the net operating income (NOI) from rents and the capital

gain from the appreciation of asset value. By the way, the two sources of economic gains are from the two different markets, respectively. The rental income (RI) is calculated by the rent level and vacancy rate determined in the rental market. However, the capital gain (CG) is determined by the price change in the asset market. The compositions of participants of the two markets are also different, except the landlords themselves, who are investors in the asset market and sellers of spaces in the rental property market at the same time. Therefore, the model interlinking the two markets is needed to figure out the entire picture of the economic gains. The author derives a model from the DiPasquale-Wheaton-Colwell (DWC) Four Quadrant model, which describes the dynamics among four different markets related to real estate in the four quadrants of the cartesian plane.

Because the analysis is not about the influence on the long-run equilibrium of supply, the author ignores the third quadrant (the construction market) and the fourth quadrant (the market for inventory) of the DWC model. Moreover, the author assumes the amount of existing stock is fixed (i.e., the supply curve is inelastic) in the short-run period. In the original Dipasquale-Wheaton (DW) model of DiPasquale and Wheaton [1992], the concept of vacancy in the market is not considered. Colwell [2002] modifies the DW model and devises a way to explain vacancies in the rental market. The concept of the DWC model is displayed in Figure 2.4.

In the modified DWC model, the rental market in the first quadrant governs the rent level (R) and occupied stocks (S) in the market. The rent and supply vary with the change in demand and the supply, in similar ways in the other markets. Here, the demand for rental space is a function of rent and other economic conditions, such as macroeconomic factors and market conditions.

$$Demand = D(R, economy) = S \qquad (The\ \ rental\ \ market) \tag{2.2}$$

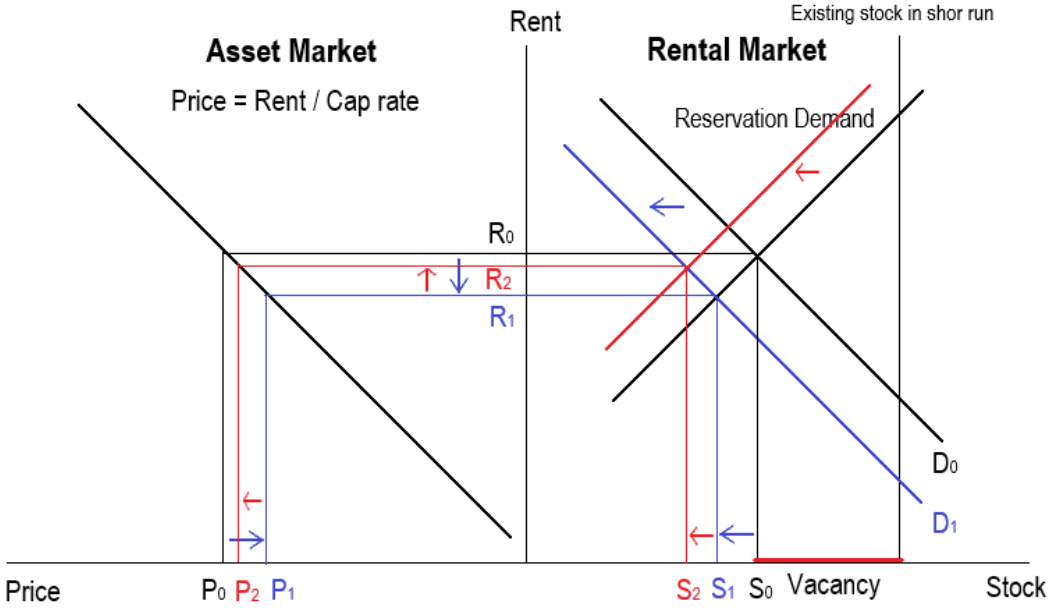
The rent level determined in the rental market affects the asset price in the asset market in the second quadrant because the asset price (P) is the function of the rent and capitalization rate (*cap rate*), which is the required rate of return to maintain the ownership of the property. Cap rate is affected by many exogenous factors from the financial market, such as the real interest rate, expected inflation, real estate taxation regime, and the risk premium. In this study, the cap rate is assumed to be stable because there is no significant difference in the interest rate or taxation in the two years from 2017 to 2018. (The base interest rate of the Bank of Korea is from 1.50 to 1.75 in this period.)

$$P = \frac{R}{Cap\ \ rate} \qquad (The\ \ asset\ \ market) \tag{2.3}$$

As it can be seen in the equations 2.2 and 2.3, the rental market and the asset market can be interconnected with the rent level determined in the rental market. The relationship can be expressed in the Figure 2.4. The figure describes what happens in the rental market and the asset market when there is a shock in demand in the rental market. When demand decreases from D_0 to D_1 due to shocks, such as the decline of the economy or consumers' dispensable income, rent level also falls from R_0 to R_1. At the same time, the vacant stocks, which is the gap between the occupied stocks and the total amount of existing stocks, increase in the market because the occupied stocks decrease from S_0 to S_1. The reduced rent affects the price in the asset market, and the price falls from P_0 to P_1.

Colwell [2002] argues that if landlords have speculative demands, the vacancy rate can be higher than the natural vacancy rate. According to Colwell's model of vacancy, the myopic landlords keep observing the market, and they react to the change in the market preemptively. When the rent falls below the previous level, the speculative landlords expect the rent will rise again, and they try to withhold their stocks, and then vacancy increases in the market. The rent and vacancy are determined in the intersection of the demand of tenants for properties and the reservation demand of landlords for vacant stocks.

Figure 2.4: DWC model explaining relationship between price, rent, and vacancy



Note. The rental market and the asset market are interconnected by the rent level determined in the rental market by the demand for spaces of tenants and the reservation demand for vacant stocks of landlords. When there is a demand shock, decreased rent affects the asset price in the asset market negatively. The landlords who are highly concerned about maintaining the price are likely to retain more vacant stocks to raise the rent level in the market (The reservation demand of landlords for vacant stocks increases).

The model in this paper provides a different point of view from Colwell [2002]. When there is a demand shock, the market rent level decreases, and it affects price in the asset market. The story so far is the same as Colwell's modified DWC model. However, as

investors, landlords not only care about the rental income but also the change in the capital value of the asset. Because the lowered rent level in the rental market affects the price negatively, the landlords try to maintain the price value by retaining the vacant properties more. In the figure, when the landlords want to retain vacant stocks more, their reservation demand for vacant stocks increases. Retaining more vacant stocks (from S_1 to S_2) will increase the rent level from R_1 to R_2. The increase in rent affects the price positively in the asset market (P_1 to P_2).

The tendency to maintain price will be strong if the proportion of the capital value appreciation to the total gains is high. Therefore, this model supports the hypothesis that the probability of vacancy will be higher in the property with a higher price-per-rent ratio.

(2) Behaviors of Setting Efficient Rents.

For whatever rationales, if landlords ask for higher rents than the market level, vacancy rates can be higher than the natural level. In this study, the author argues that landlords sometimes ask for higher rents than the market-clearing levels to raise the values of properties. This efficiency rent hypothesis is suggested by Miceli and Sirmans [2013] before. The name of the hypothesis, efficiency rent, follows the name of a similar model in labor economics. A group of economists explains unemployment as a result of setting wages by employers higher than equilibrium price (See Yellen [1995]). In this model, employers set wages higher than the market rate to prevent employees' shirking in workplaces or lower turnover rates of talented employees. These kinds of behaviors of employers can cause permanent unemployment, and the unemployment cannot be eliminated perfectly even though players in labor markets are perfectly rational.

If the landlords of properties act similarly with the employers in the labor market

for whatever rational reasons, vacancy rates will be different from the natural vacancy rates. Miceli and Sirmans [2013] applies for the efficiency rent hypothesis on behaviors of landlords to maintain a tenancy in their properties. According to their theory, positive vacancy rates give landlords incentives to invest more in maintaining the quality of rental units to avoid vacancy. In this point of view, landlords are considered to pursue to maximize rental incomes from their properties. However, if we assume that landlords are interested in maximizing total economic gains, including capital value appreciation, and if the size of capital gains are much bigger than rental incomes, concepts of efficiency rent are pretty different from the one suggested in Miceli and Sirmans [2013].

As stated above, the value of property basically depends on the ability to generate future incomes. Therefore, landlords of commercial property are highly interested in having tenants with income-generating ability because the good tenants will raise the property value by exerting good images of properties and increasing possible future rental incomes. These preferences of landlords are similar to the ones of employers who want to hire good employees. The landlords know that the good tenants will make more revenues than the bad ones, but they cannot differentiate good ones from bad ones when they make rental contracts. To sort out good tenants, landlords can set higher rents because tenants willing to pay higher rents are more likely to be good ones. These behaviors of landlords can cause permanent vacancies.

In reality, landlords' reserving stocks to maintain the asset price and behaviors of asking for the efficiency rent are likely to occur simultaneously. If landlords have tendencies of prioritizing capital gains over rental income or if the size of capital value is larger compared to the rental incomes, rent adjustment will be weakly observed. Vacancy rates will not converge to the natural level of the market. This phenomenon will be more dom-

inant in the markets where property values increase rapidly, i.e., the commercial property markets in metropolitan cities like Seoul. The critical factor here is not the absolute value of property or magnitude of rent but the relative ratio of capital gain over rental income. Therefore, according to this hypothesis, vacancies will also be likely to occur more often in properties where the ratios of price change to the rental income are high. The next section will provide the empirical test for this argument with quantitative analyses of KAB data.

2.4 Data and Estimation

2.4.1 KAB Data

As mentioned above, the data used in the analysis are from the Survey of Commercial Rental Trends, collected and constructed by the Korea Appraisal Board (KAB). The Survey of Commercial Rental Trends has been conducted every quarter since 2002, and 29,355 commercial properties are surveyed for the study period from the first quarter of 2017 to the fourth quarter of 2018. The inquiry for the survey is made in the last month of each quarter. Though the KAB data have samples all around the country, only thirty-one business districts in Seoul, which have more than one hundred samples, are chosen for the analysis to reduce the effect of regional differences.

In KAB data, all the samples are categorized into four groups by their functions, sizes, and type of ownership. The four groups are Office, Middle and Big Shops, Small Shop, and Aggregate Shop. Office properties are mainly used for business facilities by companies and organizations. Middle and Big Shop, Small Shop, and Aggregate Shop are groups of properties mainly used for sales, shopping, dining, and other commercial activities.

The four categories of shops described above are distinguished by areas of shops or type of ownership of buildings. The buildings in Office, Middle and Big Shop, and Small Shop groups are categorized as singular ownership buildings, in which the ownership of buildings is undivided. Individual persons or firms own the buildings in these categories, or the legal ownership of the buildings is unitary even when they are commonly shared. However, each property in the buildings in the group of Aggregate Shop is separately owned. In other words, separate ownership can be given to each property in aggregate buildings. The definitions of four categorized are described in Table 2.2.

Table 2.2: Four categories of commercial property in the KAB survey

<table>
<tr><th>Category</th><th colspan="2">Definition</th><th>Ownership</th></tr>
<tr><td>Office</td><td>business facility</td><td>6 floors or higher</td><td rowspan="2">building is owned by one individual/firm or commonly owned.</td></tr>
<tr><td>Middle and big Shop</td><td rowspan="2">living service, sales, sports, dining, and shopping facilities</td><td>floors ≥ 3 or gross area $\geq 330m^2$</td></tr>
<tr><td>Small shop</td><td>floors ≤ 2 gross area $< 330m^2$</td><td></td></tr>
<tr><td>Aggregate shop</td><td></td><td>no floor/area condition</td><td>shops are separately owned</td></tr>
</table>

Note. The unit of Office, Middle and Big Shop, and Small Shop are buildings, and 6,355 buildings are surveyed (824 buildings in Office group, 2,826 buildings in Middle and Big Shop group, and 2,705 buildings in Small Shop group are surveyed in the Survey of Commercial Rental Trends). The unit of Aggregate Shop is individual shop in aggregate buildings and the number of properties in this group is 25,000 in the Survey).

Unfortunately, the samples in KAB data do not have any traceable identification number even though the same samples have been repeatedly surveyed for two years of period. Therefore, the data cannot be regarded as panel data. If the data have forms of the panel, it is easier to estimate factors creating vacancy more directly by comparing the same samples between periods. Instead, estimations are done with pooled data in the analysis. The number of samples changes quarterly even though the magnitude of change is slight. In the first three months in 2017, there were 14,683 observations, but

14,909 samples were observed in the last three months in 2018. In total, the number of samples is 118,547.

Table 2.3: The number of samples in data of each quarter

quarter	17. 1/4	17. 2/4	17. 3/4	17. 4/4	18. 1/4	18. 2/4	18. 3/4	18. 4/4
samples	14,683	14,673	14,773	14,791	14,901	14,902	14,915	14,909

Note. The period for analysis in the study is from the first quarter of 2017 to the fourth quarter of 2018. Even though the sample size changes quarterly, the size of change is limited and same samples are repeatedly surveyed. However, because KAB data do not have identification number of samples, the data cannot be analyzed as panel.

