Empirical Essays on the Economic Value of Public Education: Evidence from Property Market in Japan

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Empirical Essays on the Economic Value of Public Education: Evidence from Property Market in Japan

（公教育の経済価値に関する実証研究: 日本の不動産市場を用いた分析）

Yuta Kuroda

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Chapter 1

Introduction

From an economic aspect, education is an investment in human capital. Public education is a very important factor in the accumulation of human capital in the country, and various studies have noted the important role of education in economic growth (e.g., Hanushek and Kimko, 2000; Heckman, Layne-Farrar, and Todd, 2009). Therefore, a public education policy must be managed efficiently and effectively. In order to do so, it is necessary to understand the behaviors of both parents and children. If we understand the decision-making process regarding the educational choices of parents and children more clearly, we can implement a more effective education policy. For instance, if we identify that households below the poverty threshold do not invest in their children's education, schooling support can be provided to them, thus preventing the reproduction of poverty.

However, because public education is free or compulsory in many cases (as in Japan), it is difficult to directly observe a parent's willingness-to-pay for education for their children. To address this problem, many studies indirectly observe a parent's willingness-to-pay for public education by analyzing the property market (Black and Machin, 2011; Nguyen-Hoang and Yinger, 2011). These studies consistently find that the value of education is capitalized in property prices, such as housing rents or land prices, in various countries and regions. The mechanism is as follows: under the school district system, in order to attend a specific school, it is necessary to live in the attendance district. Thus, the demand for housing or land within the designated district of a high-quality school exceeds that in the designated district of low-quality schools; as a result, the price of houses and land within the designated school district also increases.

Despite consistent results using data from various countries and regions, vast potential remains in this literature. When a change in the system that may affect educational behaviors occurs, changes in parental behavior in relation to education can be observed by analyzing the property market. Education affects the property market, and these changes in the property market in turn affect a parent's behavior. For instance, the presence of a high-quality school has the effect of increasing property prices, which causes high-ability students with high-income parents to go to high-quality schools. Therefore, the quality of these high-quality schools further improves. However, there are relatively few studies considering this interaction.

Therefore, this dissertation investigates the relationship between the quality of public education and the property market. In addition, it explores how the relationship varies with educational system changes. I analyze not only the effect of education on the property market but also the changes in population and academic achievement through the response of the property market. By doing so, I indirectly observe the parent's willingness-to-pay, or educational behavior for public education and investigate the comprehensive effect caused by the change in the education system.

This dissertation consists of three independent essays that target Japanese local cities and measure the value of public education using the property market. Although all chapters focus on Matsue City, Shimane prefecture in Japan, the purpose, objects of study, and data of each analysis are different. The first chapter concerns the effect of the quality of public elementary schools on apartment rents. The second chapter investigates the effect of the disclosure of information on public elementary school's quality on housing rents, population, and academic achievement. The last chapter explores the effect of a change in a high school district system on land price.

The overall results of these three chapters suggest that the property market is sensitive to changes in the educational system and the resulting change in parent behavior. This implies that even if the fees of public education are equal, the actual expenses for public education will differ due to increased property prices. This causes it to be more expensive to receive a high-quality education and may lead to widening disparities or a hierarchization of academic achievement. In addition, the results suggest that there may be heterogeneity in the educational behavior of parents. The inequality in education may increase due to the promotion of market principles or disclosures of the information of public education if parents with higher educational achievements, incomes, and enthusiasm will more effectively use the market principles and information.

This dissertation conducts empirical analysis using various data sets and econometric methods. In order to address the concern of unobserved characteristics, I use the regression discontinuity design and control for fixed effects using panel data. In this dissertation, I mainly use the datasets on public schools, the property market, regional population, and the economy. The following is an overview of the chapters.

In Chapter 2, I investigate the effect of public-school quality on housing rents within a school district. I estimate the causal effect of school quality, measured by average test scores, on housing rents using a regression discontinuity design to control for unobserved characteristics of neighborhoods. Specifically, I focus on apartment buildings located within school district boundaries. I find that school quality has a significant and positive effect on housing rents of apartments for families, but does not significantly affect housing rents of dwellings for single people. These results show that parents are willing to pay more to send their children to a better school.

Chapter 3 expands the analysis of Chapter 2 and focuses on the disclosure of the school quality information. I examine the effect of the disclosure of information about school quality on the stratification of elementary schools and the widening disparity in the academic ability of students between schools. Exploiting the fact that the school-level test scores were first disclosed in October 2014 in Matsue City in Japan, I estimate the difference in the effect of test scores on housing rent and population in the school district before and after the disclosure. I find that school-level test scores have a significant and positive effect on rents of apartments intended for a family after the school-level test scores were disclosed. I also find that disclosure significantly increases the population of children in the elementary school age group in the designated district of schools with high test scores. In addition, I find that the relative standard deviation of test scores after disclosure becomes larger than before disclosure. These results suggest that the disparity in the academic ability of students between schools may increase through increased housing rents after the disclosure of school-level test results.

Finally, I analyze the effect of the relaxation of a school district system's outside enrollment rate in public high schools on land price and university advancement rates in Chapter 4. In Matsue City in Japan, enrolling in a general public school when the family lives outside the school district was strictly prohibited before 2008. Therefore, nobody could enter high schools focused on preparing students to enter a university across school boundaries for a long period of time. In 2008, however, the school district system eliminated the most academic track aimed at entrance to prestigious universities. Additionally, 5% of all enrolled students in the general track were allowed to be from outside the school district. Since 2016, the enrollment limit from outside the school district was relaxed to 20%. I estimate hedonic models on land prices using the fixed effect approach with panel data from 2003 to 2018 and a regression discontinuity approach focusing on the boundary of the school district. I find that relaxing the school district system's enrollment limit significantly decreased the land prices within school districts with high-quality high schools. This suggests that the value of living within the high-quality school district may have decreased due to this relaxation of the school district system. In addition, I also analyze the effect of relaxation of enrollment limits on the number of successful candidates for universities. As a result, a partial relaxation of the school district system will increase the disparity in the ratio of successful applicants of prestigious universities, but that of national universities and all universities does not change. This implies that partial relaxation may only affect particularly high-achieving students.

Chapter 2

The Effect of School Quality on Housing Rents: Evidence from Matsue City in Japan[1]

2.1. Introduction

How much do parents pay for their children's education? Because parents' investments in education are not only for their children but also for themselves, many parents spend substantial sums to enroll their children in a good school to obtain a high-quality education. It is important to analyze parents' concrete behavior concerning their investments in their children's education from the perspective of equality in the public education system. However, it is difficult to observe parents' willingness to pay because primary education is free and compulsory in Japan.

We cannot directly observe parents' willingness to pay for public school; however, we can indirectly observe it from land prices or housing rents within a school district system. When parents purchase a house or rent an apartment, they consider the characteristics of the local public school. In other words, the value parents place on education might be capitalized as land prices or housing rents. In actuality, since real estate agencies advertise the high quality of schools in a district, the quality of schools may add capital to the land prices or housing rents.

However, endogeneity causes difficulties when estimating the value of school quality based on housing rents. Because children's test scores are influenced by their parents' characteristics, such as educational background or income level, a child's good test score does not mean that high-quality education has been provided; if so, better schools would tend to be located in better neighborhoods. Furthermore, in many cases, it is impossible to observe the parents' characteristics that influence their children's test scores, which may cause bias in estimation results.

To avoid these problems, Black (1999) uses a regression discontinuity design and focuses on houses located on opposite sides of school attendance district boundaries—the geographic lines that determine which school a child attends within a school district. By limiting the sample dwellings to

[1] I would like to thank my advisor Kentaro Nakajima and Midori Wakabayashi. I also thank two anonymous referees of JJIE for useful comments and suggestions. I am also grateful to Koichi Ushijima, Jenn-Jou Chen, the participants at the 2016 Japanese Economic Association Spring Meeting, the 30th Annual Meeting of the Applied Regional Science Conference (Kobe University), and the workshop at National Chengchi University for their helpful comments. This chapter is based on Kuroda (2018) already published in Journal of the Japanese and International Economies, 50, 16-25. All remaining errors are my own.

those very close to the attendance district boundaries, she is able to control for unobserved characteristics.

Following Black's (1999) methodology, I focus on apartments located within the public school boundary using data from Matsue City, the capital of Shimane Prefecture, on the main island in Japan. I estimate the causal effect of school quality on housing rents by using test scores as a proxy for school quality. The results show that the quality of the school has a significantly positive effect on the housing rents of apartments intended for families but not of those intended for singles. This result means that parents exhibit a willingness to pay to live in a better school district, but not people who are single.

Furthermore, I find that the effect of test scores on apartment rents is strong in proportion to the number of rooms and the occupied area. This result means that the more an apartment is intended for a family, the more the rent of that apartment will be affected by school quality. I also estimate the effect of junior high school test scores using the same equation. In contrast to the results for elementary schools, junior high school test scores have a nonsignificant effect on housing rents. These results may be doe to the tendency for parents of junior high school students whose income is relatively higher than the parents of elementary school students to live in their own houses instead of renting apartments, or the fact that elementary school and junior high school are treated as a continuous process.

The structure of the paper is as follows: Section 2 reviews the previous literature analyzing the effect of school quality on housing rents. Section 3 describes the empirical strategies. Section 4 discusses the data. Section 5 presents the results. Section 6 concludes.

2.2. Literature review

Many studies have considered the effects of school quality on housing rents around the world. Bogart and Cromwell (2000) analyze the effect of school redistricting on housing values in Shaker Heights, Ohio, in 1987 using data on all sales of houses between 1983 and 1994. Figlio and Lucas (2004) and Clapp, Nanda and Loss (2008) study the effects of school quality on housing prices using an individual fixed effects model and panel data to control for unobserved neighborhood characteristics. Figlio and Lucas (2004) estimate the effects of school grades on families' residential locations and housing prices using detailed data on repeated sales of individual residential properties in the state of Florida. The authors find that the housing market responds significantly to information about schools provided by school report cards, even when considering test scores and other variables. Clapp, Nanda and Loss (2008) estimate the relationship between property values and explanatory variables such as school district performance and demographic attributes using panel data from Connecticut over eleven years from 1994 to 2004. The authors find significant evidence that increases in the percentage of Hispanic residents have negative effects on housing prices in Connecticut, but the evidence regarding the effects of test scores on property values is mixed.

In Japan, Yoshida, Chou, and Ushijima (2008) analyze the effect of school quality on land prices and the change in this effect after the introduction of the school choice system. The authors use achievement test scores and the ratio of enrollment in private junior high schools as proxies of school quality. In addition, they address the endogeneity problems caused by unobserved neighborhood characteristics with individual fixed effect models using panel data. They conclude that the quality of elementary schools influenced land prices in the school district, but this effect decreased with the introduction of the school choice system.

Ushijima and Yoshida (2009) estimate the effect of school quality on land prices, using panel data on land prices in special wards of Tokyo Prefecture from 2001 through 2007. The authors employ the ratio of enrollment in private and national junior high schools as a proxy of school quality. They control for unobserved neighborhood characteristics by using the individual fixed effect approach. They find that the quality of the school influenced land prices only in districts with high-quality schools, and the impact was not substantial. However, there is still room for argument about the validity of using the ratio of enrollment measure as a proxy for school quality because parents consider a variety of factors, such as budget and distance, when making decisions about schools in which to enroll their children. In addition, the authors note the possibility that the relationship between school quality and land prices could have been weakened by the introduction of the school choice system, which was implemented in many special wards during the analysis period.

On the other hand, Black (1999) developed the most reliable approach for situations in which panel data are not available. She uses a regression discontinuity design and estimates the effect of test scores on housing prices by controlling for unobserved neighborhood characteristics and by focusing on houses located close to school district boundaries that differ only by the elementary school that the children attend. As a result, she finds that parents are willing to pay more to enroll their children in schools with students who have higher test scores.

Following Black's (1999) regression discontinuity design approach, I estimate the effect of school quality on housing rents. This paper's contributions are as follows. First, I use detailed information on apartments because I use housing prices instead of land prices, which were employed in previous studies on Japan. With land price data, one cannot identify whether the land is actually used for a family's residence because such data do not include information on how people use the land. On the other hand, I am able to estimate and interpret the effect of test scores on housing rents more clearly because the apartment data include indices on whether the apartments are for families or single people. I am also able to analyze the difference between an apartment that may be affected by school quality and an apartment that is not so affected because parents may be concerned about the quality of the neighborhood elementary school, but single people are not.

Second, I clearly estimate the effect of public school quality by focusing on Matsue City, a regional city in Japan. Because the cities targeted in the previous literature in Japan were subject to the school choice system, where students can attend public schools outside of the district in which they live, the relationship between public school quality and land prices was weakened. However, in Matsue City, the school choice system was not implemented and clear school districts exist, so there should be a strong relationship between public school quality and land prices or housing rents. In addition, there are few private elementary and junior high schools in Matsue City. In areas where there are many private schools, such as Tokyo, the relationship between the quality of the public schools and housing rents in a school district may be weakened because private schools are not restricted by school districts. Furthermore, because it is easy for a child with wealthy parents to go to a private school, the results will be biased. However, these problems can be solved by focusing on Matsue City, where private schools scarcely exist. For the above reasons, I can clearly estimate the effect of public school quality on housing rents in a school district system.

2.3. Empirical strategies

I estimate the effect of school quality on housing rents using hedonic regression. I regress the test scores on housing rents with some control variables included. The estimation equation is as follows:

$$ln\, P_{iaj} = \alpha + \beta X_{iaj} + \delta Z_j + \gamma test_a + \varepsilon_{ij}$$

where P_{iaj} is the rent of apartment i, in attendance district a, in school district j. The vector X_{iaj} includes characteristics of the apartment, such as the number of rooms and the age of the building, and Z_j is a vector of neighborhood and school district characteristics. $test_a$ is the average test score of the public school. Because the control variables, such as educational expenditures per student or the tax rate, are not different across schools in Matsue City, unlike in previous studies, it is not necessary to consider those variables.

However, it is difficult to observe all the socioeconomic characteristics, including access to public facilities or average income in the district and the results without including these variables, may be biased. To address this problem, I apply a regression discontinuity design. I replace the vector of observed characteristics with boundary dummies that indicate apartment buildings that share an attendance district boundary. The estimation equation is as follows:

$$ln\, P_{iab} = \alpha + \beta X_{iab} + \Phi K_b + \gamma test_a + \varepsilon_{iab}$$

where K_{iab} is a boundary dummy; if the apartment building is located within boundary b, it takes the value of one. This variable controls for any unobserved neighborhood characteristics shared by apartment buildings on either side of the boundary. It is assumed that apartment buildings within the same boundary have similar characteristics, such as accessibility to public facilities, amenities or average income.

Therefore, my analysis uses restricted data, such as I limited the sample to dwellings close to a boundary, after adding the boundary dummy to the equation. Specifically, I created a subset of apartments located within less than 500 m, 350 m, and 200 m from the boundary of a school district. Thereby, I am able to directly compare apartment buildings that have very similar geographic information, and it is thought that differences in the rents of apartments are caused by the ability to attend a different public school.

2.4. Data and summary statistics

2.4.1. About Matsue City

Matsue City is a regional city in southwest Japan. The population was approximately 200,000 in 2015.

There are several reasons why I focus on Matsue City. The primary reason is that there are very few private elementary and junior high schools in Matsue City. In an area where there are many private schools, the relationship between the quality of the public school and housing rents in the school district may be weakened because anyone can go to a private school regardless of their public school district. On the other hand, because there are few private schools in Matsue City, we can identify the effect of the quality of a public school on housing rents more clearly because it is difficult to receive a primary education from somewhere other than the public schools.

Furthermore, in Matsue City, the school choice system was not implemented, and a clear school district exists. Of course, if a school is very far from a dwelling, or if parents change their address during the school year, they can send their child to a school located outside their own school district. However, that situation is very rare.

Figure 2.1 presents a map of the school districts in Matsue City used for this analysis. The bold black lines represent the boundary lines of the school districts, and only one public school exists in each school district. There are 35 public schools in Matsue City, but the number of public schools used in this analysis is 23 because I cannot use data for schools in non-urban areas where there are very few apartments in the district or the district has a branch school that does not release its test scores due to a limited number of students. Furthermore, when the boundary dummy of a school district is estimated, a boundary divided by a large object such as a river or the site of a castle, is omitted from my dataset, because the neighborhood characteristics on different sides of such an attendance district boundary could be different.

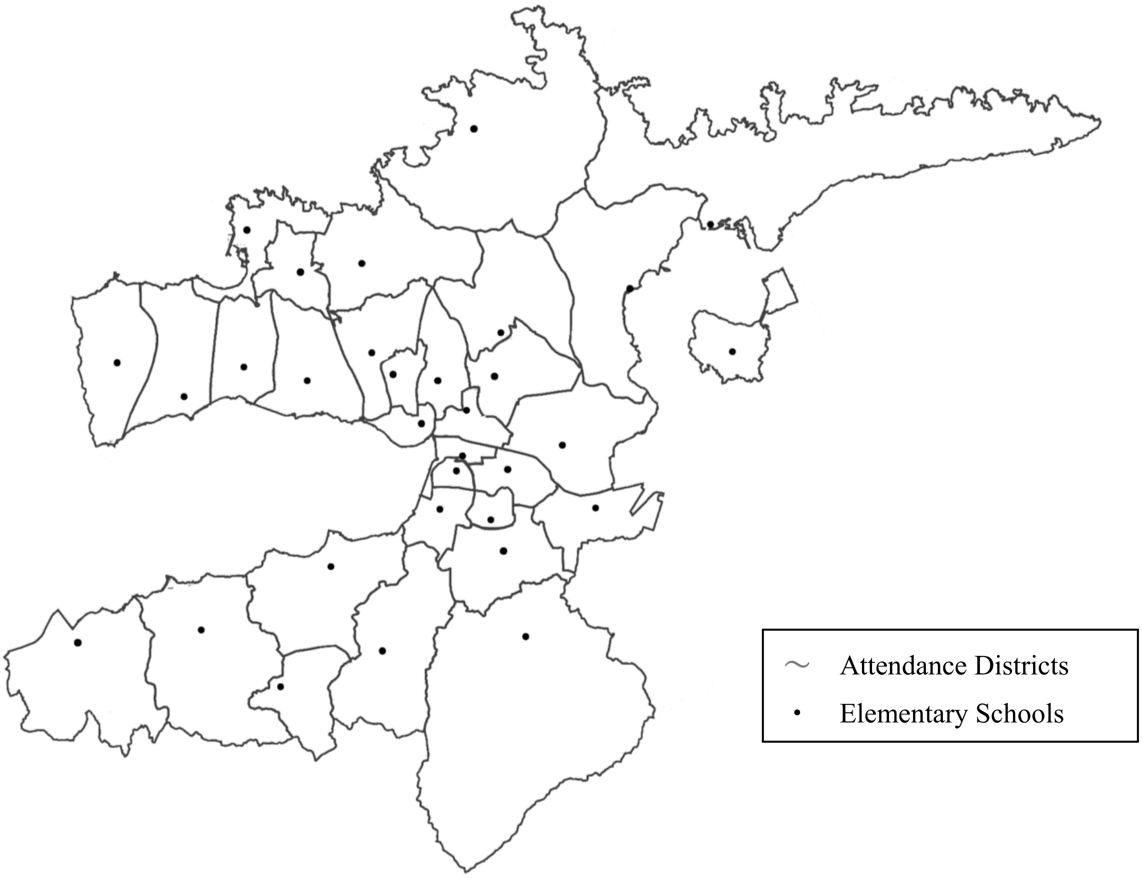

Figure 2.1 Elementary School Districts of Matsue City

2.4.2. Data

I use the apartment information from three major rental information sites: HOME MATE, CHINTAI, and SUUMO.[2] Each apartment has data on the address, the rent, the number of rooms, the layout (having a living room or dining room), the occupied area (m^2), the floor level, the number

[2] These rental information websites are representative in Japan and are widely used by people searching for apartments. Because each site includes different apartments, I merged the data obtained from these web sites for the analysis.

of floors in the building, the age of the building and the building's construction. In addition, apartments that have two or more rooms are defined as intended for a family. This definition is generally used by real estate agents in Japan.

Table 2.1 shows the summary statistics used in my analysis. The full data sample consists of 2,686 apartments. I created several dummy variables using the above apartment information. The living dummy and dining dummy variables equal one if the apartment has a living or dining room, respectively. The "for a family" dummy equals one if the apartment has two or more rooms. Furthermore, I established dummy variables for each style of building construction, such as steel frame, lightweight steel, reinforced concrete and earthquake-resistant steel (the baseline is wooden construction). Additionally, using address information and Google Maps, I calculated the distance from each dwelling to the nearest attendance boundary, the nearest train station, Matsue Station and Shimane University.[3]

I obtained statistical data about Matsue City and information about its school districts from Matsue City's official website. I used the number of students per teacher as a characteristic of the schools, and I used the age groups of less than 15 years of age and 65 or older, the sex ratio, and the average household size in the district as variables to control for local characteristics.

Test scores, which are used as a proxy for the quality of schools, are derived from two types of tests: 6th grade elementary school students take the National Assessment of Academic Ability (NAAA), and 4th and 5th grade elementary school students take the Shimane Academic Ability Survey (SAAS). I use the sum of the math and language test scores, averaged over 3 years, as the test score for each school. The NAAA is the scholastic ability investigation examination that the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has carried out once per year since 2007, and it is applied to sixth and ninth graders. The SAAS is the scholastic ability investigation examination that Shimane prefecture originally carried out, and it is applied to 4th, 5th, and 6th graders in the public elementary schools and students in the public junior high schools. In Matsue City, however, the SAAS was applied only to 4th, 5th, 7th, and 8th grade students because the 6th and the 9th graders took the NAAA instead of the SAAS.

2.4.3. Who lives in the rental house?

Because there are many people who have their own houses in local cities in Japan, it is necessary to consider whether the parents with children of elementary school going age live in the apartments. In this section, I show the relationship between household type and housing form in Shimane

[3] In Japan, there is high demand from university students for apartments close to universities, and the supply of apartments intended for students is also high in those areas. Therefore, in order to control for this influence, I added the distance from the university as an independent variable.

prefecture.[4]

Table 2.2 shows the number of households by type of household in Shimane prefecture in 2013. The number of households in Shimane prefecture is 254,700, of which 185,400 households (73%) live in owned houses and 69,300 households (27%) live in rented houses. However, households which have elementary school children (in this table, their age is assumed to be under 9 years old) exhibit a different tendency, because a great number of older people tend to live in owned houses rather than younger people. Of all the three to five person households, 5,100 households live in owned houses and 8,800 households live in rented houses. In other words, over 60% of married couples with elementary school children live in rented houses; therefore, it is reasonable to use the rented house for this study.

[4] Matsue City is the capital city of Shimane Prefecture, which has approximately one-third of the population and households of Shimane prefecture. Due to data constraints, I explain the information of Shimane prefecture instead of Matsue City.