The KAB data include various attributes of each commercial property. The data consists of information about individual shops, and the building and area where each property is located. The variables related to characteristics of shops include the state of vacancy of shops, monthly rent and price per square meter, category of shops, the floor where shops are located, area of shops, type of ownership, and the number of owners. There are variables of attributes related to buildings in which shops are located. These sort of variables include coverage ratio (rate of built area to land area) and building volume ratio (rate of all floors area to land area) of the buildings, the existence of passenger elevators, floors in overground and underground of the building, the year when buildings were built, and area of parking lots. Finally, there is information about the neighborhood environment, such as transportation and zoning regulations. The data provide the distances to the closest subway station, bus station, and road intersection, and land-use of the area where a building is located. The variables and summary statistics of KAB data are shown in Table 2.4.

Table 2.4: Summary Statistics

Variable		mean	standard deviation
vacancy (1 if vacant)		0.093	0.291
Monthly rent per m^2 (KRW)		31,112	36,094
Price per m^2 (KRW)		7,319,264	7,298,199
PRR(Price/Rent ratio)		283.128	190.876
Number of owners for property		1.437	1.435
Building coverage ratio		0.494	0.226
Building volume ratio		4.062	2.962
Dummy for passenger elevator		0.606	0.489
Distance to closet subway station (m)		53.080	36.811
Distance to closet bus station (m)		33.941	27.881
Distance to closet road intersection (m)		43.607	33.487
Category of shops	Office	0.466	0.499
	Middle and Big Shop	0.269	0.443
	Aggregate Shop	0.203	0.402
	Small Shop	0.063	0.243
Floor where shops locate	Underground 6 to 10	0.000	0.018
	Underground 2 to 5	0.010	0.100
	Underground 1	0.099	0.298
	1st floor	0.248	0.432
	2nd floor	0.120	0.325
	3 to 5	0.263	0.440
	6 to 10	0.167	0.373
	11 to 20	0.086	0.281
	21 to 30	0.006	0.079
Area of shops	Area $\leq 33m^2$	0.150	0.357
	$33m^2 <$ Area $\leq 66m^2$	0.167	0.373
	$66m^2 <$ Area $\leq 100m^2$	0.123	0.329
	$100m^2 <$ Area $\leq 330m^2$	0.322	0.467
	$330m^2 <$ Area $\leq 660m^2$	0.110	0.313
	$660m^2 <$ Area $\leq 1000m^2$	0.054	0.226
	$1000m^2 <$ Area $\leq 3300m^2$	0.071	0.257
	$3300m^2 <$ Area $\leq 6600m^2$	0.002	0.046
	$6600m^2 \leq$ Area	0.000	0.014
Type of Ownership	Individual owners	0.635	0.481
	Private firm owns the property	0.354	0.478
	Government owns the property	0.004	0.061
	Others	0.007	0.084
Overground floors of the building	1 to 2	0.072	0.259
	3 to 5	0.298	0.457
	6 to 10	0.318	0.466
	11 to 20	0.260	0.439
	21 to 30	0.051	0.221
Underground floors of the building	No underground floor	0.108	0.310
	1 to 5	0.800	0.400
	6 to 10	0.093	0.290
Year when building was built	Until 1985	0.376	0.484
	1986 to 1990	0.104	0.305
	1991 to 1995	0.214	0.410
	1996 to 2000	0.089	0.285
	2001 to 2005	0.107	0.309
	2006 to 2010	0.077	0.266
	2011 to 2015	0.031	0.174
	Since 2016	0.003	0.051
Area of parking lot of building	Area $\leq 100m^2$	0.781	0.414
	$100m^2 <$ Area $\leq 330m^2$	0.041	0.197
	$330m^2 <$ Area $\leq 660m^2$	0.023	0.149
	$660m^2 <$ Area $\leq 1000m^2$	0.009	0.094
	Area $\geq 1000m^2$	0.147	0.354
Zoning regulation	Business zone	0.679	0.467
	Residential zone	0.299	0.458
	Industrial zone	0.022	0.146
N		118,547	

Note. The third and fourth columns summarize mean and standard variations of the samples in the period from the first quarter of 2017 to the fourth quarter of 2018. The number of observations is reported in the bottom row.

2.4.2 Summary of Variables

The dependent variable for the estimation is *vacancy*, which is a dummy variable to indicate the status of vacancy of the property. The mean value of *vacancy* is 0.093, which means 9.3 percent of properties are surveyed to be vacant on average during the analysis period. The average monthly rent and price per square meter are 31,112 KRW (about 27 USD) and 7,319,264 KRW (about 6,700 USD), respectively. PRR, price-per-rent ratio, the main explanatory variable, is about 283 on average. The mean number of owners is 1.437; that is, more than one person owns each property on average.

Building coverage ratio and building volume ratio are indices for density of development on the parcel of land on which the building is built. The building coverage ratio is calculated by the rate of the built area to the land area of a building. The average building coverage ratio is 0.494, which means almost half of lands are covered by buildings. The building volume ratio is the rate of all floors area to land area. The mean value of the building volume ratio is 4.062, which means that building volumes are four times more than the area of land.

Distances to closest subway stations, bus stations, and road intersections are variables to indicate the accessibility to transportation from shops. Average values are 53m, 34m, 44m from subway stations, bus stations, and road intersections, respectively. Because Seoul is a highly developed city and 31 business districts are the most densely developed among the entire Seoul city area, conditions for accessibility to transportation are exceptionally good everywhere.

Among four categories of property, the Office group has 46.6 percent, Middle and Big Shop has 26.9 percent of the property. While 20.3 percent of samples are in the Aggregate Shop group, shops in the Small Shop category are only 6.3 percent.

Variables for floors and areas have categorical values. 24.8 percent of shops are located on the first floor, which can be accessed easily by customers. About 76 percent of shop areas are less than 330 square meters, which means that most shops are not large.

There are four types of ownership among landlords. Individual ownership is most common type as 63.5 percent, and private firms own 35.4 percent of properties. The government and other public organizations own the rest.

Floors of buildings are also categorical variables. In the samples, the most common type of buildings has six to ten overground stories (31.8 percent) and one to five underground stories (80.0 percent). The year when buildings were built for the first time is also a categorical variable. 37.6 percent of buildings were built before 1985, and 21.4 percent of buildings were constructed in the period from 1991 to 1995. The buildings built after 2015 are only 0.3 percent. This means that most of the business districts in Seoul were formed before 2000, and there is no massive supply increase in the period of analysis. And 78.1 percent of buildings have parking areas less than 100 square meters. It can be guessed that it is very hard to construct enough parking places in business districts in Seoul.

In Korea, each parcel of land is designated as one of three urban planning regulation zoning: business, residential, and industrial zones. Though there are many second-tier zones under three first-tier big categories, only first-tier zoning is considered in the analysis for simplicity. Zoning regulation determines the use of buildings and development densities. Business zones are the most freely regulated zones. Most land-uses other than manufacturing factories are allowed to be constructed in business zones, and their permitted building coverage ratios and building volume ratios are highest among the three zoning categories. Because business zones are for commercial land use, this type is most

common in the samples located in 31 business districts of Seoul. 67.9 percent of buildings have been constructed in business zones. Almost thirty percent of buildings are located in residential zones. Because shops in residential zones tend to coexist with residential housing units such as apartments and villas, living-related shops, such as retail shops, educational academies, and sports are likely to be located in the zones. In contrast, big commercial shops like department stores, culture and art centers, and offices will be more concentrated in business zones.

2.4.3 Empirical Estimation

As stated above, estimations are done with pooled data because the data are not a panel. Because the dependent variable *vacancy* is a binary variable for indicating the state of vacancy, the estimations are done with probabilistic models. Parameters of estimators indicate the changes in the probability of being vacant when estimators have specific values. The main explanatory variable is the price to rent ratio (PRR).[3] The estimation equation is as follows:

$$vacancy_{it} = f(PRR_{it},\ \boldsymbol{S_i},\ \boldsymbol{B_i}, \boldsymbol{N_i}) + BD_i + \delta_t + e_{it}. \tag{2.4}$$

In the equation 2.4, $vacancy_{it}$ is the status of vacancy of a property i at a certain quarter-year t. PRR_{it} is the price-per-rent ratio of a property i at time period t (quarter-year). $\boldsymbol{S_i}$, $\boldsymbol{B_i}$, and $\boldsymbol{N_i}$ are vectors of attributes about shop, vectors of attributes about building where the shop is in, and vectors of neighborhood attributes of individual prop-

[3]Because the data do not have forms of the panel, the price to rent ratio (PRR) is used instead of the ratio of price change to rental income during a certain period. When comparing the average prices and their standard deviations, which mean the magnitude of price change, in 31 business districts, price change is estimated to be proportional to the abstract level of price. The estimated relationship is $log(standard\ \ deviation) = 0.6344\ log(mean) - 1.9309$. and the statistical significance level of the coefficient is about 1.5 percent.

erty i, respectively. BD_i is the fixed effect for the business district and δ_t is time fixed effect of the quarter of survey t. e_{it} is residual. The estimations are done by two probabilistic methods: logistic regression and linear regression models.

2.5 Results

2.5.1 Main Results

The results of logit and linear regression are provided in Table 2.5. As displayed in Table 2.5, the price-per-rent ratio (PRR) of commercial property has statistically positive significant impacts on probabilities of occurring vacancy.

Table 2.5: Correlation between Price Rent Raio (PRR) and the Probability of Vacancy

	(1)	(2)	(3)
Models		Logit	LPM
	Odds Ratio	Marginal effect	
PRR(divided by 100)	1.0442***	0.0030***	0.0040***
	(0.0163)	(0.0011)	(0.0018)
Psuedo R^2	0.0724		
R^2			0.0434
Nobs.	118,400		118,416

Note. Values of PRR are divided by 100 in the estimations. All the estimations include business district fixed effects. They also include a set of dummy variables for time (year-quarter) of survey. All the regressions control for characteristics of individual shops, such as category of shops, the floor where shops are located, area of shops, type of ownership, and number of owners, as well as characteristics of buildings where shops are located, such as coverage ratio (rate of built area to land area) and building volume ratio (rate of all floors area to land area) of the buildings, the existence of passenger elevators, distances to the closest subway station, bus station, and road intersection, floors in overground and underground of the building, the year when buildings were built, area of parking lots, and zoning regulations. Robust standard errors are in parentheses. Marginal effects of PRR in Logit estimation are predicted at mean values of all the independent variables. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

The estimation results are similar in the logit model and linear probability model. In column (1) of Table 2.5, odds ratio of PRR(divided by 100) is 1.0442. This means that when the PRR of a shop is one hundred higher, the odds of entering into a vacancy state

increase by 4.42 percent. In column (2), when I predict the marginal effect of PRR on the probability to be vacant at mean values of variables, a difference of one hundred of PRR affects the probability of vacancy by 0.0030. Column (3) displays the marginal effect of PRR in the linear model. When PRR increases by one hundred, the probability of being vacant increases by 0.0040. In both logit and linear estimations, the effects of PRR on vacancy are statistically significant at a one percent level.

If PRR is higher as much as 190, which is the level of one standard error (σ) of PRR, and other conditions are equal, the probability of being vacant of commercial property will increase by 0.57 percent (Logit) to 0.76 percent (LPM) points.[4] Because the mean value of variable *vacancy* is 0.0934, which means that the average vacancy rate of all the samples is 9.34 percent and its standard deviation is 29.1 percent, the effects of PRR on vacancy rates are not major factors in determining the difference of vacancy rates. However, considering that a variety of factors that can create vacancy are controlled, the effects of PRR cannot be negligible.

2.5.2 Subgroup Analysis

A. Regional differences

The extent of PRR's influences on the probability of vacancy can differ among regions. Logistic and linear regressions are done for each sub-regions to find out the difference in effects of PRR among regions. As stated above, the business districts of Seoul are grouped into four regions depending on their location and centrality: City Central Area, Gangnam Area, West Sub-Center, and Other Local Centers. The results are provided in

[4]In estimations, the marginal effects of 100 PRR on vacancy are 0.0030 to 0.0040. The effects of 190 PRR are 0.0057 (=0.0030 $\times$ 190/100) and 0.0076 (= 0.0040 $\times$ 190/100) in logit and linear models, respectively.

Table 2.6.