Table 2.1 Summary Statistics

	Full Sample				500m			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Housing rent (YEN)	56724	12376	17000	135000	56577	13154	23000	135000
School characteristics								
Elementary school test score	67.35	2.77	61.58	72.75	67.92	2.89	61.58	72.75
Junior high school test score	63.83	2.06	59.75	66.80	64.03	1.88	59.75	66.80
House characteristics								
Number of rooms	1.67	0.69	1	4	1.65	0.72	1	4
Living Dummy	0.39	0.49	0	1	0.38	0.48	0	1
Dining Dummy	0.73	0.45	0	1	0.70	0.46	0	1
For a family Dummy	0.55	0.50	0	1	0.52	0.50	0	1
Occupied area (㎡)	44.30	14.43	12.15	157.86	43.28	14.79	15.60	106.06
Number of floors	2.60	1.55	1	14	2.72	1.67	1	14
Age of building	14.26	9.60	0	68	15.67	10.36	0	49
Steel frame Dummy	0.33	0.47	0	1	0.31	0.46	0	1
Lightweight steel Dummy	0.20	0.40	0	1	0.22	0.42	0	1
Reinforced concrete Dummy	0.13	0.34	0	1	0.17	0.38	0	1
Earthquake-resistant Steel	0.00	0.05	0	1	0	0	0	0
Distance from nearest station(km)	1.78	1.05	0.03	5.90	1.70	0.94	0.03	4.81
Distance from Matsue station(km)	3.18	2.25	0.10	17.06	2.63	1.72	0.10	9.15
Distance from Shimane University(km)	3.78	2.56	0.12	17.89	3.65	2.40	0.12	10.64
Distance from elementary school(km)	0.82	0.50	0.10	3.96	0.87	0.53	0.10	3.96
Distance from junior high school(km)	1.29	0.59	0.09	3.73	1.27	0.61	0.09	3.24
Neighborhood characteristics								
Pupil/teacher ratio	17.30	2.88	6.17	21.56	17.07	2.71	9.00	21.56
Percent 0-15 years old	0.15	0.04	0.01	0.36	0.15	0.04	0.01	0.36
Percent 65+ years old	0.24	0.07	0.00	0.55	0.23	0.08	0.04	0.55
Parcent mele	0.48	0.02	0.41	0.56	0.48	0.02	0.41	0.53
Average number of household	2.25	0.28	1.47	3.28	2.20	0.29	1.48	3.18
N	2686				1423			

	350m				200m			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Housing rent (YEN)	56671	13353	23000	135000	55450	12373	23000	110000
School characteristics								
Elementary school test score	67.87	2.81	61.58	72.75	67.55	2.77	61.58	72.75
Junior high school test score	64.16	1.81	59.75	66.80	64.14	1.82	59.75	66.80
House characteristics								
Number of rooms	1.65	0.73	1	4	1.60	0.72	1	4
Living Dummy	0.39	0.49	0	1	0.37	0.48	0	1
Dining Dummy	0.71	0.46	0	1	0.70	0.46	0	1
For a family Dummy	0.51	0.50	0	1	0.48	0.50	0	1
Occupied area (㎡)	43.28	14.74	15.60	106.06	42.35	14.50	15.60	106.06
Number of floors	2.79	1.76	1	14	2.73	1.64	1	14
Age of building	15.68	10.74	0	49	15.17	11.09	0	46
Steel frame Dummy	0.29	0.45	0	1	0.25	0.43	0	1
Lightweight steel Dummy	0.23	0.42	0	1	0.20	0.40	0	1
Reinforced concrete Dummy	0.19	0.39	0	1	0.19	0.39	0	1
Earthquake-resistant Steel	0	0	0	0	0	0	0	0
Distance from nearest station(km)	1.67	0.95	0.03	4.81	1.7079	1.0489	0.219	4.807
Distance from Matsue station(km)	2.65	1.81	0.10	9.15	2.81	2.05	0.23	9.15
Distance from Shimane University(km)	3.62	2.37	0.12	10.64	3.56	2.31	0.12	10.64
Distance from elementary school(km)	0.91	0.52	0.10	3.96	0.98	0.51	0.10	3.96
Distance from junior high school(km)	1.28	0.63	0.09	3.24	1.35	0.65	0.09	3.24
Neighborhood characteristics								
Pupil/teacher ratio	16.97	2.68	9.00	21.56	16.86	2.61	9.00	21.56
Percent 0-15 years old	0.15	0.05	0.01	0.36	0.15	0.05	0.02	0.36
Percent 65+ years old	0.23	0.08	0.04	0.55	0.23	0.08	0.04	0.55
Parcent mele	0.48	0.02	0.41	0.53	0.48	0.02	0.42	0.53
Average number of household	2.19	0.30	1.48	3.18	2.20	0.31	1.48	3.18
N	1088				718			

Table 2.2 Number of Household Living in Owned Houses and Rented Houses

Type of household	Owned houses	Rented houses	Total
Total	185,400	69,300	254,700
Single person households	33,100	35,000	68,100
Two person households	60,800	14,000	74,800
Three to five person households			
married couple and children (under 9 years old)	5,100	8,900	14,000
married couple and children (from 10 to 17 years old)	7,600	4,200	11,800
married couple and children (over 18 years old)	43,400	3,300	46,700
others	15,000	3,000	18,000
Over six person households	15,300	800	16,100

※Created by editing 2013 Housing and Land Survey (Statistics Bureau, Ministry of Internal Affairs and Communications)

2.5. Results and discussion

2.5.1. Baseline Results

Table 2.3 shows the baseline results. Column (1) shows the results using the full sample and not including boundary fixed effects. It shows that the elementary school test score has a significantly positive effect on housing rents, similar to Black's (1999) result. Furthermore, the other major variables also show a similar tendency. However, these results still have the problem of unobserved neighborhood characteristics.

I then restrict the sample based on distance from a boundary to control for unobserved neighborhood heterogeneity. Column (2) shows the results when restricting the sample to apartment buildings located within 500 m of a boundary, using the boundary dummy instead of census variables. Columns (3) and (4) show the results when restricting the sample to apartment buildings located within 350 m and 200 m of a boundary, respectively. Unlike previous studies, these results show that the test score does not have a significantly positive effect on housing rents. In addition, to show that the difference between the results of column (1) and columns (2)–(4) is not caused by the sample size but the boundary fixed effects, I estimate the regression without the boundary dummy for the sample located within 200 m of a boundary, as shown in column (5). Column (5) shows a similar trend to column (1), except for the significance level of the test score coefficient.

The results in Table 2.3 indicate that the public elementary school test score does not affect the housing rents of apartments within its attendance district. One of the reasons for this result is the different dependent variables used in this study compared to previous studies. In previous studies, the dependent variable was the land price or the house price. However, in this study, I use the rent amount for apartments or condominiums, and approximately half of these dwellings are one-room apartments designed for a single person. Naturally, only a family with children will care about the quality of the schools when renting an apartment. Therefore, the quality of the school will only affect the rent of apartments intended for a family.

To analyze this issue in detail, I introduced the “for a family” dummy and added the interaction term of the test score and the dummy into the equation. The results are shown in Table 2.4.

Column (1) of Table 2.4 shows the results using the full sample while not controlling for boundary fixed effects but including the “for a family” dummy and the interaction term of the test score and the dummy. The coefficient of the test score is negative and significant, indicating that the higher the test score is, the lower the housing rent will be. The “for a family” dummy is also negative and significant. This means that family-oriented apartments had lower rents than apartments intended for a single person. However, the interaction term of the test score and the “for a family” dummy is positive and significant; thus, for families, the rent increases as the test score rises.

Column (2) shows the results when restricting the sample to apartment buildings located within 500 m of a boundary while controlling for boundary fixed effects and including the “for a family” dummy and the interaction term. Columns (3) and (4) show the results when restricting the sample to apartment buildings located within 350 m and 200 m of a boundary, respectively, using the same variables as those used in column (2). These results show the same tendency as in column (1) and indicate that the test score has a significantly positive effect on housing rents only for apartments intended for a family, even when controlling for boundary fixed effects. Column (5) shows the results using the same equation as in column (1) in Table 2.4 for the sample located within 200 m of a boundary. The results show a similar trend to column (1) and indicate that the difference between the results of column (1) and columns (2)-(4) is not caused by the sample size.

In summary, the results in Table 2.4 show that the test score has a significantly positive effect on the rent for an apartment intended for a family and a significantly negative effect on the rent for an apartment intended for a single person.

Regarding the impact of the regression results, the results for apartment buildings that are only 200 m from a boundary (column (4)) suggest that a 10 percent increase in the test score leads to an approximately 1.7 percent increase in housing rents. This implies that parents are willing to pay JPY921 more in monthly housing rent for a 6.7 point increase in the test score (the mean of housing rents is approximately JPY55,000, and the mean of test scores is approximately 67).

In the specification in Table 2.4, I pool together both single and family houses, and which assume all the house characteristics like living dummy, age of buildings, and so on, have the same impact on housing prices for singles and families alike. I relax this assumption by separating houses for singles and families and estimating them independently. The results are shown in Table 2.5. Column (1) shows the results using family-oriented apartments while not controlling for boundary fixed effects and indicates that the test score has a significantly positive effect on housing rents. Column (2) shows the results when restricting the sample to apartments intended for families located within 200 m of a boundary and using the boundary dummy. This result also shows that the test score has a significantly positive effect on housing rents. Column (3) shows the results using apartments intended for a single person while not controlling for boundary fixed effects and indicates that the test score has a significantly negative effect on housing rents of single-person apartment. However, from the results in column (4) obtained when restricting the sample to apartments intended for a single person located within 200 m of a boundary and using the boundary dummy, I find that the quality of the school does not have a significant effect on the single-person apartments. This suggests that there is no difference in amenity situation across school district boundaries.

Table 2.3 Baseline Estimation

	(1) All houses	(2) 500m	(3) 350m	(4) 200m	(5) 200m
Elementary school test score	.0029**	-0.0033	-.0065**	-0.0055	0.0025
	(.0008)	(.0021)	(.0024)	(.0028)	(.0017)
House characteristics					
Number of rooms	.0793***	.0852***	.1049***	.1138***	.1016***
	(.0126)	(.0151)	(.0131)	(.0125)	(.0114)
Living Dummy	.0359***	.0467***	.0681***	.0732***	.0739***
	(.0081)	(.0111)	(.0110)	(.0144)	(.0122)
Dining Dummy	.0501***	.0513***	.0436***	.0363**	.0293*
	(.0091)	(.0103)	(.0109)	(.0134)	(.0128)
Occupied area (㎡)	.0073***	.0078***	.0067***	.0062***	.0067***
	(.0008)	(.0009)	(.0008)	(.0008)	(.0007)
Number of floors	.0216***	.0152***	.0150***	.0121**	.0121**
	(.0022)	(.0026)	(.0028)	(.0044)	(.0044)
Age of building	-.0126***	-.0126***	-.0125***	-.0129***	-.0122***
	(.0005)	(.0005)	(.0004)	(.0005)	(.0005)
Steel frame Dummy	.0228***	.0438***	.0488***	.0478***	.0293**
	(.0110)	(.0074)	(.0091)	(.0118)	(.0097)
Lightweight steel Dummy	.0654***	.0670***	.0747***	.0686***	.0719***
	(.0065)	(.0078)	(.0094)	(.0116)	(.0095)
Reinforced concrete Dummy	.0240*	.0573***	.0688***	.0601***	.0446**
	(.0091)	(.0108)	(.0120)	(.0147)	(.0157)
Earthquake-resistant Steel	.1291***				
	(.0174)				
Distance from nearest station (km)	-.0239**	-.0396	-.0549	-.0747	-.0420*
	(.0091)	(.0271)	(.0290)	(.0475)	(.0204)
Distance from nearest station squared	.0033	.0075	-.0106*	.0126	-.0075*
	(.0019)	(.0052)	(.0048)	(.0067)	(.0034)
Distance from Matsue station (km)	-.0304***	.0057	-.0045	.0630	-.0204
	(.0037)	(.0037)	(.0230)	(.0354)	(.0151)
Distance from Matsue station squared	.0009***	-.0033	.0030	-.0114**	-.0003
	(.0002)	(.0025)	(.0028)	(.0041)	(.0015)
Distance from Shimane University (km)	.0039	.0079*	-.0086*	.0124*	.0072
	(.0020)	(.0039)	(.0043)	(.0052)	(.0051)
Distance from Shimane University squared	-.0003	-.0010*	-.0011**	-.0014*	-.0011
	(.0002)	(.0004)	(.0004)	(.0006)	(.0006)
Distance from elementary school (km)	-.0095	-.0345*	-.0247	-.0216	-.00365
	(.0102)	(.0161)	(.0201)	(.0266)	(.0234)
Distance from elementary school squared	.0041	.0037	.0003	.0006	-.0124*
	(.0026)	(.0041)	(.0049)	(.0066)	(.0058)
Distance from junior high school (km)	-.0032***	-.0311	-.0116***	-.0007	-.0429
	(.0134)	(.0259)	(.0313)	(.0378)	(.0281)
Distance from junior high school squared	.0048	.0003	.0039	-.0114	.0064
	(.0041)	(.0075)	(.0090)	(.0093)	(.0085)
Boundary fixed effects	NO	YES	YES	YES	NO
Census variables	YES	NO	NO	NO	YES
N	2642	1369	1035	668	692
Number of boundaries	N/A	33	32	29	N/A
Adjusted R2	0.8442	0.8641	0.8758	0.8741	0.852

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Clustered standerd errors at the attendance district level are in parenthesis.

Table 2.4 Family *vs.* Single: dummy variable

	(1) All houses	(2) 500m	(3) 350m	(4) 200m	(5) 200m
Elementary school test score	-.0043**	-.0087***	-.0122***	-.0122***	-.0051*
	(.0014)	(.0025)	(.0027)	(.0032)	(.0021)
For a family Dummy	-.8408***	-.7608***	-.8535***	-.9333***	-1.0302***
	(.1547)	(.1311)	(.1400)	(.1729)	(.1666)
Test score × For a family	.0126***	.0118***	.0135***	.0147***	.0160***
	(.0016)	(.0019)	(.0021)	(.0025)	(.0025)
House characteristics	YES	YES	YES	YES	YES
Boundary fixed effects	NO	YES	YES	YES	NO
Census variables	YES	NO	NO	NO	YES
N	2640	1367	1033	666	690
Number of boundaries	N/A	33	32	29	N/A
Adjusted R2	0.8494	0.8683	0.8820	0.8815	0.8607

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Clustered standerd errors at the attendance district level are in parenthesis.

Table 2.5 Family *vs.* Single: subsample

	Family		Single	
	(1) All houses	(2) 200m	(3) All houses	(4) 200m
Elementary school test score	.0071***	.0086**	-.0035**	-.0084
	(.0009)	(.0029)	(.0013)	(.0047)
House characteristics	YES	YES	YES	YES
Boundary fixed effects	NO	YES	NO	YES
Census variables	YES	NO	YES	NO
N	1442	303	1184	339
Number of boundaries	N/A	23	N/A	19
Adjusted R2	0.8042	0.8809	0.8247	0.8596

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Standard errors are adjusted for clustering at the attendance district level.

2.5.2. Robustness

2.5.2.1 Definition of "For a Family"

In this section, I check the robustness of the definition of "for a family". In the analysis in Table 2.4, I define an apartment with more than two rooms as an apartment intended for a family based on the definition used on rental housing information websites. However, in actuality, the more rooms and the larger the occupied area is, the more the dwelling is suitable for a family. According to Table 2.6 which shows the number of each type of household by occupied area of rented houses in Shimane prefecture, the ratio of two or more person households increases as the occupied area increases. In addition, the share of households with elementary school children is relatively high in apartments with areas between 29.7 to 59.3 square meters. Therefore, I estimate whether the effect from the test score becomes stronger as the degree of suitability for a family becomes larger.

Table 2.7 shows the results using the interaction term of the test score and the family-related characteristics instead of the “for a family” dummy. Columns (1) and (2) show the results when using the interaction term of the test score and the number of rooms. Column (1) shows the results using the full sample and not including boundary fixed effects. Column (2) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary using the boundary dummy. The coefficients for the interaction term of the test score and the number of rooms are significantly positive at the 0.1 percent level; this means that the effect of the test score on housing rents is stronger in proportion to the number of rooms. The results shown in columns (3) and (4) are obtained using the interaction term of the test score and the occupied area. Column (3) shows the results using the full sample and not including boundary fixed effects. Column (4) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary using the boundary dummy. The coefficients for the interaction term of the test score and the occupied area are significantly positive at the 0.1 percent level in column (3) and at the 1% level in column (4); thus, the larger the occupied area is, the stronger the effect of the test score on housing rents. According to Table 2.6, the share of households with elementary school children (under 9 years old) living in houses starts to decrease as the area of houses exceeds 49.5 square meters. This implies that the relationship between suitability for family which has elementary school children and the occupied area of apartment does not increase monotonically. To address the concern, I construct the "family volume zone" dummy. This dummy is equal to one if the occupied area is from 29.7 to 59.3 square meters where the relatively large share is of families with elementary school children. Columns (5) and (6) in Table 2.7 show the results which are obtained using this dummy instead of using occupied area. Column (5) shows the results using the full sample and without including boundary fixed effects and column (6) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary using the boundary dummy. The coefficients for the interaction term of the test score and "family volume zone" dummy are significantly positive. The results indicate that the test scores have a significantly positive effect on apartment rents for families with elementary school children. These results also indicate that the rent for an apartment intended for a family tends to be more affected by the test score than that intended for a single person.

Table 2.6 Number of Households by Occupied Area of Rooms

		Occpied area (square meters)							
	Total	under 9.8	9.9-19.7	19.8-29.6	29.7-39.5	39.6-49.4	49.5-59.3	59.4-79.1	over 79.2
Total	69,300	700	16,000	14,600	17,800	10,900	4,400	3,800	1,100
Single person households	35,000	700	14,300	9,000	6,200	2,800	1,100	700	100
	(.505)	(1.00)	(.894)	(.616)	(.348)	(.257)	(.250)	(.184)	(.091)
Two person households	14,000	NA	800	2,200	5,200	2,700	1,400	1,300	400
	(.202)		(.050)	(.151)	(.292)	(.248)	(.318)	(.342)	(.364)
Three to five person households									
married couple and children (under 9 years old)	8900	0	300	1400	3200	2200	800	500	0
	(.128)		(.019)	(.096)	(.180)	(.202)	(.182)	(.132)	
married couple and children (from 10 to 17 years old)	4200	NA	100	600	1300	1200	400	300	100
	(.061)		(.006)	(.041)	(.073)	(.110)	(.091)	(.079)	(.091)
others	6400	0	400	1200	1500	1400	600	800	0
	(.092)		(.025)	(.082)	(.084)	(.128)	(.136)	(.211)	
Over six persons households	800	NA	NA	0	100	200	100	200	100
	(.012)				(.006)	(.018)	(.023)	(.053)	(.091)

※Created by editing 2013 Housing and Land Survey (Statistics Bureau, Ministry of Internal Affairs and Communications)
※According to the definition of the data set, I converted tatami unit to square meters at a rate of 1.65 square meters per tatami unit.
※The ratio of each type of households for each group of occupied area in parentheses.

Table 2.7 Robustness of "for a family"

	Number of Rooms		Occupied area		Family volume zone	
	(1)	(2)	(3)	(4)	(5)	(6)
	All houses	200m	All houses	200m	All houses	200m
Elementary school test score	-.0140***	-.0206***	-.0183***	-.0198**	.0003	-.0124**
	(.0023)	(.0042)	(.0033)	(.0062)	(.0015)	(.0040)
Test score × Number of rooms	.0097***	.0091***				
	(.0011)	(.0019)				
Test score × Occupied area			.0005***	.0004**		
			(.0001)	(.0001)		
Test score × Family volume zone Dummy					.0051**	.0118**
					(.0015)	(.0038)
Family volume zone Dummy					-.2988**	-.7662**
					(.1047)	(.2543)
Number of Rooms	-.5772***	-.5059***	.0753***	.1086***	.0808***	.1071***
	(.0798)	(.1282)	(.0129)	(.0128)	(.0104)	(.0130)
Occupied area	.0071***	.0061***	-.0247***	-.0192*	.0075***	.0065*
	(.0021)	(.0008)	(.0044)	(.0085)	(.0007)	(.0008)
Other house characteristics	YES	YES	YES	YES	YES	YES
Boundary fixed effects	NO	YES	NO	YES	NO	YES
Census variables	YES	NO	YES	NO	YES	NO
N	2641	667	2641	667	2640	666
Number of boundaries	N/A	29	N/A	29	N/A	29
Adjusted R2	0.8504	0.8782	0.8508	0.8765	0.8497	0.8796

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Standard errors are adjusted for clustering at the attendance district level.

2.5.2.2 Other Concerns

In this section, I conduct further robustness checks to address other potential concerns.

First, parents who are strongly interested in school quality may be more likely to be also interested in apartment quality. Because apartment quality strongly correlates with housing rent, if there is a positive correlation between school quality and the quality of an apartment, our findings may only represent housing quality effects instead of school quality effects. To address this concern, I regress the apartment quality, such as the number of rooms and the occupied area, on the test score (shown in Table 2.8, column (1) and column (2)). Column (1) shows that the quality of the school does not affect the number of rooms, and column (2) shows that the school quality does not affect the occupied area. These results demonstrate that there is no positive correlation between the quality of the school and the quality of the apartment.

Second concern is that the test score used in this study might be accidental. Because the test score used in this paper is from a single year, using different test scores from other years may produce different results. Therefore, I estimate the same equation from the previous estimation using the other year's test score, as shown in column (3) and column (4). Column (3) shows the results using the full sample, and column (4) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary, using the boundary dummy and the "for a family" dummy. The results in both columns are somewhat different in magnitude, but the positive and negative directions are the same as the main results. Thus, I can emphasize the validity of using these test scores as a proxy of school quality.

Table 2.8 Sensitivity Tests

	House quality		Other test score	
	(1)	(2)	(3)	(4)
	Number of Rooms	Occupied Area	Housing Rent	Housing Rent
Elementary school test score	-.0014	-.1820	-.0023	-.0052
	(.0106)	(.1464)	(.0035)	(.0034)
For a family Dummy				-.5331***
				(.1258)
Test score × For a family Dummy				.0096***
				(.0020)
Other house characteristics	YES	YES	YES	YES
Boundary fixed effects	YES	YES	YES	YES
Census variables	NO	NO	NO	NO
N	669	669	668	668
Number of boundaries	29	29	29	29
Adjusted R2	0.8640	0.8842	0.8734	0.8793

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Standard errors are adjusted for clustering at the attendance district level.

Third concern is that other local characteristics may coincide with the school district. In Matsue City, a local community center district coincides with the attendance district. Local community would be one of the determinants of housing rents. Because the local community center provides various services to residents in the district, unobserved characteristics of local community may be confounded with school quality. However, a boundary of local community center district is not as strict as an attendance district boundary, and according to the website on local community center, residents outside the district can receive services if they wish. Thereby the unobserved characteristics of local community are considered to change continuously. On the other hand, school districts are defined strictly and students are not allowed to go to a school located in a different district. In addition, a local community center provides services not only for families with children but also for residents regardless of age, gender, or family structure. In this sense, community quality will affect the housing rents for families and singles. However, the main results indicate that school quality only affect family-oriented apartments significantly. Furthermore, Table 2.6 shows that there is no effect of school quality on the housing rents for a single person. Above results suggest that housing rent premium for families estimated in my main analysis does not necessarily include the community quality premium.

2.5.2.3 Junior high school

The above results show that there is a significantly positive correlation between the elementary school test score and housing rents. However, in Matsue City, the elementary school districts are completely included in junior high school districts (see Figure 2.2), so parents may consider the quality of the junior high school rather than the elementary school. To address this concern, in this section, I analyze not only the elementary school test scores but also the test scores of the junior high schools.