Table 2.6: Correlation between PRR and Vacancy: Regional Difference

Models	(1) Logit	(2) Logit	(3) LPM
	Odds Ratio	Marginal effect	
City Central Area	1.0726*	0.0051	0.0051
	(0.0450)	(0.0033)	(0.0052)
Gangnam Area	1.0034	0.0002	-0.0003
	(0.0259)	(0.0016)	(0.0019)
West Sub-Center	1.0460***	0.0028***	0.0064**
	(0.0151)	(0.0009)	(0.0026)
Other Local Centers	1.0704***	0.0033***	0.0072***
	(0.0273)	(0.0012)	(0.0029)

Note. Values of PRR are divided by 100 in the estimations. All the estimations include business district fixed effects. They also include a set of dummy variables for time (year-quarter) of survey. All the regressions control for characteristics of individual shops, such as category of shops, the floor where shops are located, area of shops, type of ownership, and number of owners, as well as characteristics of buildings where shops are located, such as coverage ratio (rate of built area to land area) and building volume ratio (rate of all floors area to land area) of the buildings, the existence of passenger elevators, distances to the closest subway station, bus station, and road intersection, floors in overground and underground of the building, the year when buildings were built, area of parking lots, and zoning regulations. Marginal effects of PRR in Logit estimation are predicted at mean values of all the independent variables. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

In column (1), the odds ratio in City Central Area is about 1.0726, which means that if the PRR of a commercial property is higher as much as 100, the odds of being vacant of a shop will increase by 7.26 percent. The estimation value is statistically significant at the 10 percent level. In West Sub-Center and Other Local Centers, odds ratios are 1.0460 and 1.0704, respectively, and they are statistically significant at a 1 percent level. In contrast, the estimation value in Gangnam area is much smaller (1.0034), and it is not significant at the 10 percent level.

The marginal effects estimated by logit and linear models are similar to each other. The estimated values are seen in columns (2) and (3). The marginal effects of logit are

predicted at the means of all the explanatory variables. While the estimated values in City Central Area and Gangnam Area are not statistically significant, they have statistical significance in West Sub-Center and Other Local Area regions at 1 to 5 percent level. In West Sub-Center, marginal effects are estimated at 0.0028 in logistic estimation and 0.0064 in the linear model. In the Other Local Centers group, the estimated marginal effects are 0.0033 (logit) and 0.0072 (LPM).

The regional heterogeneity of impacts of PRR on vacancy may be related to the categorical heterogeneity of shops among sub-regional groups, explained in the next section with more detail.

B. Analysis of Sub-categories

All the shops in the data are categorized as one of the types among four categories: Office, Middle and Big Shop, Small Shop, and Aggregate Shop, depending on their functions, type of ownership, and area of shops. The estimations are done with samples of different categories separately to find whether there is heterogeneity related to categories of shops. The estimation results are displayed in Table 2.7.

Categorical differences are observed in estimation values. In column (1), the odds ratios range from 1.0394 in the Office category to 1.1558 in the Small Shop group. While Middle and Big Shop and Small Shop have statistically significant estimation values at 5 percent level, the estimated values of Office and Aggregate Shop groups are not significant even at 10 percent level. Small Shops have the highest impact of PRR on the vacancy rate.

The marginal effects estimated by logit and linear models are a little different. The estimated values are seen in columns (2) and (3). The marginal effects of logit are

Table 2.7: Correlation between PRR and vacancy: differences by categories of properties

Models	(1) Logit	(2) Logit	(3) LPM
	Odds Ratio	Marginal effect	
Office	1.0394	0.0036	0.0048
	(0.0295)	(0.0026)	(0.0039)
Middle and Big Shop	1.0404**	0.0020**	0.0046
	(0.0204)	(0.0010)	(0.0026)
Aggregate Shop	1.0703	0.0022	-0.0037
	(0.1003)	(0.0030)	(0.0310)
Small Shop	1.1558**	0.0011**	0.0012
	(0.0687)	(0.0005)	(0.0021)

Note. Values of PRR are divided by 100 in the estimations. All the estimations include business district fixed effects. They also include a set of dummy variables for time (year-quarter) of survey. All the regressions control for characteristics of individual shops, such as the floor where shops are located, area of shops, type of ownership, and number of owners, as well as characteristics of buildings where shops are located, such as coverage ratio (rate of built area to land area) and building volume ratio (rate of all floors area to land area) of the buildings, the existence of passenger elevators, distances to the closest subway station, bus station, and road intersection, floors in overground and underground of the building, the year when buildings were built, area of parking lots, and zoning regulations. Marginal effects of PRR in Logit estimation are predicted at mean values of all the independent variables. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

predicted at the means of all the explanatory variables. While the logistic estimation of the Middle and Big Shop and Small Shop group have statistically significant values at 5 percent level, the other estimations are not significant at 10 percent level.

The heterogeneity of impacts in different categories can be related to the regional difference stated above. As displayed in Table 2.8, the proportion of Office is higher in City Central Area and Gangnam Area than West Sub-Center and Other Local Centers groups. West Sub-Center and Other Local Centers have higher proportions of Middle and Big Shop and Small Shop. The composition of shops can be related to the impact of PRR on vacancy.

Figuring out why Office has the smallest and non-significant impact of PRR is beyond

Table 2.8: Shop Compositions: Regional Difference

	Office	Middle and Big Shop	Aggregate shop	Small Shop
City Central Area	55.39%	18.84%	19.44%	6.32%
Gangnam Area	58.03%	25.10%	14.03%	2.83%
West Sub-Center	47.13%	25.73%	20.51%	6.63%
Other Local Sub-Centers	24.71%	38.96%	26.95%	9.37%
Average	46.57%	26.85%	20.26%	6.31%

Note. Proposition of four categories of shops are calculated in four groups of building districts.

of research area defined in this paper, even though it can be another interesting research topic. The cause of uniqueness in the Office group may be related to the composition of owners in offices, distinct from other categories of shops. For example, owners of offices are likely to be large size investors such as REITs (Real Estate Investment Trusts) or big firms that often use entire area or most area of building for their companies. In those cases, owners of offices tend to own an entire building or a group of buildings that include many office units inside buildings. Conversely, owners in the Small Shop and the Middle and Big Shop group are more likely to own individual shops rather than buildings. For the owners of office buildings, increasing vacant units in their buildings can be a serious problem to deteriorate the profits generated from buildings. The management costs of buildings cannot be reduced much though vacant offices increase. Increasing vacancy rates within the building can affect the asset values of buildings negatively. In addition, institutional investors like REITs have distinct profit targets, and they should maintain vacancy levels at less than a certain level predetermined to pay financial costs, i.e., interests or dividends. Therefore, office owners will be more likely to try to reduce vacancies than individual shop owners. However, detailed analyses regarding how heterogeneity of owners affect their behaviors differently remain untouched in this paper and are saved for future studies.

2.6 Conclusions

This article suggests new insights into the relationship between rent level, price, and vacancy of commercial properties. The traditional views have claimed that the rental price would move and vacancy rate would converge to the natural level when the vacancy level in the market deviates from the equilibrium level due to some changes in demand and supply. However, for the recent two decades, researchers have found cases for the phenomenon called rent rigidity, in which rents do not change much while vacancy level soars or plummets. Rent rigidity is also observed in the data of 31 business districts in Seoul for two years from 2017 to 2018. In other papers claiming rent rigidity, researchers have tried to find the causes of rigidity in the behaviors of landlords to hedge inflation risks or to change ways of price setting. This paper provides a new explanation as to why landlords are reluctant to adjust rents quickly when vacancies occur. Unlike other previous studies, landlords regard their commercial properties as capital assets in this article. In that framework, landlords cannot accept the market equilibrium rent level when they think that adjusting rents can affect asset values negatively.

This article attempts to provide two hypothetical mechanisms to explain rigid rents: landlords' reserving stocks to maintain asset values and setting efficiency rents to screen better tenants. Landlords are likely to care about the variability of price than maintaining rental income when capital gains from asset value appreciation are much bigger than income from rents. Therefore, according to the hypothesis, the probability of being vacant is higher in properties where asset prices are relatively higher than the rent level. As logit and linear regression estimation results indicate, units with a high price-per-rent ratio (PRR) show a higher probability of vacancy. The empirical evidence supports the hypothesis that commercial properties are capital assets for landlords, and landlords are

highly concerned about asset value depreciation by rent adjustment.

Another critical point of this paper is the heterogeneity of impacts of PRR on vacancy. The magnitude and statistical significance of impacts of PRR are diverse among regional groups or categories of commercial properties. The regional difference of effects seems to be related to the different categorical compositions of commercial shops in regional groups. City central Area and Gangnam Area have shown relatively fewer effects of PRR on the vacancy, and it is related to the high proportion of Office, which has the smallest effects among four categories, in the regions. Further studies should be directed to the reasons why office groups show fewer effects of PRR on vacancy.

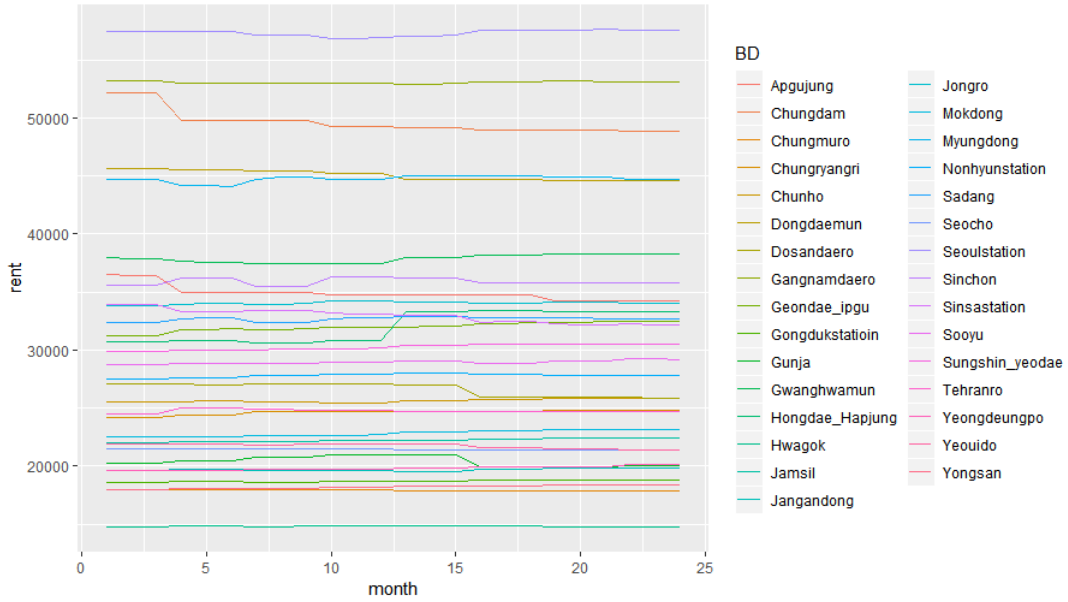
The conclusion implies that landlords may not be responsive to vacancy changes caused by demand and supply shocks in case their property values are incomparably higher than rents. In the Republic of Korea, many small enterprises have complained about expensive rents, while the vacancy rates in Seoul business districts are about 9 percent. Expensive rents and increasing vacancies in business districts have been raised as social issues recently. However, the conclusion of this paper indicates that stabilizing the property rental market and reducing vacant units may not be easy jobs because vacancies are the results of choices by owners concerned about the valuation of properties. Incentives, such as tax benefits for owners who decrease rent, cannot help much. If rental income is not as important as maintaining the capital value of properties for landlords, tax returns or credit for decreasing rent cannot provide enough incentive to landlords. Policymakers should consider the behavioral aspects of landlords to achieve policy goals of revitalizing small enterprises in business districts. To induce cooperation from landlords, measures to raise the reputation and public image of business districts, which can help maintain property values in the districts, will be more effective and acceptable than giving

incentives to individual shop owners.