Table 2.9 shows the results when estimating the equation using the junior high school test scores and the junior high school district boundaries. Columns (1)-(3) show the results when using the junior high school test score instead of the elementary school test score. Column (1) shows the results using the full sample. Column (2) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary, using the boundary dummy. Column (3) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary, using the boundary dummy and the “for a family” dummy. These results show that the junior high school test score has a positive and significant effect on housing rents of apartments for families and show the same tendency as the results of the estimation using the elementary school test score. Of course, in this analysis, it is not possible to distinguish between the effect of an elementary school and the effect of a junior high school.

Next, I estimated an equation that contained both the elementary school test score and the junior high school test score, as shown in columns (4)-(6). Column (4) shows the results using the full sample. Column (5) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary, using the boundary dummy. Column (6) shows the results when restricting the sample to apartment buildings located within 200 m of a boundary, using the boundary dummy and the “for a family” dummy. Based on the results in column (6), the effect of the elementary school test score remains positive and significant, but it turns out that the effect of the junior high school test score is nonsignificant. These results indicate that only the elementary school test score has a significantly positive effect on housing rents, and the junior high school test score has a nonsignificant effect on housing rents of apartments intended for a family.

The possible reasons for these results are as follows. First, the variation in junior high school test scores is small in comparison to the elementary school test scores because the number of junior high schools is smaller. Second, elementary schools and junior high schools may be considered a continuous integrated process, and parents make decisions about their residential area only when their children enter elementary school. In Matsue City, the attendance districts for the junior high schools are combined with the elementary school attendance districts; therefore, an elementary school’s students are schoolmates of the junior high school’s students. Thus, parents and children may refuse to change schools when entering junior high school. Third, parents who have children in junior high school may have a higher tendency to have their own house instead of renting an apartment in comparison to those with elementary school children because they are older and their income and social status is higher. Actually, Table 2.2 shows that family who has children aged from 10 to 17 are more likely to live in owned houses than family who has children under 9 years of age.

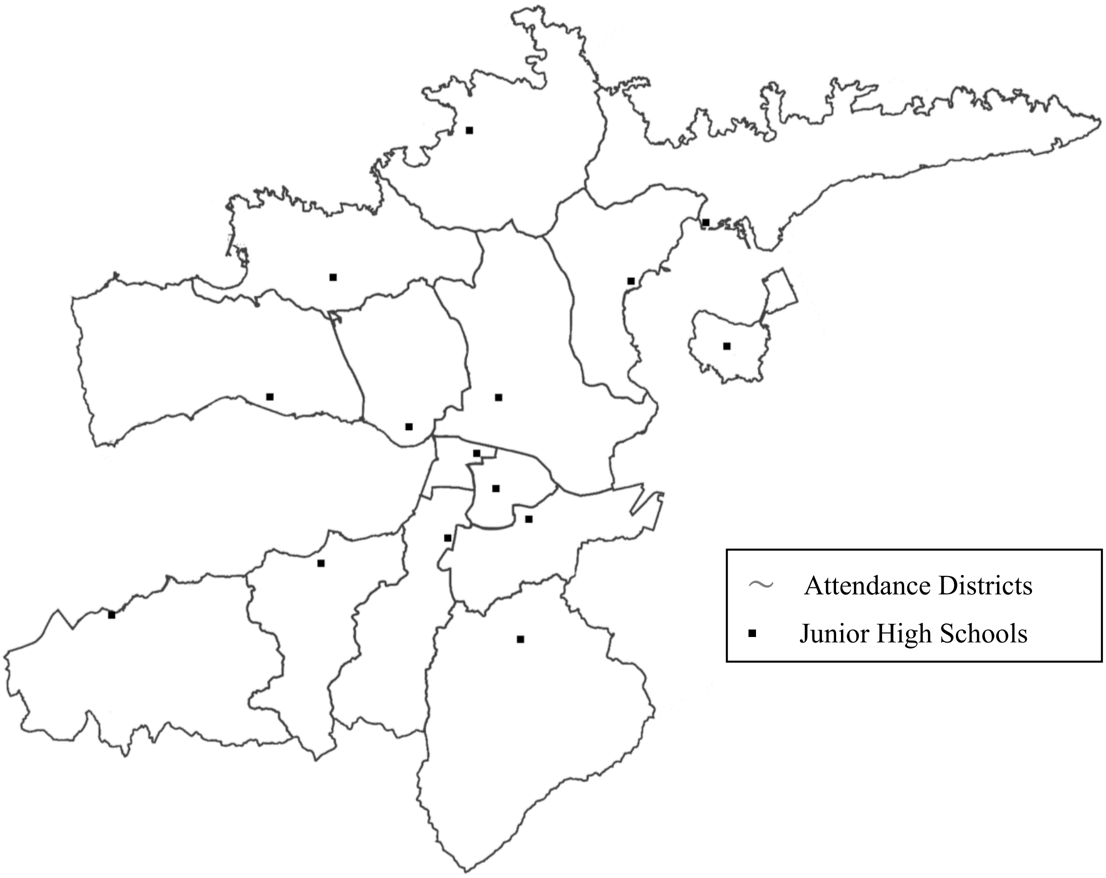

Figure 2.2 Junior High School Districts of Matsue City

Table 2.9 Using Junior High School Data

	(1) All houses	(2) 200m	(3) 200m	(4) All houses	(5) 200m	(6) 200m
Elementary school test score				.0037***	-.0076**	-.0145***
				(.0010)	(.0028)	(.0032)
Junior high school test score	-.0005	-.0131**	-.0221***	-.0027*	-.0016**	-.0199**
	(.0012)	(.0047)	(.0049)	(.0013)	(.0060)	(.0061)
For a family Dummy			-.6955*			-1.0218***
			(.2774)			(.2985)
Elementary test score × For a family						.0149***
						(.0027)
Junior high test score × For a family			.0128**			.0012
			(.0043)			(.0049)
Other house characteristics	YES	YES	YES	YES	YES	YES
Boundary fixed effects	NO	YES	YES	NO	YES	YES
Census variables	YES	NO	NO	YES	NO	NO
N	2659	363	361	2641	671	668
Number of boundaries	N/A	15	15	N/A	25	25
Adjusted R2	0.8431	0.9051	0.9137	0.8445	0.8722	0.8800

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.

※Clustered standerd errors at the attendance district level are in parenthesis.

2.6. Conclusion

In this paper, I estimate the effect of elementary school quality on housing rents using a regression discontinuity design. I find that school quality has a significantly positive effect on the housing rents of apartments intended for families. This result shows that parents are willing to pay more to send their child to a better school. Specifically, a 10 percent increase in the test score leads to an approximately 1.7 percent increase in housing rents.

In contrast, the test score has a negative or nonsignificant effect on the housing rents of apartments for a single person. This result indicates that the relative demand for a single room decreases in districts that have better schools because university students and single people, who are considered to be the main consumers of single rooms, do not consider school quality.

Compared with previous studies of Japan, my test score analysis shows a strong positive effect and a larger magnitude. There are several reasons why these results differ. First, there are many private schools in Tokyo, which was analyzed in the previous research, so the effect of public elementary schools may be weakened. Next, land prices were used in the previous studies, and land prices do not include information about who is actually using the land and for what purpose, so the results may be diluted. On the other hand, in this paper, I can determine whether a property is for families by using data on rental housing. Furthermore, by analyzing Matsue City, where there are few private schools, I am able to estimate the effect of public elementary schools more precisely. Therefore, I can conclude that the quality of the public elementary school is certainly capitalized in rental properties in the surrounding area. However, in Japan, educational environments differ greatly between large metropolitan areas and other areas, so it is necessary to consider the possibility that the results of this paper are unique to Matsue City. In addition, since this study uses only rental housing data, further study is needed as to whether the test score has similar effect on families which live in owned houses.

Chapter 3

Does Disclosure of School Quality Information Increase the Disparity in Academic Achievement? The Effect through the Housing Market[1]

3.1. Introduction

In recent years, accountability has been introduced by many public institutions for the purpose of efficient operation and improving performance, and the disclosure of information regarind the quality of service is progressing. With disclosure of information on quality, suppliers will operate more responsibly, and demanders will be able to make better decisions. In the field of education, the disclosure of school quality information may change the educational behavior of parents or improve students' academic performance. Koning and van der Wiel (2013) found that disclosure of negative information related to quality of a school decreased the number of first-year students in the Netherlands who chose that school after disclosure. Hastings and Weinstein (2008) demonstrated that the fraction of parents who chose higher-performing schools significantly increased with receipt of information on school quality. Burgess, Wilson, and Worth (2013) found significant and robust evidence indicating that the abolition of school performance tables markedly reduced school effectiveness in Wales relative to England.

In Japan, despite concerns over excessive competition and expansion of disparities among schools, national academic achievement tests for elementary and junior high school (compulsory education) students were not conducted until 2007. Furthermore, only the average scores of prefectures on the national test were disclosed until 2014 (Kawaguchi, 2011). Under such circumstances, since 2000, several educational problems such as a decline in children's academic performance, inequality of education, and expansion of child poverty have been discussed in Japan (Kariya et al., 2002; Abe, 2008), and the introduction of a national test and disclosure of its results were strongly requested for

[1] I would like to thank my advisors, Kentaro Nakajima, Midori Wakabayashi and Akira Hibiki. I am deeply grateful to Paul Thorsnes, Lixing Li, Iljoong Kim, Jenn-Jou Chen, and Wen-Chieh Wu for helpful comments and suggestions. I would also like to express my gratitude to the participants at the Joint Seminar at the University of Tsukuba, the 2018 Japanese Economic Association Spring Meeting, the 21st Labor Economics Conference at Doshisha University, the Tokyo Labor Economics Workshop and the Data Science Workshop at Tohoku University. All remaining errors are my own. This study was supported by Joint Research Program No.762 at the Center for Spatial Information Science (CSIS), University of Tokyo (Real Estate Database 1999-2016 by At Home Co., LTD).

efficient operation and improved performance. As a result, the national test known as the National Assessment of Academic Ability (NAAA) has been conducted since 2007, and since 2014 schools' average test scores have been disclosed in several municipalities.

In this study, I used the unique event of disclosure of school quality information, which had not occurred until 2014, and investigated how it affected students' academic performance and parental educational behavior. However, because there is no difference in fees associated with public education among schools in Japan, parents' educational demand is not reflected in school fees and it is difficult to directly observe their educational investment behavior and willingness to pay for their children's schooling. Therefore, I focused on the housing market in areas where a school district system existed to indirectly observe the effect of the disclosure of school quality information on the behavior of parents.

There have been many studies investigating the effect of school quality on real estate prices, and consistent results have been obtained indicating that "school quality has a significantly positive effect on housing or land prices" (Black & Machin, 2011; Nguyen-Hoang & Yinger, 2011). The mechanism is as follows: If a school district system exists, in order to attend a specific school it is necessary to live within its attendance district; thus, the demand for housing or land within the attendance district of high quality schools rises, and as a result, the price of housing and land within the attendance district also become high. Specifically, the value that parents place on education is capitalized as housing or land prices. However, there have not been many studies investigating the effect of the disclosure of school quality information on the housing market compared to studies focusing on the relationship between school quality and the housing market. Particularly, few studies have tried to determine whether competition and disparities among schools occurs as a result of disclosure, and therefore the effect of disclosure on them must be examined. Additionally, from the policy evaluation perspective, because the educational system and environment greatly differ from country to country, it is also important to investigate what happened after disclosure of school quality information using Japanese data..

In this study, using the event that the school-level test scores were first disclosed in October 2014 in Matsue City in Japan, I estimated the effect of disclosure on housing rents and population in the school district. To avoid the problem of unobserved confounding factors, I controlled the area fixed effect and the various trends of the region. I also investigated how disparity in academic achievement among schools changed after disclosure. As a result, I found that school-level test score had a significantly positive effect on rents of apartments intended for a family after the school-level test scores were disclosed. I also found that the disclosure effect was significant only in areas with many children, and was insignificant in areas with few children. Additionally, my results suggest that disclosure significantly increased the population of elementary school-aged individuals within the attendance district of schools with high test scores. These results indicate that parents choose residential areas in response to new information regarding school quality, and that the housing market is also affected. Finally, I also found that the value which indicated the degree of disparity (i.e., relative standard deviation of test scores) became large as a result of disclosure.