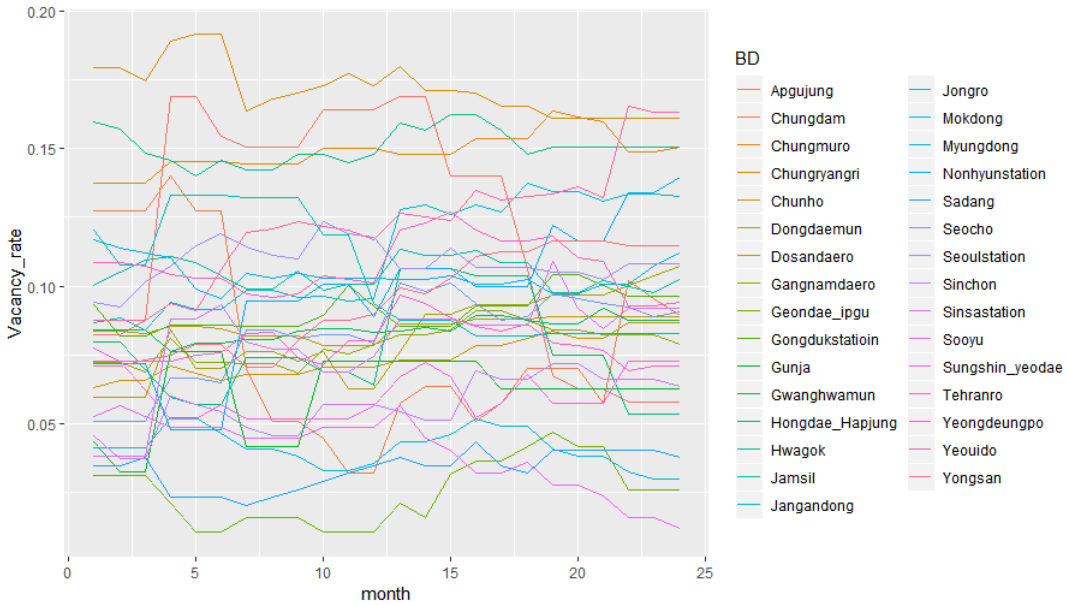
2.A Appendices

2.A.1 Graphical Analysis of Rents and Vacancy Rates

Figure 2.5: Trends of Monthly Rents and Vacancy Rates



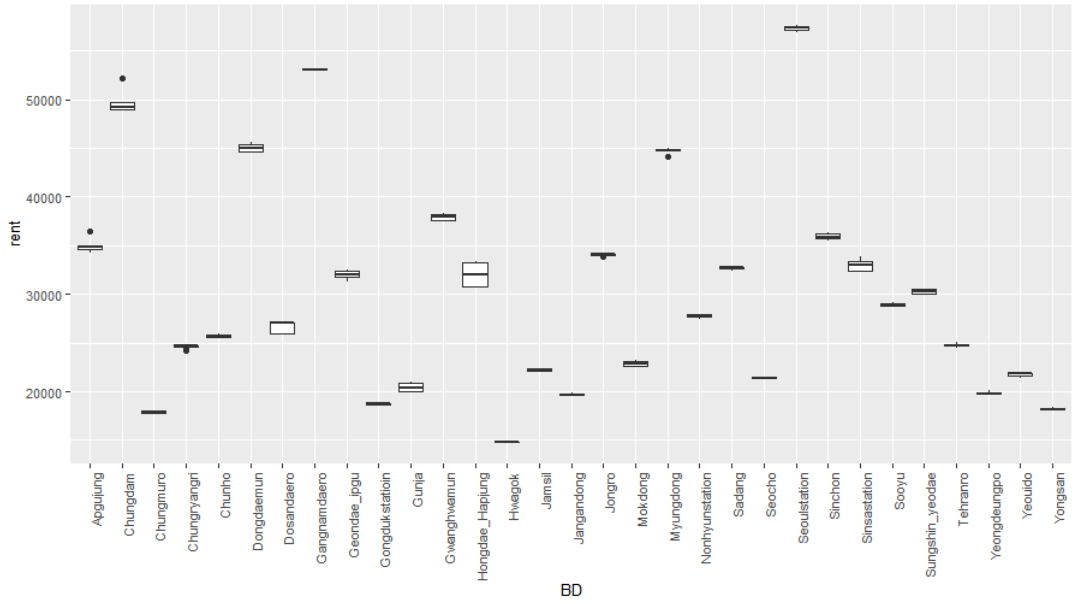
(a) trends of monthly rents



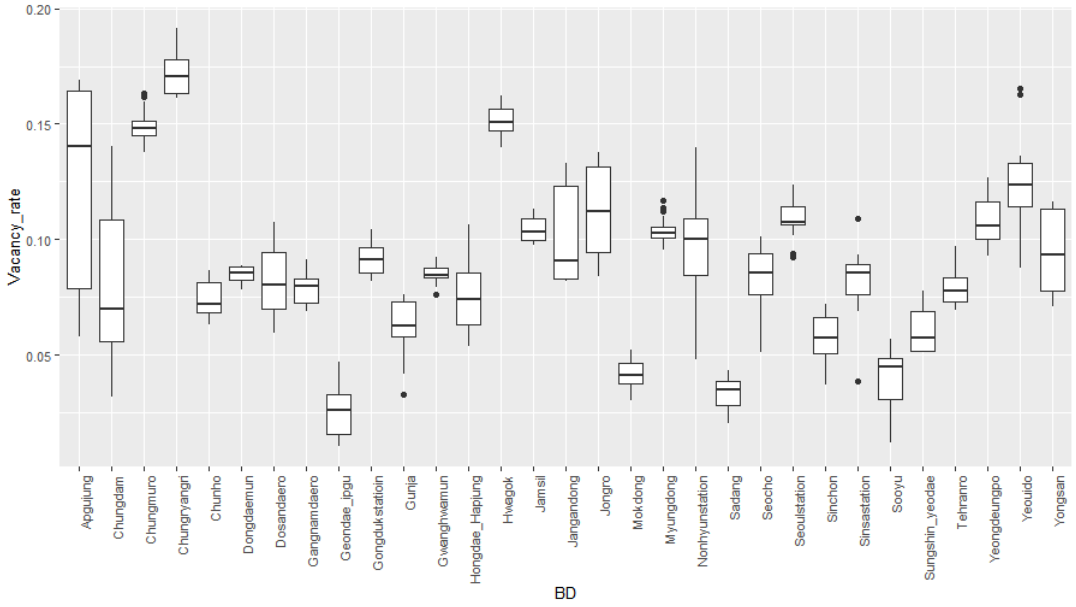
(b) trends of monthly vacancy rates

Note. The number of horizontal axis from 1 to 24, in both diagrams, stand for each month of the analysis period from January of 2017 (1) to December of 2018 (24). The vertical axis in (a) is monthly rent per square meter and the unit is Korean Won (KRW). The vertical axis in (B) is vacancy rate, which is the proportion of vacant unit to all the units of business district.

Figure 2.6: Box Charts of Rents and Vacancy Rates



(a) box chart of rent



(b) box chart of vacancy rates

Note. The number of horizontal axis from 1 to 24, in both diagrams, stand for each month of the analysis period from January of 2017 (1) to December of 2018 (24). The vertical axis in (a) is monthly rent per square meter and the unit is Korean Won (KRW). The vertical axis in (B) is vacancy rate, which is the proportion of vacant unit to all the units of business district.

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Chapter 3

Estimates of Electoral Competition and Change of Political Behaviors in Land Use Policy

3.1 Introduction

Abundant amounts of literature in political sciences and public economics have linked behaviors of politicians to the public choice theories that have argued that politicians can be regarded as economic agents and are not neutral policymakers who prioritize public interests to their own stakes. In this point of view, politicians pursue to stay in the positions that have powers as long as possible to take economic or other gains out of the positions. Though there can be many ways for politicians to acquire powers, the only way to earn powers in democratic societies, such as the Republic of Korea, is to be elected by the popular election. Therefore, incumbent politicians, who are steering wheels of policymaking currently in critical positions, are likely to try to earn more affection and popularity from the constituents during their present terms to attract more votes in the next election. In this regard, it is reasonable to assume that the degree of competition in the last election will influence the behaviors of incumbent mayors. In this article, the author tests the hypothesis that politicians will try to satisfy constituents' needs in terms of land use policy more when competition in the previous election is more fierce among candidates.

The data chosen for this study is about local elections for mayors and changes in land use in the Republic of Korea from 2002 to 2018. Because lands designated for urban uses have more degrees of freedom in development activities, such as construction of houses, factories, and other commercial buildings, their values are much higher than the rural-use ones. If an incumbent mayor is willing to satisfy constituents' needs more eagerly and has enough power to implement it, the conversion of rural-use lands to urban-use in the municipality under the mayor will increase faster than the other municipalities. On the contrary, if a policymaker determines the land use policy according to the considerations

of objective factors such as the efficiency of land use depending on the socioeconomic factors, the urbanization in this municipality will be restricted with caution. In this regard, the main hypothesis tested in the article is that the conversion from rural lands to urban-use ones is more prominent in the municipalities where mayors won the previous election by a smaller margin.

To test the hypothesis, two indices that can measure the degree of competition in elections are adopted. One index is victory margin, the difference of votes turnout rate between the elected candidate and the second most vote earning one. The other one measuring competition level is the Herfindahl index, often used in analyzing the competition level among firms in the market. For the index of urbanization of lands, the main explanatory variable, two indices are applied: the *change in developable land* and *the conversion rate* during mayoral terms. The first one is calculated by measuring differences of the rates of *developable lands*, which are the summation of the area of rice paddies, crop fields, orchards, and mountains, to the total area between the previous election year and the last year of the mayoral term. The conversion rate is the ratio of newly urbanized land area during the mayoral term to the non-urban area in the previous election.

Unlike the prior expectations, the evidence for behavioral changes of incumbent mayors is not found in the estimations with entire samples. However, when the municipalities are separately estimated in five quantiles depending on the scarcity of developable lands, which are measured by the area of developable land per capita, the first quantile, where the degree of urbanization is the highest, shows the statistically significant correlations between electoral competition and the land use conversion during the mayoral term. In the other quantiles, there is no such correlation estimated. The results suggest that deviation by political influence in land use policy is strong in the regions where the rural lands

convertible to urban land use does not remain much. This result supports the hypothesis of *electoral productivity*, in which politicians focus their efforts on the policy options that can produce more votes if other things are equal. At the same time, no correlation in the four quantiles of developable land area per capita indicates that the land uses administrations are independent of the influences of elected officials in the local governance system of Korea in most cases. Incumbent politicians, who aim to be reelected, are likely to compare the gains (electoral productivity of land use conversion) and the costs (efforts to exert influence in the policymaking through the resistance of career public officers) when they intervene in the process of policymaking. Analysis of the factors affecting the gains and costs can be discussed further in future research, but the concentration of power in the central government in Korea can be one of the factors affecting the trade-off of the gains and the costs.

In the subsequent section, the author follows discussions in the previous research literature that range from theories of behaviors of politicians to empirical results of estimation. The following section explains the structure of local governance, election systems for local governors and mayors, and land use categorization in Korea. The fourth section will describe data of competition in elections and urbanization indices and other attributes. In the fifth section, the estimation results are provided, and the final section will discuss the meanings of estimation results.

3.2 Literature Review

Papers claiming that elections and party systems significantly affect politicians' behaviors can be found without much difficulty. Key Jr [1949] suggests that inter-party competitions or inner conflicts within a party affect public policy. Besley and Coate [2003] argue that

elected politicians have more pro-electorate tendencies and try to satisfy the needs of electorates in implementing regulatory policy than government-designated policymakers. There is plenty of literature to suggest that there is a positive correlation between elections and public policy. Park and Kim [2005] claim that, with data of the Republic of Korea, after local elections were introduced through the reform of the local administration system in Korea, mayors or governors invest in public facilities more than before the reform. Bae and Kang [2007] suggests that local government expenditure affects the probability of reelection of incumbents positively. Dahlberg and Johansson [2002] find supporting evidence for the hypothesis that incumbents utilize grant programs to buy more votes in the data of the 1998 Swedish election. Grossman and Helpman [1996] argue that parties are inclined to maximize the weighted sum of the welfare of special interest groups to win a majority in elections.

Not only the existence of elections itself but also the magnitude of competition in the elections seem to influence politicians' attitudes in implementing public policy. The more fierce competitions are in elections, the more intensely vote purchasing behaviors prevail in political scenes. Ji and Kim [2003] shows that local expenditure increases with the level of competition in elections from the local election data of the Republic of Korea. Barrilleaux et al. [2002] demonstrate, with data of state legislature election from 1973 to 1992 in the US, that welfare spending is greater in the periods when democrats dominate state legislature and their margin of victory in the election is tighter if the numbers of seats taken by democrats are same. Laslier and Picard [2002] demonstrates that parties try to take more egalitarian stances and distributive policies when they face more severe competition. Comiskey [1993] shows that electoral competitions for public offices have enhanced the growth of public spending after World War II.

There are papers that explain the mechanisms of political economy in decision-making in the investment to transportation infrastructures. Castells and Solé-Ollé [2005] provide interesting viewpoints about the political factors that can deviate policy options from the reasonable considerations in the determination of allocating expenditure for transportation infrastructures to different local municipalities. According to them, there are two political motivations, which are *electoral productivity* and *partisanship*, in the decision-making about infrastructures. Electoral productivity means that political parties have tendencies to allocate more budget to the constituencies where the electoral gains are expected to be higher. On the contrary, the concept of partisanship indicates that parties will be more interested in the regions where they can secure supports from other parties. While the former concept argues that parties will focus on swing voters, the latter suggests the risk-averseness of parties. Glaeser and Ponzetto [2018] argues that transportation infrastructures can be overbuilt or underbuilt depending on the political influences. The political decision will be affected by not only the preference of voters but also voter attention, created by education on the real costs of the investment.

On the other hand, some scholars are skeptical about the positive effects of the election on public policy. In these arguments, because the powers of policymakers should abide by rules and laws in democratic regimes, local expenditure cannot be expanded beyond the limits of fiscal rules. Most government employees, not elected but appointed by neutral hiring processes, tend to stick to rules. Dawson and Robinson [1963] test the hypothesis that public policy is related closely to the political competition, argued by Key Jr [1949], but they find that correlation between the level of competition in elections and public policy disappears when other socioeconomic factors are included. Walker [1969] and Kim and Kim [2011] demonstrate similar results.