These results suggest that disparity in the academic ability of students between schools may expand through increased housing rents after disclosure of school-level test results. The potential mechanisms are as follows: The disclosure of information on school quality makes parents exercise more selective behavior for their children, and as a result, the amount of money they need to pay to attend good schools increases, reflecting growing demand for good education. Additionally, parents' school choice behavior is heterogeneous, and parents with a higher educational background and income, or with more enthusiasm for their children's education, tend to choose higher quality schools. In contrast, parents with a relatively low educational background and income, or with less willingness to pay for their children's education, are crowded out of good school districts through increased housing rentals, and sorting of students occurs. As a result, potentially talented students (who have parents with good educational backgrounds, higher incomes, or enthusiasm for education) gather at high quality schools, and therefore disparity in academic achievement between schools will expand.

Relative to previous studies, this study makes several contributions to the literature. First, by using housing prices instead of land prices, I was able to estimate and interpret the effect of school quality on the property market more clearly because the rental housing data included indices on whether the properties were intended for families. Second, previous studies mainly imply the possibility of selective disclosure by real estate agencies; however, by using not only housing data but also population census data for small areas organized by age group, my results indicate that there is evidence that the residential choice of parents is also changing due to disclosure of school quality information. Third, I was able to clearly measure the effect of disclosure of public school quality information on a regional community by focusing on a city where a school district system clearly existed and few private schools were present. Finally, although academic performance, school choice, and the property market were estimated in each previous study, in this investigation I consider the effect of disclosure on all three categories.

The structure of this paper is as follows: Section 2 reviews the previous literature and explains the contributions of this study. Section 3 describes the empirical strategies used. Section 4 discusses the data and setting of the study. Section 5 presents the results and discussion. Finally, Section 6 provides concluding remarks.

3.2. Literature review

Many studies have considered the effects of school quality on housing rents, and Black and

Machin (2011) and Nguyen-Hoang and Yinger (2011) offer comprehensive reviews of this literature. These studies have shown consistent results, indicating that school quality has a significant positive effect on the price of housing or land (e.g., Black, 1999; Figlio & Lucas, 2004). In Japan, Ushijima and Yoshida (2009) and Kuroda (2018) also found that increasing school quality increased property price significantly. Ushijima and Yoshida (2009) found that school quality affected land prices only in areas with high-quality schools, and the results of Kuroda's investigation (2018) indicated that school quality had a greater effect on rents of apartments with larger occupied areas. These results suggest that there is heterogeneity among families or properties affected by school quality.

Studies investigating the effect of disclosure of school quality information can be roughly classified as focusing on the following categories, depending on the type of outcome variable: academic achievement, school choice, and property price. Koning and van der Wiel (2012) investigated the effect of disclosure of school quality information on academic performance. They found that disclosure of information on the relative quality of schools in the national newspaper improved performance in a group of schools with relatively lower performance scores. Conversely, Burgess, Wilson, and Worth (2013) investigated whether the abolition of disclosure of school performance information negatively affected school effectiveness. They found significant and robust evidence suggesting that abolition of school performance tables markedly reduced school effectiveness, but that it did not affect schools in the top quartile of the league tables. The results of these studies indicated that disclosure of school quality information had an effect on academic performance, but that the effect might have heterogeneity among schools depending on quality.

There have also been studies on the effect of disclosure of school quality information on choice of school. Koning and van der Wiel (2013) found that the number of enrollments for schools with lower scores decreased after disclosure of information about the quality of high schools in the Netherlands. They also found that these effects were large for the most academically rigorous path, such as the college-preparatory track. Nunes, Reis, and Seabra (2015) found that disclosure of school ranking based on the national academic exam decreased the number of enrollments in schools that were rated poorly and increased the probability that they would be closed. They also observed that these effects were stronger for private schools. Hastings and Weinstein (2008) examined both a natural experiment and a field experiment in which direct information on school test scores was provided to lower-income families in a setting involving a public school choice plan, and they found that receiving information significantly increased the fraction of parents who chose higher-performing schools. Their results also indicated that attending a higher-scoring school increased student test scores, thus implying that school choice would effectively increase academic achievement for disadvantaged students when parents could access school quality information. According to these results, parents and children referred to school quality information when choosing their school if they could access the information; therefore, high-quality schools attracted a large number of enrollments. Conversely, the number of enrollments at low-quality schools decreased. Additionally, because of the heterogeneity among schools and parents, children and parents that were more interested in education cared more about school quality; thus, high-quality schools might be attractive to students with high motivation or ability. Consequently, disparity in academic achievement among schools might expand due to disclosure of school quality information.

Recently, there have been several studies on the effect of disclosure of school quality information on the price of housing or land. Imberman and Lovenheim (2016) studied the effect of disclosure of value-added information regarding school quality. Their results suggest that parents and homeowners do not value the ability of schools and teachers to increase test scores, nor are they unaware of the importance of value-added information because the measures are derived from a complicated statistical model that is difficult for non-experts to understand. Carrillo, Cellini, and Green (2013) found evidence indicating that real estate agents selectively disclosed information on school assignments. They also found no significant effects of disclosure on home prices and observed point estimates very close to zero by controlling for school quality with elementary school fixed effects. They reasoned that school quality information might be obtained by buyers before disclosure because of the growth of the Internet and the increasing availability of data. Haisken-DeNew et al.'s (2018) study examined the effect of launching a website providing standardized information about school quality to the Australian public. They found that favorable information on schools increased real estate prices, but bad information did not have a significant effect, and even controlling for school quality, this result is significant. They interpreted these results as indicative of buyers being unaware of the importance of school quality information and real estate agents conducting strategic and selective disclosure (i.e., disclosing information on good schools and not disclosing information on bad ones) to raise selling price.

In short, previous studies have found consistent results suggesting that disclosure of school quality information has a positive effect on academic performance in low-quality schools and increases the number of enrollments in schools with good quality. The former effect can reduce disparity between schools, while the latter can expand it. Due to heterogeneity among schools and parents, children and parents that are more interested in education care more about school quality; therefore, high-quality schools may be attractive to students with high motivation or ability. Thus, through disclosure, the scores of schools that originally had higher scores increased, while the scores of schools that originally had lower ones decreased. As a result, disparity between schools might expand.

However, there is no consistent evidence as to whether the real estate market accurately reflects of disclosure of information on school quality. If property prices within good school districts increase as a result of disclosure of information on school quality, parents have to pay more money to send their children high-quality schools. Therefore, high quality schools attract parents that have high income and high educational backgrounds, and disparity among schools may increase due to parents' income and educational background strongly correlating with their children's academic ability.

Relative to the previous research discussed above, this study makes several contributions to the literature. First, by using housing prices instead of land prices, I was able to estimate and interpret the effect of test scores on the property market more clearly because rental housing data included indices regarding whether the properties were intended for families. I was also able to show that there were no events besides disclosure of school quality information that affected the property market by analyzing properties intended for single people and rental shops/offices that were thought insignificant in relation to school quality.

Second, I was able to demonstrate that the population of school-aged children changed as a result of disclosure, by using not only housing data but also population census data by age group of small areas. Previous studies have mainly suggested that housing rents will increase in high quality school districts due to selective disclosure by real estate agencies. However, in this study, I was able to show that disclosure of school quality information affected not only housing rents but also population. This suggests that the rise in housing rental reflects actual parents' demands for their children's education.

Third, I was able to clearly measure the effect of disclosure of public school quality information by focusing on a city where a school district system clearly existed and few private schools were present. Schwartz, Voicu, and Horn (2014) and Fack and Grenet (2010) suggest that the relationship between school quality and real estate price becomes weak when schools can be freely chosen irrespective of school district. Thus, if there are many ways to receive education besides public schools, the effects of school quality or disclosure might not be measured accurately. However, in Matsue City, which I analyzed, these problems were solved since most ways of receiving primary education are limited to public schools. Additionally, there are no entrance exams in Japanese public elementary and junior high schools; thus, the importance of residential choice is high.

Finally, I examined not only the effect of disclosure on the property market and population, but also on disparity between schools. In previous research, academic performance, school choice, and the property market have been evaluated, but in this study, I consider the effect of disclosure on all three categories. By doing so, I can suggest the possibility of the existence of the following mechanism: The disclosure of school quality information promotes parents' residential choice behavior, which is reflected in the real estate market, and as a result, disparity between schools will expand. Although I cannot refer to each causal relation, it is important from a policy evaluation perspective to suggest the possibility that disparity will expand due to disclosure.

3.3. Empirical strategies

3.3.1. Housing rents

I estimated the effect of test scores on housing rents and the change in the effect due to information disclosure using hedonic regression. Since parents did not have a way of obtaining official information regarding school quality before disclosure, and they were able to access that information after disclosure for the first time, so the effects of the test score (which was an index of school quality) on housing rents would change before and after disclosure. Therefore, I regressed the interaction term of the test score and “after-disclosure dummy" on housing rentals with various control variables included. The basic estimation equation was as follows:

$$ln\, P_{itaj} = \alpha + \beta_1 Test_a \cdot After_t + \beta_2 Test_a + \beta_3 After_t + \gamma X_i + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{itaj}$$

where P_{itaj} was the rent of apartment i in area j in attendance district a in quarter t. $Test_a$ was the test score of the school located in attendance district a, and was to be used as a proxy variable of the school's quality, which was converted into the deviation value and the rank of the school within the area from raw data. $After_t$ was the after-disclosure dummy taking one after disclosure of school-level test scores[2], or indicating the days elapsed from the date of disclosure. The vector X_{iaj} included characteristics of the apartments in question, such as occupied area and the age of the building. Y_t was a quarter dummy and Z_j was an area dummy to control time and area fixed effect respectively[3]. W_{jt} contained the area characteristics that changed over time (such as population and average age). W_{jt} also controlled for specific trends in the central urban and suburban areas[4], as well as the north and south areas[5].

In the above estimation equation, β_2 represented the effect of the test scores on housing rents before disclosure of school-level test scores, and β_1 represented the effect of test scores on housing rents after disclosure. If parents considered the test scores as representative of school quality, and if they could not know that information before the disclosure of school-level test scores, there was no significant relationship between the test scores and housing rents before disclosure, and there should

[2] Specifically, this dummy variable took one after October 23, 2014.

[3] I used quarter dummies instead of year dummies because the real estate market experiences seasonality. I also analyzed data using month dummies, and the results were consistent.

[4] The definitions of central urban and suburban were based on the "Matsue City Central Area Revitalization Basic Plan" published by Matsue City.

[5] Matsue City is divided into northern and southern areas by a large river, and each has different characteristics. The southern area is downtown and has a central station, and the northern area is a residential one where a university and castle ruins exist.

have been a significant relationship between the test scores and housing rents only after disclosure[6]. As Carrillo, Cellini, and Green (2013) suggest, we must note that parents could obtain school quality information from not only official disclosure, but also other data source such as local communities and networks. Therefore, school quality was capitalized to a certain extent by housing rent before disclosure, but the impact of the first official disclosure of information was still large, and it might have had the effect of raising the rent, as well.