Mostly, previous research has focused on the impact of political pressure on local finance and public expenditure. Surprisingly, the impact on policy of urban developments and land use is not examined well. Governors and mayors have considerable powers to determine the urban planning of municipalities, and they can issue development permits. They have the authority to make ordnance related to regulation on land use and development activities, such as environmental impact assessment, land use control, construction process supervision, etc. Like public spending of local governments, administration related to land use and development permits can be the main political tools for incumbents to utilize to be reelected. Therefore, if the hypothesis that politicians attempt to satisfy residents to win more votes is correct, it seems evident that politicians would exert their powers in land use and development administration with similar passion in local finance administration.

3.3 Institutional Backgrounds

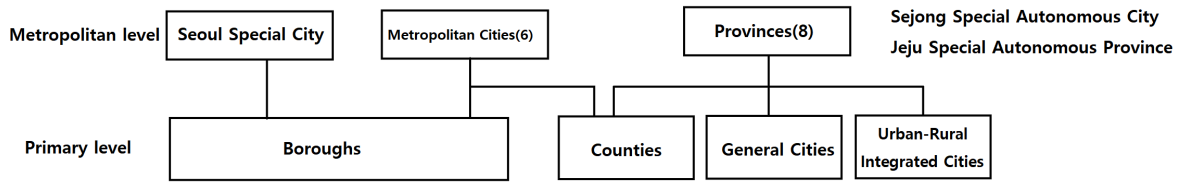
This section describes the structures of local governments, the electoral system of Korea, land use management system, which are highly important to design, implement, and interpret the estimations in this paper. The first subsection explains how municipalities are separated and governed in the Republic of Korea. The following subsection provides brief explanations about local mayoral elections and political parties of Korea. Finally, the last subsection introduces the unique land use system, including 28 categories in the country.

3.3.1 Local Governments of the Republic of Korea

The structure of local governments of the Republic of Korea has two tiers, which are the metropolitan level municipalities that have wide territories (upper-tier) and the primary

level of units comprising metropolitan level municipalities (lower tier). The upper tier has five types and seventeen municipalities: one Special City (Seoul), six Metropolitan Cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), eight Provinces (Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, Gyeongnam), one Special Autonomous City (Sejong), and one Special Autonomous Province (Jeju). The lower tier has three types: Gu (boroughs, the elements of Special City and Metropolitan Cities), Si (the cities under provinces, mainly urban area), Gun (the counties under provinces and some Metropolitan Cities, mainly rural area). The number of lower-tier municipalities is about 230. Si (cities) has two types: general cities (mostly urban area) and urban-rural integrated cities (urban area and rural area are mixed in the territories). Sejong Special Autonomous City and Jeju Special Autonomous Province have characteristics of upper-tier and lower-tier municipalities simultaneously.

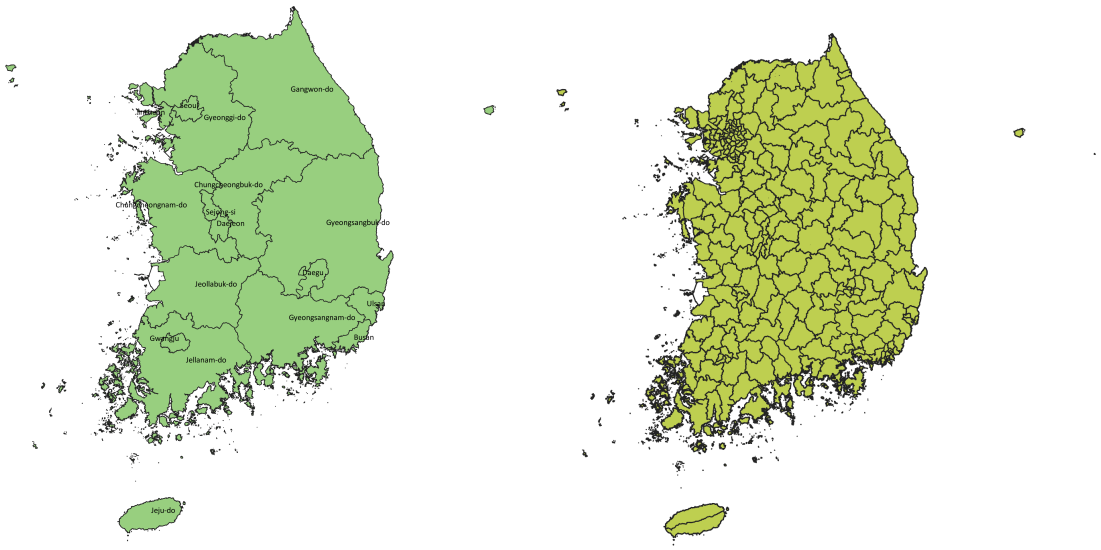
Figure 3.1: Municipalities System of the Republic of Korea



Note. The Republic of Korea has a dual system of municipalities. The upper level is metropolitan municipalities, which have fourteen entities including Seoul Special City, six metropolitan cities (Busan, Daegu, Incheon, Gwangju, Daejeon, and Ulsan), and eight provinces (Gyeonggi, Gangwon, Chungbuk, Chungnam, Jeonbuk, Jeonnam, Gyeongbuk, and Gyeongnam). In the lower level municipalities, boroughs are units under Special City and Metropolitan cities, while counties, cities, and urban-rural integrated cities are basic units of Provinces. Sejong Special Administrative City and Jeju Special Administrative Province are special units of municipalities, which are simultaneously regarded as upper and lower levels of municipalities.

The territories of municipalities have not changed much during the last 20 years, even though some cities or counties were merged into big cities, separated, or created. Excluding some municipalities lacking data and two special autonomous entities (Sejong and Jeju), 226 primary municipalities construct a kind of panel data in this study.

Figure 3.2: Municipalities of Republic of Korea



(a) metropolitan municipalities (b) primary Municipalities

Note. There are 17 metropolitan municipalities and about 230 primary municipalities. Excluding special units like Sejong Special Administrative City and Jeju Special Administrative Province, 226 primary municipalities are estimated in the paper.

3.3.2 Election System for Mayors and Parties of Korea

The Republic of Korea introduced a public election system for local governors and mayors in 1995 for the first time. Before then, the central government appointed local administrative offices, and there was no legislative body at the local municipalities' level. Before 1995, because high-rank positions in local entities were filled with public officials whose careers were mostly accumulated in the central government, it can be said that appointed mayors and governors were less responsive to the needs of local residents than the ones elected through votes.

According to the electoral law of the Republic of Korea, a person can become a mayor up to three times. The period of each term is four years. Winners are selected by simple pluralistic rule, and there is no run-off. If one candidate gains the most votes, he or she will inaugurate to mayor though he or she did not get more than fifty percent of support.

In the Republic of Korea, there have been many parties according to the political orientations. Though parties have changed their names from time to time, there have been two main parties according to their political stances: liberals and conservatives. In this analysis, the author dubs the liberal progressive party as Minju party because it mostly includes the word Minju in the name during most of the history of the party. The conservative party is dubbed as Hannara party after the name of the party during elections of 2002, 2006, and 2010. Besides the two competing main parties, there have been third parties that target political middle grounds. Though many third parties arose and fell, I aggregate the parties as one group since parties' characteristics and supporting voters are not significantly different.

Rather, the more important groups among third parties are region-based parties. The regional factors have been the centerpiece of the politics of Korea. Minju party dominates Honam area (Southwest part of the country) while Hannara party sweeps the votes of Youngnam area (Southeast part of the country). The regional separation of political orientation is derived from history, and, therefore, the regional separation is very intrinsic in Korean politics. From time to time, third parties based on regions other than Honam and Youngnam area appear. Mostly, Chungcheong area (middle-west regions of Korea) is one of their strongholds. However, the power of Chungcheong-based parties did not last long enough to become one of the major political powers. There is also a party based on the national labor union. They sometimes take about 10 to 15 percent of national support, but they are not good in local elections for mayors and governors because they do not have any regional home ground.

Furthermore, there have been a significant number of independent candidates. In many cases, because local elections are to choose mayors who will work for regional

matters, they are dominated by the capabilities of individual politicians rather than the party of candidates. Voters in local elections are more interested in local developments than big political issues when they cast their ballots in mayoral elections.

3.3.3 Categories of Land Use

In Korea, every parcel of land is designated for a distinct purpose by law, and it cannot be used for purposes other than the designated ones. According to related law, the number of categories of land use purposes is twenty-eight. The categories of land use can be seen in the Table 3.1.

Categories of land are crucial for landowners because the value of lands may vary extremely according to the designated categories. For example, people can build houses only in lands designated as "Dae," the land category for building houses and commercial buildings. If a parcel of land, which was "Jun" (dry-paddy field) or "Dab" (rice paddy-field), is converted to "Dae," the market price of the land will soar at once. The conversion of land use is possible only after the development activities, such as the construction of houses, factories, and warehouses, are completed, and the permission or initiation of projects are in the authority of mayors, in many cases.

The mayors of cities and counties in the Republic of Korea have a wide range of discretion in determining policies related to land use. The mayors have powers to issue permission to construct individual buildings, factories, and warehouses. For small size development, mayors independently determine the development. For mass urban development projects converting area more than 300,000 square meters of rural lands to urban areas, mayors of the cities with more than 500,000 population can establish development plans and designate the area for developments by themselves. Mayors of less populated municipalities can establish development plans by themselves and request the designation

Table 3.1: 28 categories of land by purposes

	Name (Abbrebiated)	English name	Purpose
1	Jun	Dry paddy-field	Field for agriculture except rice and water-use plants
2	Dab	Paddy-field	Agriculture in water, such as rice
3	Gwa	Orchard	Orchard
4	Mok	Pasture site	Livestock farming and dairy
5	Im	Forestry	Mountainous area and wild plain
6	Gwang	Mineral spring site	Mineral Spring, petroleum from underground
7	Yum	Saltern	Gathering salts
8	Dae	Building site	Site for residential and commercial buildings
9	Jang	Factory site	Site for factories and industrial buildings
10	Hak	School site	Site for Schools
11	Cha	Parking lot	Site for parking lots
12	Joo	Gas station site	Site for gas stations
13	Chang	Warehouse site	Site for warehouses
14	Do	Road	Roads for automobiles
15	Chul	Railway site	Railways and stations
16	Je	Bank	River and ocean banks
17	Chun	River	River
18	Goo	Ditch	Site for artificial water channel
19	Yoo	Marsh	Land for dam, reservoir
20	Yang	Fish-farm	Fishery farm
21	Soo	Water supply site	Water and wastewater facility
22	Gong	Park	Parks
23	Che	Gymnasium site	Sport facility
24	Won	Recreation area	Amusement parks, swimming pool, playgrounds and etc.
25	Jong	Religious cite	Churches, Buddhist temples
26	Sa	Historical site	Historic relics and monuments
27	Myo	Graveyard	Land for buried, cemetery
28	Jab	Miscellaneous Land	Purposes not specified above

Note. The definition and purposes of 28 categories of land are according to the Enforcement Decree of the Act on the Establishment, Management, Etc. of Spatial Data.

of the development area to the governor of metropolitan level municipalities. The permit for conversion is dependent on the legal interpretation and discretion of public officials working in departments of urban planning and regional development in the second-tier primary municipalities (Si, Gun, Gu) in many cases. Sometimes, the central government can implement development projects by itself when they have importance at the national

level. In any case, the development projects cannot be done without the consent of mayors of primary municipalities. In conclusion, there are many ways that mayors can affect the promotion of development activities and issuance of permissions, although the process should be reviewed by the separate urban planning committee in the municipalities or monitored by audit agencies.

Therefore, central governments and upper-tier municipalities of Korea strictly regulate the conversion of land uses with the legal systems and supervise the mayors. Many laws, decrees, and ordnance limit the range of discretion of public officials to prevent the unjust intervention of political leaders on land use. Moreover, higher-rank government organizations often regularly audit and supervise the land use policy of lower-tier municipalities. In most municipalities, independent committees to review the process of issuing development permits and conversion of categories of lands are established and operated.

3.4 Data Descriptions

The main hypothesis to be tested in this article is that mayors of cities (Si), counties (Gun), or boroughs (Gu), have significant tendencies to allow or promote more development or urbanization during their terms to increase the possibility of being reelected when they faced more severe competition in the last election. Therefore, the dependent variables of estimations are indices indicating the change in the degree of urbanization during the four years of mayoral terms, and the main explanatory variable of the estimations must measure the level of competition in the previous elections. Alongside competition indices, socioeconomic factors and dummy variables of regional and political factors are also included as independent variables.

3.4.1 Indices for Changes in Degree of Urbanization

The statistics about land use of municipalities are obtained in the Urban Planning Information Service (UPIS, upis.go.kr), the online information system constructed and operated by the Ministry of Land, Infrastructure, and Transport (MOLIT) of Korea. The data system collects and publishes yearly statistics of areas of lands of twenty-eight land uses of each municipality at the moment of the end of the year. Therefore, the proportion of each category of land to the municipality's total land area can be calculated yearly, and the trend of changes can be observed.