Additionally, I used the intersection terms of each quarter dummy and school rank to analyze changes in effect over time. I used the following estimation equation:

$$\ln P_{itaj} = \alpha + \sum_{t=2}^{20} \beta_t Y_t Test_a + \gamma X_i + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{itaj}$$

where β_t represented the impact of school quality on housing rents for each quarter t. In this study, I performed my analysis using 20 quarterly (5 yearly) data, and information on school quality was disclosed between the 12[th] and 13[th] quarters. Therefore, with the first quarter ($t = 1$) as the baseline, if school quality became capitalized related to housing rents due to disclosure, β_t indicated significance when $t \geq 12$. Conversely, if there was no significant relationship between school quality and housing rents before disclosure, β_t indicated insignificance when $t < 12$. I also analyzed whether the effect of disclosure on housing rents was short-term or long-term. Additionally, by confirming the significance of β_t before the 12[th] quarter, we could also verify whether the parallel trend assumption was satisfied.

3.3.2. Number of posted apartments

There was concern that the property data that I used in this study came from data posted on real estate information websites and did not indicate actual transactions. If cheap property was posted at a specific time and area, or a high-class condominium with large capacity was built during the analysis period, the average regarding property rentals might have been affected greatly. Additionally, if there was bias in the number of properties between the high-quality and low-quality school districts, the results might also have been biased accordingly. To deal with this concern, I estimated the number of samples in each area per month as the control variable. Additionally, I also made panel data which indicated the number of properties used for each area and month and estimated the number of properties regressed by the school quality indicator. The estimation equation used is as follows:

$$N_{taj} = \alpha + \beta_1 Test_a \cdot After_t + \beta_2 Test_a + \beta_3 After_t + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{taj}$$

[6] Since the planned disclosure of school-level test scores was announced in local news, etc. for several months prior to the disclosure date, it was likely that many people knew about the disclosure at that time.

where N_{ta} indicated the number of posted properties in area j in attendance district a in quarter t. As in the case of estimating of housing rents, to analyze the change in the relationship between school quality and the number of posted properties over time, I estimated by using the intersection terms of the quarterly dummy and school quality. The estimation equation used is as follows:

$$N_{taj} = \alpha + \sum_{t=2}^{20} \beta_t Y_t Test_a + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{itaj}$$

where β_t represented the impact of school quality on the number of posted properties for each quarter t. By these analyses, I was able to confirm that the number of posted properties had not changed in areas with high or low test scores. Specifically, there was no significant relationship between the number of posted properties and school quality.

3.3.3. Enrollment and population

Apart from analysis using housing rents, I also estimated the enrollments of each school and population by specific age of each area and each month as an independent variable to analyze the change in school and residential choice after disclosure. The estimation equation used is as follows:

$$Enroll_{ta} = \alpha + \beta_1 Test_a \cdot After_t + \beta_2 Test_a + \beta_3 After_t + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{taj}$$

$$Pop_{otaj} = \alpha + \beta_1 Test_a \cdot After_t + \beta_2 Test_a + \beta_3 After_t + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{taj}$$

where $Enroll_{ta}$ indicated the number of enrollment students of school a, in year t, and Pop_{otaj} indicated the number of people aged o years old in area j in attendance district a in month t. For analysis on enrollment of students, I used panel data at the annual and school level, and analysis on population by age was estimated using panel data at the month and area level.

As with analysis of housing rents, I also analyzed changes in the effect of disclosure on population over time[7]. The estimation equation used is as follows:

$$Pop_{otj} = \alpha + \sum_{t=2}^{20} \beta_t Y_t Test_a + \delta Y_t + \theta Z_j + \mu W_{jt} + \varepsilon_{itaj}$$

By this estimation, I analyzed the change in population in the area with high (low) test scores.

[7] Since enrollment data had a small number of samples, only population by age was estimated.

3.4. Data

In this study, I mainly used three kinds of data (e.g., housing, school, and district data). This section provides detailed information regarding the data used.

3.4.1. About Matsue City

Matsue City is a regional city in southwest Japan. Its population was approximately 200,000 and its population density was approximately 390 people per square meters in 2018. The average score on national tests of elementary school students in Matsue City in 2014 was 66.613, which was almost the same as the national average of 66.175; therefore, Matsue City was an average city in terms of academic achievement.

In Matsue City, information on school quality was first disclosed in 2014. There was no official announcement on school quality (such as the average test score) before 2014, so parents were able to access this information for the first time after disclosure in 2014. Whether to disclose school-level results had been discussed since the beginning of 2014, and after disclosure had been decided upon, plans regarding it were announced on local news or websites a few months before the disclosure occurred. Therefore, it was believed that many people who lived in Matsue City knew about the disclosure and when it would take place.

There are several reasons why I focused on Matsue City, just like Kuroda (2018). The primary reason is that there are very few private elementary and junior high schools in Matsue City. If many private schools are present, the relationship between public school quality and housing rentals in the school district may be weakened because anyone can go to a private school regardless of where they live (Schwartz, Voicu, & Horn, 2014; Fack and Grenet, 2010). However, because there are few private schools in Matsue City, we could clearly identify the effect of public school test scores on housing rentals because it was difficult for students to receive primary education from somewhere other than public schools.

Furthermore, in Matsue City, a school choice system had not been introduced, and a school district existed. Therefore, the school that a student can attend is decided according to his/her residential address, and students cannot go to school outside the boundaries of their school district. In exceptional situations such as when an address is changed due to moving during the school fiscal year, students can go to school outside their school district; however, this situation is very rare. Therefore, in Matsue City, one's place of residence is closely related to the quality of education that he or she can receive, and the importance of residential choice for parents with children is high.

Figure 3.1 presents a map of the school districts in Matsue City used for this study. The bold black lines represent public elementary school district boundaries, and only one school exists in each school district.[8] There are 35 public elementary schools in Matsue City, but the number of schools used in this analysis was 25 because I could not use data for schools in non-urban areas where there were very few apartments in the district or where the district had a branch school that did not release its test scores due to a limited number of students. In Matsue City, the residential choice of parents could be influenced by school quality information due to identical school fees, lack of entrance examination, and the presence of several public transport options within the narrow area..

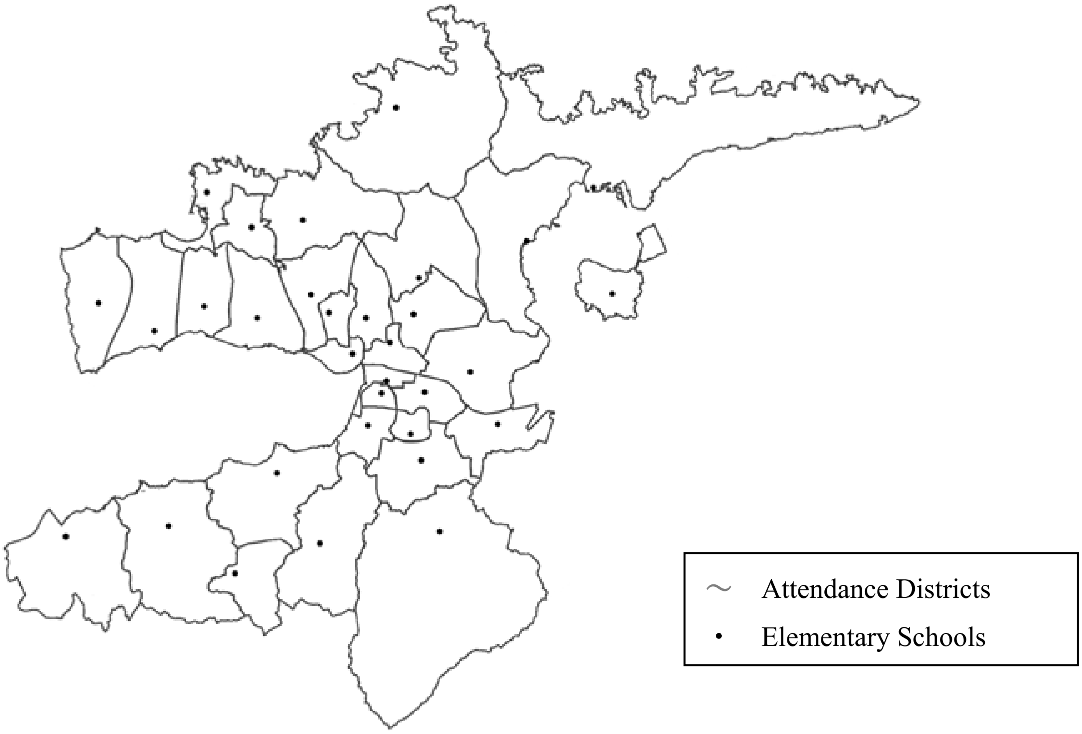

Figure 3.1 Elementary School Districts of Matsue City

[8] As an exception, one branch school exists. However, since its number of students during the analysis period was only one or two and its test scores were not disclosed, this school would not affect the estimation results.

3.4.2. Property data

I used rental property data from 2012 to 2016 for Matsue City from the "Real Estate Database 1999-2016."[9] This dataset includes nationwide real estate data from 1999 to 2016, and there are 22,767 samples from 2012 to 2016 for Matsue City. As I mentioned in the previous section, this property data was obtained from data posted on real estate information websites and did not indicate actual transactions. Property offered for sale by the real estate agency was included in this dataset, and it contained the date that properties were posted as for sale on the real estate websites.

In this study, I excluded land and sales property data from samples because I focused on rental properties. Each property had data on the property number, category (such as owned house or rental apartment, and newly or used), the rent or price, the occupied area (by square meter), the floor level, the number of floors in the building, the age of the building, the building's construction (such as wooden or block), and the date of disclosure. As shown in Table 3.1, I set the dummy variables for each category (e.g. rental apartment, rental townhouse, rental mansion, rental store, or office[10]) and structure (e.g. autoclaved lightweight aerated concrete, precast concrete, reinforced concrete, steel reinforced concrete, block, light steel, steel, and wooden). Furthermore, I set the "after-disclosure dummy" and "the number of elapsed days after disclosure."

In this study, I defined apartments of over 40 square meters as "family-oriented apartments." In Japan, some real estate agencies have said that apartments with two or more rooms, or of 40 or more square meters are intended for families (e.g., Homemate, n.d.).[11] As shown in Figure 3.2, it seems that 40 square meters is the boundary between one room and two or more rooms, so this definition was considered reasonable. I derived the main results using samples which included family-oriented apartments. To confirm the robustness of this definition, I also made estimates that divided the sample according to the occupied area.

Additionally, because this dataset did not contain a strict address, there were properties that could not be identified, such as to which school district a property belonged. In this study, since such properties were excluded from the sample, 16,065 properties (7,781 for families; 7,752 for singles; and 532 for rental shops and offices) were used for analysis.[12]

I must address another concern regarding whether parents with elementary school children lived

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[9] This dataset was provided by the Center for Spatial Information Science, the University of Tokyo.

[10] In Japan, the terms *apartment*, *town house*, and *mansion* all refer to a general type of residential real estate, indicating a meaning similar to "apartments" in American English.

[11] Of course, this definition changes depending on population density or economic conditions of a city, but in Japanese local cities, it is ordinarily said that an apartment with 40 or 50 square meters or more is intended for families.

[12] Analysis using all apartments and single-person apartments was also conducted, and the results were used for confirming the robustness of the main results. Summary statistics of samples of single-person apartments and rental shops/offices are shown in Appendix 3.A.

in the apartments, since many people live in their own houses rather than rental properties in Japanese cities. Therefore, I demonstrated the relationship between household type and housing format in Shimane Prefecture[13] as follows. Table 3.2 indicates the number of households by type in Shimane Prefecture in 2013. The number of households in Shimane Prefecture was 254,700, of which 185,400 households (73%) lived in owned houses and 69,300 households (27%) lived in rented ones. However, households which had elementary school children (in this table, their age was assumed to be under 9 years old) exhibited a different tendency because many elderly households rather than younger ones tended to live in owned houses. Of all the three to five-person households evaluated, 5,100 households lived in owned houses and 8,800 households lived in rented ones. Specifically, over 60% of married couples with elementary school children lived in rented houses; therefore, it was reasonable to use the rented house for this study.