In calculating the area of urban-use lands, the areas designated for only three categories are summed up out of all the twenty-eight land use purposes. They are the lands for residential and commercial buildings ("Dae"), the lands for schools ("Hak"), and the lands for factories ("Jang"). Though other categories like lands for roads, railways, and parks can be related to urban uses, these land uses are excluded in the calculation of urban-use lands because the lands for those infrastructures can also exist in rural areas in many cases.

For calculating the land areas that can be converted to urban land use by development activities, a new concept, the *developable land*, which is the summation of the area of crop field ("Dab"), rice paddy ("Jun"), orchard ("Gwa"), and Mountain ("Im") in each municipality, is defined. The new concept is applied here because the decrease of developable lands means that developable lands are converted to urban ones, and thus it can capture the change of urbanization more accurately.

Because the main goal of this study is to test the effects of competition in the last elections on the urbanization during present terms of mayors, the author measures changes in urban-use land area yearly for four years after the election year. There are two ways,

in this study, measuring changes in the urban-use land area: *the change of developable lands* and *the conversion rate*.

The first index is the change of developable lands, which measures the decrease of developable lands during the mayoral term. In this study, the changes of developable lands are calculated as the difference in the rate of developable lands to the total area during the four years of the mayoral term. The formula for this index is as below, and its unit is percentage point,

$$(RR_0 - RR_4) \times 100 \ \ (\%p), \tag{3.1}$$

where RR is equal to the proportion of the area of developable lands to the total area of a municipality, and 0 and 4 stand for the years of the previous election and the end of term, respectively.

The second index for the change in urbanization is the conversion rate, the ratio of the newly urbanized area during the term to the area of the non-urban area at the previous election year. The formula is as below,

$$(u_4\text{–}u_0)/(total \ \ area\text{–}u_0) \times 100 \ \ (\%), \tag{3.2}$$

where u_4 and u_0 are the urban areas in the end of the term and in the previous election year, respectively. This index measures how much the undeveloped area is converted to urban land use.

The summary statistics of change in urbanization can be seen in Table 3.2. A notable thing in the table is that the average area of urbanized rate increases as the mayoral term reaches the final year. Here, u_n is the area (km^2) of urbanized land of each municipality at n^{th} year after the election. It is evident that the urbanized area increases with time

because the developments of lands are mostly irreversible once they are changed to urban land use. The average area of the urbanized area at the election year is 15.66 km^2, but it increased to 17.04 km^2 at the next election year.

On the contrary, the area of developable lands in municipalities decreases with time. The opposite movement of urbanized land and developable land areas is easily explained because the decreased developable lands are mostly converted to urban land use. The mean value of developable land area at the election year is 364.67 km^2, and it decreased to 362.83 km^2 after four years of mayoral terms.

3.4.2 Data of Competition in Elections

The local election results for mayors are gathered from the archive provided by the National Election Commission (NEC) of the Republic of Korea. The detailed election data can be obtained from the website, info.nec.go.kr, operated by the NEC. The website openly provides statistics of all the elections, from local government elections to presidential and parliamentary elections.

Even though elections for local governments were introduced in 1995 in the Republic of Korea, the first (1995) and second election (1998) data are excluded from this study's analysis. One reason for the exclusion is due to the lack of data on socioeconomic factors, such as Gross Regional Domestic Production (GRDP), during the years before 2002 at the primary municipality level. The other reason is that, because the period from 1995 to 2002 was a transitional period from the system of government-appointed mayors to one of the elected ones, the elections in this early period have different characteristics from the later ones. For example, many previous government-appointed incumbent mayors ran for the early local elections and were elected based on their familiarity with the public. Therefore, I exclude the earlier elections data considering this transitional uniqueness in

Table 3.2: Summary statistics of Urbanization and Election variables

varname	mean	standard deviation
Panel A. Urbanization		
urbanized land area (km^2)		
election year (u_0)	15.66	10.72
next election year (u_4)	17.04	12.34
developable land area (km^2)		
election year (r_0)	364.67	346.82
next election year (r_4)	362.83	345.76
Panel B. Election		
Voting rate of winner (%)	53.70	12.73
Number of candidates	3.32	1.28
Competition indices		
Victory margin (%p)	19.94	19.74
H (Herfindahl index)	0.4460	0.1297
H_N (Normalized Herfindahl index)	0.1625	0.1684
Terms of mayorship	1.59	0.70
Party affiliation		
Hannara	0.5404	0.4986
Minju	0.2591	0.4384
Independent	0.1351	0.3420
Third party (Chungcheong)	0.0354	0.1850
Third party (Honam)	0.0221	0.1472
Third party (North Youngnam)	0.0011	0.0333
Third party (labor)	0.0055	0.0742
Third party (etc.)	0.0011	0.0333
N	903	

Note. In Panel A, the urbanized land area is the summation of land for residential and commercial buildings ("Dae"), land for schools ("Hak"), and land for factories ("Jang"). The developable land area is the summation of land area for crop field ("Dab"), rice paddy ("Jun"), and Mountain ("Im"). In Panel B, victory margin is the difference of vote turnout rates between a winner and the second most vote-earner. Herfindahl index (H) is sum of the square terms of voting rate of all the candidates in a constituency. In normalized Herfindahl index (H_N), all the values are from 0 to 1 by normalization.

these periods. As a result, the election data used for the analysis are from the third local election (2002) to the sixth one (2014). The summary statistics about electoral competition and other election-related data can be found in Table 3.2.

As indices for the competition levels in elections, two measures are used in the analysis: victory margin and Herfindahl index.

A. Victory margins

A victory margin is calculated as the difference in the rate of votes between a candidate who gets the most votes and a candidate getting the second-most votes. For example, if the rate of votes of the most popular candidate is 53.8 percent and the second popular candidate gets 34.4 percent, the victory margin in this constituency is 19.4 percentage points (53.8 percent - 34.4 percent). The average voting rate of winners is 53.70 percent, and its standard error is 12.73 percent. The number of candidates is 3.32 people on average. The mean value of the victory margin is 19.97 percentage points. That means winners lead 19.97 percentage points of a gap ahead of the second most voting candidate on average.

The margin of victory was used by Holbrook and Van Dunk [1993] once to measure the degree of electoral competition in the state legislature elections in the US. Because victory margin is simple and intuitive, it is easy to grasp the whole picture of electoral competition. However, this index cannot reflect how many candidates compete in the election. Because the level of competition is affected not only by the gap of votes but also the number of candidates, a more comprehensive index reflecting the number of contenders can be needed to check the robustness of estimations.

B. Herfindahl index

Herfindahl index is an index for measuring the competition level of firms in market analysis. The political election is an analogy for a market where many firms compete because candidates try to get more votes from constituents as firms do the same to attract consumers. Herfindahl index in this paper is calculated by summing up the square terms of the voting rate of all the candidates in every constituency. To normalize the effects caused by different numbers of candidates, the author uses the normalized Herfindahl

index, in which all the values are from 0 to 1.

Herfindahl index and normalized Herfindahl index are as follows.

$$H = \sum_{c=1}^{N} s_c^2 \qquad (Herfindahl\ \ index) \tag{3.3}$$

$$H_N = \frac{H - 1/N}{1 - 1/N} \quad (Normalized\ \ Herfindahl\ \ index), \tag{3.4}$$

Here, s_c is the voting rate of candidate c, equivalent to the proportion of votes acquired by candidate c to all the effective ballots, and N is the number of candidates.

The mean value of the Herfindahl index is 0.4460, and its standard error is 0.1297. Normalized Herfindahl index has 0.1625 of mean value and 0.1684 of standard error, respectively.

3.4.3 Other Data about Election

There are other important factors related to elections that may affect the behaviors of incumbent mayors, such as terms of mayorship and party affiliation of mayors.

A. Terms of mayorship

The electoral law of the Republic of Korea allows a person to become a mayor up until three consecutive terms. Because mayors in their third term cannot run for the next election for the same positions, they may have less passion for satisfying constituents than mayors in the first and second terms. Though some mayors during their third term may have desires for higher positions, such as governor of province or congressman, after the third terms as mayor, their magnitude of vote-purchasing behavior may not be as strong as the mayors in their first and second terms, who want to be in same positions.

The mean value of terms of 903 elections is 1.59, and the standard deviation is 0.71,

which means that the number of mayors in the first term are more than the ones in the third term on average [1].

B. Party affiliation

Characteristics of parties can also affect patterns and tendencies in the administration of land use. Some parties may tend to represent needs and demands for development than other parties. In other cases, incumbent mayors who think that their party's positions in the region are weak may exert more development-friendly attitudes in their policymaking.

As stated above, there have been two dominant parties in the politics of the Republic of Korea. The party dubbed Hannara is often regarded as representing conservative values and market-friendly economic policies. The Minju party has had a reputation that its agenda is close to progressive and liberal values. There have been a group of third parties between the two dominant parties. However, their lives as political parties are relatively short compared to the two dominant parties, and they emerged and disappeared from election to election. The more important group in local elections is independent candidates. Unlike presidential and congressional elections for the national assembly, dominated by big political issues, constituents tend to care more about the individual ability to contribute to regional developments in the choice of mayors. Out of 903 mayors during four elections in 2002, 2006, 2010, and 2014, 54.0 percent were from Hannara party, while 25.9 percent of mayors were members of Minju party. The proportion of independent mayor is 13.5 percent, more than half of the one chosen from Minju party. The political impact of other third parties is meager. Only parties based on Chungcheong and Honam regions gain 3.5 percent and 2.2 percent of mayors, respectively.

[1] If the numbers of mayors in the first term and the third term are identical, the mean value will be 2.

3.4.4 Population and GRDP

Because population and level of economic activity can affect the demand for urban-use lands, the population and GRDP of each municipality are included in the estimation. Since this study aims to find any peculiarity caused by the desires of incumbent politicians, separated from the socioeconomic factors, the data of population and GRDP change are included in estimations. However, in many cases, population and GRDP in a year strongly correlate with the state of urbanization in that year, which indicates a high possibility of reverse causality. In this regard, in the estimations, only the level of population and GRDP at the election year, when the mayoral term begins, are included to avoid the potential endogeneities. Summary statistics of yearly population and GRDP are provided in the Table 3.3.

Population data is extracted from residence registration data collected by the Ministry of Public Administration and Safety of the Republic of Korea. According to the residence registration act, all the people who own Korean nationality, except those who reside overseas, should register their residence statuses to the municipality where their residences are located. Because reporting different residences from real addresses is illegal, population data in the residence registration system are nearly close to the real population of each municipality. The Ministry of Public Administration and Safety has published all the population data of municipalities yearly, based on the registration data.

As it can be seen in Table 3.3, the average population keeps increasing during the mayoral term, which is evident because the population of Korea has kept increasing during the estimation period. The mean population in the election year is 216,275, but this number increases to 220,669 in the fourth year after the election.

GRDP is the representative index for the economic viability of municipalities. How-

Table 3.3: Summary statistics(population, GRDP, Regional factors)

varname	mean	standard error
Panel A. Change in Population		
Population (persons)		
election year (p_0)	216,275	203,536
election year+1 (p_1)	217,122	204,953
election year+2 (p_2)	217,962	206,604
election year+3 (p_3)	218,657	207,958
election year+4 (p_4)	220,669	211,964
Panel B. Change in GRDP		
GRDP (billion Korean won)		
election year (G_0)	117,764	105,160
election year+1 (G_1)	122,436	109,748
election year+2 (G_2)	126,409	113,636
election year+3 (G_3)	130,429	118,591
election year+4 (G_4)	136,602	124,543
Panel C. Category of municipality		
Borough (Gu)	0.3056	0.4609
General city (Si)	0.0952	0.2937
Urban-rural Integrated city (Si)	0.2303	0.4213
County (Gun)	0.3688	0.4827
Panel D. Regions		
Capital area	0.2935	0.4556
Chungcheong area	0.1351	0.3420
Honam area	0.1805	0.3848
Daegu and Gyungbuk	0.1373	0.3444
Busan and Gyungnam	0.1739	0.3792
Gangwon area	0.0797	0.2710
N	903	

Note. In Panel A, the population data is collected and published by Ministry of Public Administration and Safety and the unit of survey is primary municipalities (boroughs, cities, and counties). In Panel B, the GRDP data is from Korean Statistical Information Service and its survey area is the upper-tier municipalities where primary municipalities are located.

ever, all the GRDP data of primary level municipalities (boroughs, cities, and counties) were not constructed before 2012. Therefore, the GRDP data of upper-tier level metropolitan municipalities, where each primary municipality is included, is used instead of one of the lower-tier municipalities. However, because the GRDPs of metropolitan cities and provinces are the summation of GRDP of primary level municipalities and there is considerable variation among municipalities, using GRDP of upper-tier entities

in the analysis may cause biases and a cautious approach is needed in interpreting the results. The mean value of GRDP in the election year is 117,764 billion Korean Won, and it increases to 136,602 in the final year of the mayoral term.

3.4.5 Regional Factors

A. Category of municipality

The category of the municipality can also affect the pattern of land use heavily. Boroughs (Gu), the primary municipalities under Seoul Special City and other six Metropolitan Cities, are highly urbanized areas. Because borough areas are already densely developed, there is less land to urbanize further than other categories of municipalities. Counties (Gun) are typically rural areas and have much potential for development if appropriate development plans are prepared. Cities (Si) are separated into two groups: general cities and urban-rural integrated cities. Urban-rural integrated cities were products of the merging of adjacent cities and counties in 1995 when local elections were adopted in the Republic of Korea. Therefore, municipalities in this group have both urban and rural characteristics altogether. The proportion of boroughs in the sample is 30.6 percent, and the counties are 36.9 percent of 903 samples. General cities and urban-rural integrated cities have 9.5 percent and 23.3 percent of proportion, respectively.

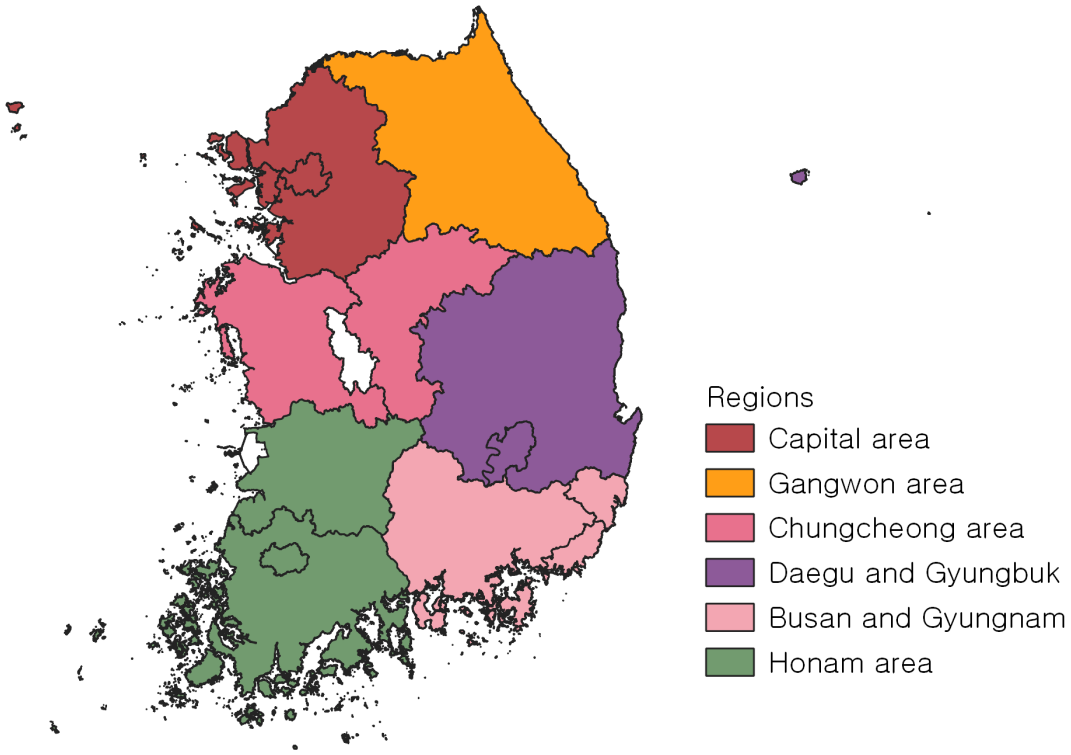
B. Metropolitan Regions

The entire nation is separated into six regions according to the traditional division of the regions based on economic, social, and cultural similarities to consider the fixed effects of different regions in the estimations.

Those six regions are (1) Capital Area (Seoul Special City, Incheon Metropolitan City, and Gyeonggi Province), (2) Chungcheong area (Daejeon Metropolitan City, Chungbuk Province and Chungnam provinces), (3) Honam area (Gwangju Metropolitan city, Jeon-

buk Province, and Jeonnam Province), (4) Daegu and Gyungbuk (Daegu Metropolitan City and Gyeongbuk Province), (5) Busan and Gyungnam area (Busan and Ulsan metropolitan cities, and Gyeongnam province), and (6) Gangwon province. (See Figure 3.3).

Figure 3.3: Six regions of the Republic of Korea



Note. All the nations are separated into six regions according to economic, social, and cultural similarities. Six regions are (1) Capital Area (Seoul Special City, Incheon Metropolitan City, and Gyeonggi Province), (2) Chungcheong area (Daejeon Metropolitan City, Chungbuk Province and Chungnam provinces), (3) Honam area (Gwangju Metropolitan city, Jeonbuk Province, and Jeonnam Province), (4) Daegu and Gyungbuk (Daegu Metropolitan City and Gyeongbuk Province), (5) Busan and Gyungnam area (Busan and Ulsan metropolitan cities, and Gyeongnam province), and (6) Gangwon province. Sejong special autonomous city and Jeju special autonomous province are excluded from the analysis.

3.5 Estimation Method

The main goal of this study is to test the hypothesis that the incumbents have strong tendencies to allow or promote more urban development when they faced more fierce competition in the previous elections. The estimation equation has a form of ordinary

least squares regression (OLS) with competition level indices in the previous election as a main explanatory variable and other confounding factors, including socioeconomic factors, regional factors, and election-related elements. The change in the urbanization of land use during the term is the dependent variable. The form of the estimation equation is as follows.

$$y_{i,t} = \beta_0 + \beta_1(Competition\ \ Index)_{it_0} + \boldsymbol{S_{i,t_0}\beta_2} + \boldsymbol{E_{i,t_0}\beta_3} + \boldsymbol{R_i\beta_4} + \delta_i + \delta_e + e_{it}. \quad (3.5)$$

Here, subscript i indicates each municipality unit, and t means each mayoral term after four elections (2002 to 2006, 2006 to 2010, 2010 to 2014, and 2014 to 2018). The t_0 means the election year when the term starts (2002, 2006, 2010, and 2014).

The dependent variable $y_{i,t}$ is a variable indicating a change in urban-use land area and, as mentioned above, it has two indices, the change in developable lands and the rate of conversion to urban-use land during mayoral term t. For the variable measuring competition level ($Competition\ Index$) in the last election, the margin of victory and normalized Herfindahl index are used in the estimations.

$\boldsymbol{S_{i,t_0}}$ is a vector of socioeconomic variables at the election year when the mayoral term starts. The population of each municipality and GRDP of the upper-level metropolitan municipality to which the primary municipality i belongs are in this category. Both population and GRDP are included in the log forms. $\boldsymbol{R_i}$ is a vector for regional variables, such as the category of municipalities (general cities, counties, boroughs, urban-rural integrated cities), and the regions where municipalities locate (Capital area, Chungcheong area, Honam area, Daegu and Gyungbuk, Busan and Gyungnam, and Gangwon area). $\boldsymbol{E_{i,t_0}}$ stands for variables related to elections. The number of terms as mayors (first

term, second term, and third term) and the parties in which mayors are affiliated (Minju, Hannara, labor, region-based third parties, and independents) are included in this group. δ_i is the fixed effect of each municipality and δ_e is the election (2002, 2006, 2010, 2014 elections) fixed effect. Finally, e_{it} is the error term.

3.6 Results

3.6.1 Estimation Results with Entire Area across the Nation

The detailed results of the estimation with all the municipalities are provided in Table 3.4. The results are the opposite of the prior expectations in the hypothesis, where the competition indices in the previous election would affect the land use policy of mayors. According to the prior expectations, the victory margin and the normalized Herfindahl index must have negative effects on the urbanization indices because smaller victory margin and normalized Herfindahl index indicate more severe competitions in elections.

However, the results in most estimations do not support the hypothesis. In columns (1) and (2) of Table 3.4, only the normalized Herfindahl index has a negative influence on the change of developable land at a 10 percent statistical level. In this estimation, the normalized Herfindahl index has -0.3694 of estimated value on the change of developable land, which means that 0.1 of difference in the normalized Herfindahl index are correlated with 0.04 percentage point of decrease of rural-use lands. The other estimations do not provide statistically significant results. Moreover, in these results, one of the noticeable points is that population and GRDP at the starting moment of the mayoral term also do not affect the change in urbanization.

Table 3.4: Influence of competition in election on the change of urbanization

	(1)	(2)
Dependent variable	Change of developable land (%p)	Conversion rate (%)
Panel A: Victory margin		
Victory Margin(%p)	-0.00446	0.00241
	(0.00314)	(0.00507)
log (population at t_0, person)	0.96384	-1.64332
	(0.70164)	(1.09831)
log (GRDP at t_0, KRW)	0.20546	0.49527
	(0.54197)	(0.61922)
R^2	0.5363	0.4869
Nobs.	903	903
Panel B: Normalized Herfindahl Index		
H_N	-0.36936*	-0.22065
	(0.19678)	(0.25997)
log (population at t_0, person)	1.01501	-1.64046
	(0.70686)	(1.10772)
log (GRDP at t_0, KRW)	0.20607	0.55017
	(0.54720)	(0.63358)
R^2	0.5356	0.4869
Nobs.	903	903

Note1. In column (1), the change of developable land is the difference of the rates of area of developable lands to the total area during the four years of mayoral term ($RR_0 - RR_4$). Here, RR is equal to the ratio of (rice paddy + crop field + orchard + mountain area) / total area. In column (2), the conversion rate is calculated by the ratio of newly urbanized land area during the mayoral term to the land areas other than urbanized area at the previous election year.
Note2. All the regressions include election fixed effects and the municipality fixed effect. They also include variables of log of population and GRDP at the previous election year, and a set of dummy variables for the terms of mayorship, party which mayors are affiliated, regions where municipality is located, and category of municipality such as borough, city, and county. GRDPs are the ones of metropolitan municipalities, in which samples of primary municipalities are located. Standard errors in paretheses are clustered at municipality level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

3.6.2 Considerations of Different Degree of Urbanization

The estimations described in the previous subsection, which estimated all the municipalities jointly, have limitations because they do not consider the difference of initial urbanized states of different municipalities. For example, the boroughs in Seoul Special cities and six other Metropolitan cities are highly urbanized, and their territories do not have much potential to get urbanized further. On the contrary, the counties and

Table 3.5: Estimations of regions with different degree of urbanization

	(1)	(2)	(3)	(4)
Dependent variable	Change of developable land (%p)		Conversion rate (%)	
Panel A: Boroughs of Seoul and metropolitan cities				
Victory Margin(%p)	-0.00205		-0.00208	
	(0.00329)		(0.00517)	
H_N		-0.5428**		-0.808*
		(0.2704)		(0.44018)
R^2	0.6534	0.6562	0.6764	0.6797
Nobs.	276	276	276	276
Panel B: Cities and counties under provinces				
Victory Margin(%p)	-0.00609		0.00711	
	(0.00464)		(0.00770)	
H_N		-0.3398		-0.335
		(0.2912)		(0.32159)
R^2	0.4865	0.4842	0.3724	0.3700
Nobs.	627	627	627	627

Note1. In column (1) and (2), the change of developable land is the difference of the rates of area of developable lands to the total area during the four years of mayoral term ($RR_0 - RR_4$). Here, RR is equal to the ratio of (rice paddy + crop field + orchard + mountain area) / total area. In column (3) and (4), the conversion rate is calculated by the ratio of newly urbanized land area during the mayoral term to the land areas other than urbanized area at the previous election year.
Note2. All the regressions include election fixed effects and the municipality fixed effect. They also include variables of log of population and GRDP at the previous election year, and a set of dummy variables for the terms of mayorship, party which mayors are affiliated, regions where municipality is located, and category of municipality such as borough, city, and county. GRDPs are the ones of metropolitan municipalities, in which samples of primary municipalities are located. Standard errors in paretheses are clustered at municipality level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

urban-rural integrated cities are less urbanized, and there are wide rural areas that can be converted to urban uses.

To reflect the intrinsic difference of urbanized levels among municipalities, I separate the entire municipalities into two different groups: the boroughs and the others. The results of separation by the degree of urbanization are intriguing. The electoral competition still does not affect the change of urbanization in the non-borough group; however, it is statistically correlated with the urbanization change in the borough group when the normalized Herfindahl index is estimated. In column (2), the normalized Herfindahl index

has -0.543 of the estimated value, and it is statistically significant at a 5 percent level. Moreover, in panel A of column (4), the normalized Herfindahl index has -0.808 of estimated value on the conversion rate in the boroughs of Seoul and Metropolitan cities. On the contrary, there is no such correlation found in the other categories of municipalities.

The reason for the heterogeneity between the boroughs and the other categories can be related to the scarcity of developable lands convertible to urban land use in the more densely developed municipalities. In the boroughs, the conversion of lands to urban land use can be regarded as more valuable than in regions with more space to develop further. Therefore, politicians' efforts to influence the land-use conversion might have more electoral productivity because the political interventions seem to be more precious to voters in the more densely urbanized area. For testing this hypothesis, all the samples are separated into five quantiles depending on their developable land area per population at the election year (r_0/p_0). The results of estimations with cross variables between electoral competition indices and five quantiles depending on the developable lands per capita are provided in the Table 3.6. In column (1) of Table 3.6, both electoral competition indices have statistically significant and strong correlations with the change of developable land in the first quantile, in which the developable land is the most scarce. One percentage point of difference in the victory margin decreases 0.009 percentage points of the rural land-use area. In panel B of column (1), the normalized Herfindahl index has -0.738 of estimated value, which is statistically significant at a 5 percent level. Moreover, in column (2), the influence on conversion rate is also estimated in the more densely developed municipalities though the magnitude and level of statistical significance are weaker than the ones in the estimations on the change of developable land.

Table 3.6: Estimation with different level of developable land per capita (5 quantiles)

Dependent variable	(1) Change of developable land (%p)	(2) Conversion rate (%)
Panel A: Victory margin		
Victory Margin(%p)	-0.00916**	-0.00264
	(0.00423)	(0.00642)
1st(0-20%) × Victory Margin	0	0
	(.)	(.)
2nd(20-40%) × Victory Margin	-0.00331	0.0205
	(0.00314)	(0.00507)
3rd(40-60%) × Victory Margin	0.00722	0.00289
	(0.00551)	(0.00622)
4th(60-80%) × Victory Margin	0.00688	0.00407
	(0.00444)	(0.00604)
5th(80-100%) × Victory Margin	0.01025**	0.00324
	(0.00421)	(0.00646)
R^2	0.5379	0.4874
Nobs.	899	899
Panel B: Normalized Herfindahl Index		
H_N	-0.7381**	-1.0591*
	(0.3589)	(0.5934)
1st(0-20%) × H_N	0	0
	(.)	(.)
2nd(20-40%) × H_N	-0.1499	1.8926*
	(0.8232)	(1.1102)
3rd(40-60%) × H_N	0.7734	1.2307
	(0.6702)	(0.7488)
4th(60-80%) × H_N	0.3327	1.0915*
	(0.4475)	(0.5915)
5th(80-100%) × H_N	0.8948**	1.0485*
	(0.3732)	(0.6066)
R^2	0.5361	0.4862
Nobs.	899	899

Note1. All the municipalities are categoried into five quantiles depending on the developable land area per capita. *Note2.* In column (1), the change of developable land is the difference of the rates of area of developable lands to the total area during the four years of mayoral term ($RR_0 - RR_4$). Here, RR is equal to the ratio of (rice paddy + crop field + orchard + mountain area) / total area. In column (2), the conversion rate is calculated by the ratio of newly urbanized land area during the mayoral term to the land areas other than urbanized area at the previous election year.
Note3. All the regressions include election fixed effects and the municipality fixed effect. They also include variables of log of population and GRDP at the previous election year, and a set of dummy variables for the terms of mayorship, party which mayors are affiliated, regions where municipality is located, and category of municipality such as borough, city, and county. GRDPs are the ones of metropolitan municipalities, in which samples of primary municipalities are located. Standard errors in paretheses are clustered at municipality level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

3.6.3 The Heterogeneity by Regions

This subsection estimates how correlations between competition level in election and urbanization can change in subgroups of different regions. Behaviors of incumbent mayors

Table 3.7: Heterogeneity of effects of competition by regions

	(1)	(2)
Dependent variable	Change of developable land (%p)	Conversion rate (%)
H_N	-1.2172	-0.0961
	(0.0.8819)	(1.143)
Capital area × H_N	0	0
	(.)	(.)
Chungcheong area × H_N	-1.4984	3.864
	(2.5295)	(3.978)
Honam area × H_N	0.6401	0.539
	(1.050)	(1.180)
Daegu and Gyungbuk × H_N	1.374	1.048
	(0.891)	(1.120)
Busan and Gyungnam × H_N	0.832	0.515
	(0.9025)	(1.181)
Gangwon area × H_N	1.2605	0.922
	(0.873)	(1.139)
R^2	0.5389	0.4890
Nobs.	903	903

Note1. In column (1), the change of developable land is the difference of the rates of area of developable lands to the total area during the four years of mayoral term ($RR_0 - RR_4$). Here, RR is equal to the ratio of (rice paddy + crop field + orchard + mountain area) / total area. In column (2), the conversion rate is calculated by the ratio of newly urbanized land area during the mayoral term to the land areas other than urbanized area at the previous election year.
Note2. All the regressions include election fixed effects and the municipality fixed effect. They also include variables of log of population and GRDP at the previous election year, and a set of dummy variables for the terms of mayorship, party which mayors are affiliated, regions where municipality is located, and category of municipality such as borough, city, and county. GRDPs are the ones of metropolitan municipalities, in which samples of primary municipalities are located. Standard errors in paretheses are clustered at municipality level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

can differ when the situations and environments they face are different. The different regions can have distinct patterns of influence on mayors' stances on land policy even though the competition levels in the last election are similar. Each metropolitan region in Figure 3.3 has its own economic, social, and cultural characteristics, which have been inherited from the historical and geographical contexts. The characteristics of regions, such as the historical and cultural traits of residents, the status of current developments, and even geographical environments, can differentiate the behaviors of politicians. The detailed analysis of heterogeneity by metropolitan regions is seen in Table 3.7.

However, as demonstrated in Table 3.7, the heterogeneity by regions is not found. This result suggests that regional difference does not affect politicians' behavioral patterns.

3.6.4 Heterogeneity by Political Factors

This subsection analyzes how political factors can affect the heterogeneity of influences of electoral competition on urbanization indices. The characteristics of the party to which mayors belong may significantly influence the policy directions. Moreover, because electoral laws of the Republic of Korea allow mayors to be reelected in the same position until three times in a low, the terms of mayorship can be a factor that affects the behaviors of mayors. The detailed analyses of the heterogeneity by political factors are provided in Table 3.8.

A. Party affiliation

If characteristics or policy orientations of a particular party are more development-friendly than other parties, the party affiliation of incumbent mayors can affect the attitude toward urbanization of land use. In contrast, independent mayors or mayors from the third parties, who are not from the two dominant parties, are more likely to try to attract more voters by satisfying their demands because they cannot expect any help from strong parties. Besides the cases stated above, there can be many channels through which parties can influence the behaviors of mayors.

However, the differences among parties are not observed in the estimations with interaction terms of the Herfindahl index and parties variables. In columns (1) and (2) of panel A in the Table 3.8, the normalized Herfindahl index does not have any significant values on the change of developable land and the conversion rate in all the parties.

Table 3.8: Heterogeneity of effects of competition by political factors

Dependent variable	(1) Change of developable land (%p)	(2) Conversion rate (%)
Panel A: Party affiliation		
H_N	-0.305	-0.0487
	(0.266)	(0.458)
Hannara party × H_N	0	0
	(.)	(.)
Minju party × H_N	-0.493	-0.816
	(0.912)	(1.184)
Third parties × H_N	0.375	-0.396
	(2.601)	(0.873)
Independent × H_N	1.069	-0.055
	(0.627)	(0.812)
R^2	0.5364	0.4875
Nobs.	903	903
Panel B: Terms of mayorship		
H_N	-0.8746*	-0.667
	(0.5107)	(0.695)
first term × H_N	0	0
	(.)	(.)
second term × H_N	0.554	0.634
	(0.5596)	(0.717)
third term × H_N	1.051	0.395
	(0.523)	(0.656)
R^2	0.5367	0.4873
Nobs.	903	903

Note1. In column (1), the change of developable land is the difference of the rates of area of developable lands to the total area during the four years of mayoral term ($RR_0 - RR_4$). Here, RR is equal to the ratio of (rice paddy + crop field + orchard + mountain area) / total area. In column (2), the conversion rate is calculated by the ratio of newly urbanized land area during the mayoral term to the land areas other than urbanized area at the previous election year.
Note2. All the regressions include election fixed effects and the municipality fixed effect. They also include variables of log of population and GRDP at the previous election year, and a set of dummy variables for the terms of mayorship, party which mayors are affiliated, regions where municipality is located, and category of municipality such as borough, city, and county. GRDPs are the ones of metropolitan municipalities, in which samples of primary municipalities are located. Standard errors in paretheses are clustered at municipality level. *Statistically significant at the 10% level; **at the 5% level, ***at the 1% level.

B. Terms of mayorship

Terms of mayorship are also regarded as a factor that can affect behavioral differences among incumbent mayors. According to the prior hypothesis that mayors will change their land-use policy to get reelected in the next election, the mayors in their first term

are most likely to respond to the competition level in the last election. Because mayors in their third term cannot run for the next election, they may have fewer incentives to get more votes for the next election, and their behavioral patterns are expected to be different from the mayors in the first and second terms.

However, the estimation results provide no such difference among different terms of mayors. In column (1) of panel B of Table 3.8, the effect of electoral competition is weakly observed in the estimation with the change of developable lands in the first term mayors group. In the group of first-term mayors, the intensity of impacts of the normalized Herfindahl index on the change in urbanization is strongest, and its sign is negative. However, with the weak statistical significance level of the estimated values, the impacts by different terms are inconclusive. Meanwhile, in column (2) of panel B, no correlation is demonstrated in the estimation with the conversion rate as the urbanization index.

3.7 Discussions and Conclusions

When the estimation results are comprehended, strong statistical correlations are not found between the electoral competition in the previous elections and the change in urban use lands after the election across the country. However, the indices for electoral competition, especially the Herfindahl index, demonstrate statistical associations with the decrease of rural use lands and the conversion to urban-use ones in the group of the boroughs.

The statistical significance in the borough group seems to be related to the scarcity of developable lands in the more densely urbanized area. The scarcity argument is supported by the estimations with different quantiles depending on the area of developable land per population of municipalities. The first quantile from 0 to 20 percent, where the

developable land area is the least, demonstrates the strongest and statistically significant correlations between electoral competition indices and urbanization changes. This suggestive estimation results support the hypothesis of electoral productivity, in which politicians focus on geographic locations or policy options that can create a higher marginal rate of return in terms of votes. In the more urbanized area where the developable lands are scarce, the land-use conversion is more valuable and visible to voters. The political efforts of mayors can be regarded as a sign of his capabilities. On the contrary, in the less urbanized area, the conversion of lands may not be needed because the supply of urban-use lands is already enough to meet the demands.

The strong correlation in the more urbanized municipalities is not related to the high demands in the metropolitan cities because the population and GRDP at the beginning of the mayoral terms are not estimated to have statistical associations with the change in urbanization during the terms.

However, in spite of the estimation results mentioned above, it is still inconclusive to argue that the difference in the electoral competitions causes political behaviors of mayors in terms of land use policy because, in most municipalities, the distinct differences in urbanization change depending on electoral competitions are not observed. The reasons as to why there is a weak or little association between electoral competition level and the land use policy can be investigated with the more detailed data of how each permission is issued. However, the weak associations suggest that land-use policy in Korea is based on the neutral administration process, and the public employees are highly bound to the legal system. Though figuring out the sophisticated mechanisms behind the weak association can be studied in future research works in detail, the plausible explanation considering the institutions of Korea can be provided as follows.

The first candidate for the reasons behind little correlation between electoral competition and change of land development is a strict legal system of Urban planning in the Republic of Korea. All the activities related to lands are regulated by the National Land Planning and Utilization Act. Because a rigorous zoning system is applied to every parcel of land in the Republic of Korea, the utilization of lands is bound to the zoning regulations. If a person or an entity wants to construct buildings or change the shape or state of the land, permission from mayors is mandatory. When mayors decide permission, they should consult with the urban planning council installed in central government or local municipalities. The entire process related to permissions of development activities is subject to audit from the Board of Audit and Inspection or other central government ministries. If the suspicions of corruption and malpractice are severe, the cases can be subject to investigation of police or prosecution into a criminal lawsuit. When the size of a development project is above a certain amount, its feasibility should be tested to proceed with the project. Therefore, though elected mayors have intentions to promote development and issue more development permits with their discretionary judgment, public officials under mayors cannot support them beyond the boundary of their legal authority.

The second reason may be related to the limited power of local municipalities. The balance of powers is skewed to the central government in the Republic of Korea. The annual budget for the central government is four times more than the summation of all the budgets of local governments, and the ordnance of local governments cannot override the laws or acts of the central government. In many cases, the central government provides a standard form of ordnance to guide the administration of local municipalities. The big-size projects in the local area often are initiated by the central government. In many cases, local municipalities try to persuade the member of the national assembly who

represent the region to acquire more budget and projects rather than implement projects with their capital and authority. Mayors of municipalities cannot control the allocation process of central government subsidies to local governments on many occasions.

The final considerable point is that the size of the nation is not big enough to promote diversified development. Municipalities of Korea have relatively homogenized characteristics, and architectures and ways of building structures and developments are not different across the country. Therefore, individual mayors do not have room for changing policy in an entirely different direction.

Despite all the estimation results, this study has some limitations for interpretation. In the data used in this paper, detailed information about individual permission of developments or land-use change is not included. If more detailed data about each development permit or project can be obtained, the behaviors of mayors can be observed at a microdata level.

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