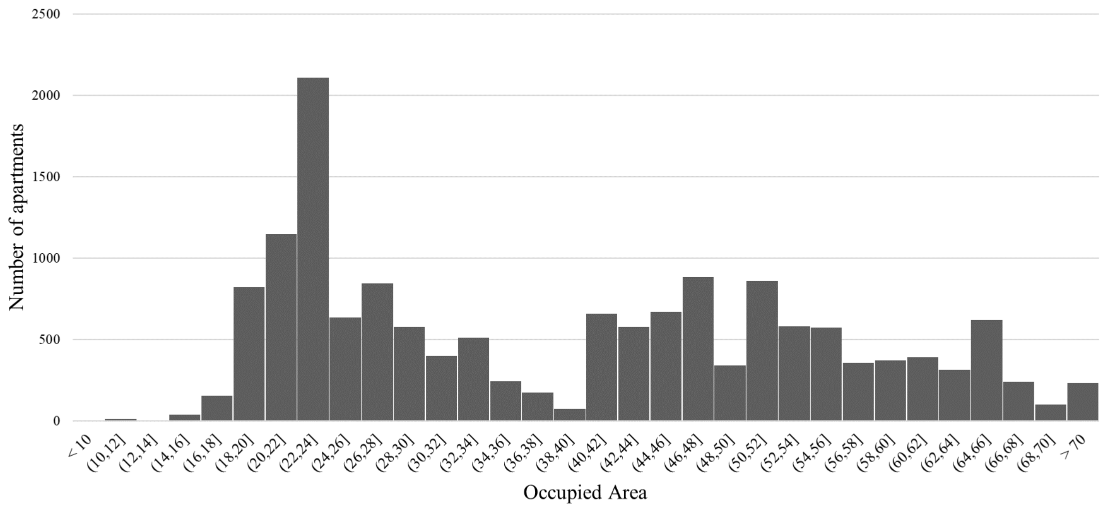


Figure 3.2 Number of Properties by Occupied Area

[13] Matsue City is the capital city of Shimane Prefecture, and holds approximately one-third of the population and households of the prefecture. Due to data constraints, I used Shimane Prefecture's information instead of Matsue City's.

Table 3.1 Summary Statistics (Main Estimation)

	Mean	S.D.	Min	Max
House characteristics				
Housing rent (YEN)	58971	11189	35000	550000
After-disclosure dummy	0.447	0.497	0	1
Elapsed days after disclosure	168.600	238.209	0	801
Number of floors	2.479	1.309	1	14
Located floor	1.796	1.079	1	10
Occupied area	53.130	9.130	40	106.640
Age of building	14.050	7.942	0	50
Rental apart dummy	0.800	0.400	0	1
Rental town house dummy	0.006	0.074	0	1
Rental mansion dummy	0.195	0.396	0	1
Structure ALC dummy		NA		
Structure PC dummy	0.002	0.045	0	1
Structure RC dummy	0.136	0.343	0	1
Structure SRC dummy	0.008	0.092	0	1
Structure block dummy	0.001	0.025	0	1
Structure light steel dummy	0.120	0.325	0	1
Structure steel dummy	0.455	0.498	0	1
Structure wooden dummy	0.278	0.448	0	1
N		7781		
Area characteristics				
Number of households	496.272	588.424	8.4	4460
Population	1151.646	1382.317	10.800	9250.200
Average household size	2.269	0.378	1.286	3.280
Number of children	141.891	184.623	0	1073
Number of elementary students	77.132	98.131	0	559
Average age	45.451	6.434	25.813	61.168
Number of samples (family)	13.960	12.685	0	51
Number of samples (single)	12.030	7.840	0	42
Urban dummy	0.244	0.430	0	1
North dummy	0.370	0.483	0	1
N		148		
School characteristics				
Number of enrollments	70.210	39.8166	8	185
Test score 2014	66.613	3.202	59.525	72.750
N		25		

※ALC, PC, RC, and SRC stand for "Autoclaved Lightweight aerated Concrete", "Precast Concrete", "Reinforced Concrete", and "Steel Reinforced Concrete", respectively.

Table 3.2 Number of Households Living in Owned Houses and Rented Houses

Type of household	Owned houses	Rented houses	Total
Total	185,400	69,300	254,700
Single-person households	33,100	35,000	68,100
Two-person households	60,800	14,000	74,800
Three- to five-person households			
married couple and children (under 9 years old)	5,100	8,900	14,000
married couple and children (from 10 to 17 years old)	7,600	4,200	11,800
married couple and children (over 18 years old)	43,400	3,300	46,700
others	15,000	3,000	18,000
Over six-person households	15,300	800	16,100

※Created by editing 2013 Housing and Land Survey (Statistics Bureau, Ministry of Internal Affairs and

3.4.3. Area data

I obtained statistical data and information on school districts from Matsue City's official website. Population census data are reported on the website monthly, and populations by age and gender in each area are described.[14] In the main estimation, I used the number of households, population, average age, number of people per household, number of children (under 12 years old), number of elementary school students, and total population by each area and each month to control for local characteristics that change over time. The number of areas was 148, and details of each variable are shown in Table 3.1. In Matsue City, the residential environment is totally different in central urban areas versus the suburbs[15], so I controlled for different time trends of housing rentals, respectively. Additionally, because the characteristics and amenities of houses are different between areas north and south of the central river, I also controlled for different trends, respectively.

3.4.4. School data

In this study, I used two kinds of data on schools: the number of enrolled students and the results of academic achievement tests. The summary statistics are shown in Table 3.1. Test scores were derived from two types of tests: 6th grade elementary school students took the National Assessment of Academic Ability (NAAA), and 4th and 5th grade elementary school students took the Shimane Academic Ability Survey (SAAS). I used the sum of the math and language test scores, averaged

[14] In this study, the minimum unit of address was called "area." This is known as "cho-cho" in Japanese, which describes a location that is more detailed than a city but less detailed than an exact street address. Although not strict, it refers to a location such as a street name in the United States.

[15] Central urban areas are commercial areas that are centered about Matsue Station, and there are many residential areas and agricultural lands in the suburbs.

over 3 years, as the test score for each school. The NAAA is the scholastic ability examination that the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has carried out once per year since 2007, and it is applied to sixth and ninth graders. The SAAS is the scholastic ability examination that Shimane Prefecture originally conducted, and it is applied to 4th, 5th, and 6th graders in public elementary schools and students in public junior high schools. In Matsue City, however, the SAAS was applied only to 4th, 5th, 7th, and 8th grade students because 6th and 9th graders took the NAAA instead of the SAAS.

Both academic ability tests did not disclose school-level results before October 2014, and school-level results were first disclosed on October 22, 2014. The NAAA was administered on April 22, 2014, and the SAAS was given on April 24th and 25th. After 2015, these tests began being conducted around May, and results are disclosed at the end of October every year. In this study, I considered the test scores of 2014 as the scores for each school and used them, since school-level test scores did not demonstrate extreme change over several years.

For analysis, the test scores were converted into a deviation value, and the school rankings of the test scores were also used.[16] This was because parents might have considered the rank of a school in the region, rather than how many points the school's score had risen. In either case, results that were almost consistent were obtained, but I show both results below to compare the coefficients with the previous studies.

3.5. Results and discussions

3.5.1. Main results for the housing market

Tables 3.3 shows the results of estimating the housing samples by restricting them into family-oriented apartments.[17] Column (1) indicates the results of using deviation values while controlling for house and area characteristics. This result shows that school quality had a significant positive effect on housing rents before disclosure of school quality information, and the effect was significantly increased additionally after disclosure. Column (2) shows the result of controlling time fixed effects in addition to column (1), but the result was almost the same as in the first column.

[16] The deviation value was obtained by normalizing the test score so that the mean was 50 and the standard deviation was 10, and this value is ordinarily used in Japan as the index of students' academic achievement. Specifically, it is derived by dividing the difference between each test score and the mean of test scores by the standard deviation, multiplying by 10, and adding 50.

[17] I analyzed data using all the samples without dividing, but the results suggested that main variables had no significant effect on housing rents if I controlled for all the variables (see Appendix 3.B and 3.C). I interpreted these results as suggesting that the impact of family-oriented and single-person apartments was canceled out.

Column (3) shows the result of adding area fixed effects to the control variables, and the coefficient of the interaction term of school quality indicator and the after-disclosure dummy still had significant positive effect, although the impact was weaker than in columns (1) and (2). Column (4) shows the result of adding the different trends in the central urban and suburban areas, and column (5) shows the result of adding the different trends in the northern and southern portions of the city, but the coefficients of the intersection term were still positive and significant. These results indicated that the rents of family-oriented apartments located within a high-quality school district significantly increased additionally after the disclosure of school quality information, and these results were robust even if various variables were controlled. The effect of the disclosure of school quality information on single-person apartments will be analyzed in a later subsection. The bottom part of Table 3.3 shows the results of estimation using school rank instead of deviation value as a proxy variable of school quality. Since the level of school ranking decreased as school quality increased, the main coefficients indicated the opposite of the results using deviation value. Column (6) shows the results of controlling the house and area characteristics similarly to column (1), and the results indicated that school quality had a significant positive effect on housing rents before disclosure, but the effect was strengthened by disclosure. The results of columns (7)-(10) are also similar to those of column (2)-(5). Summarizing the main result of this study, after disclosure of information on school quality, rents of family-oriented apartments located in a district with a high-quality school increased compared to those located in a school district with a low-quality school.[18]

Table 3.4 shows the result using the number of elapsed days from disclosure instead of the after-disclosure dummy, were other specifications the same as in Table 3.3. Columns (1) and (2) show the results of using deviation value without controlling the area fixed effects. Both results showed that the interaction terms were positive and significant coefficients, suggesting the possibility that test score would affect housing rents gradually as time passed after disclosure. Column (3) shows the results of adding the area fixed effects, Column (4) shows the result of adding the different trends in the central urban and suburban areas, and column (5) shows the result of adding the different trends in the northern and southern parts of the city. All the coefficients of intersection terms were still positive and significant, but the number of elapsed days had no significant effect on housing rents. The results from column (6) to column (10) showed the same results as column (1) to column (5), and there were no large differences between deviation value and school rank in this estimation.

To analyze the effect of changing over time, I estimated using the intersection terms of each quarter dummies and school quality indicator, and the results are shown in Table 3.5 and Figure

[18] I also analyzed data using housing rents per occupied area used in previous studies instead of raw housing rents; however, the results were almost the same as those obtained using raw housing rents data. The results are shown in Appendix 3.D.

3.3.[19] Column (1) and column (2) show the results obtained using deviation value and school rank respectively. In Figure 3.3, the horizontal axis represents time, the vertical axis represents the coefficient, the black dot represents the coefficients of interaction terms of each quarter dummy and school quality indicator, and each width represents the 95% confidence interval. According to the results of Table 3.5, school quality had a nearly significant effect on housing rents before disclosure of school quality information. Specifically, there was no significant difference in housing rents between high-quality school districts and low-quality school districts before disclosure, which also suggests that the probability of satisfying the parallel trend assumptions was high. However, after disclosure of school quality information, school quality had a significant positive effect on housing rents. These results emphasized that the rise in housing rents for family-oriented apartments was not due to prior trends or other shocks, but was certainly due to disclosure of school quality information. Although it was not statistically significant, it was important to note that even when controlling various variables and fixed effects, the rents of apartments in a high-quality school district were higher than those in a low-quality school district. This suggests that even before the official disclosure occurred, residents might have accessed school quality information from informal sources such as reputations or rumors. In fact, in areas where school quality information was not disclosed, unofficial information on school quality was available through parents' interactions or local communities, so this is a plausible explanation.

Regarding the impact of the main regression results, the results for column (5) in Table 3.3 suggest that a 10-point increase in deviation value led to an approximately 0.05 percent additional increase in housing rents after disclosure. This implied that parents were willing to pay JPY294 more in monthly rent for housing, and this impact was very small (the mean associated with housing rents was approximately JPY59,000). This impact was about two-thirds of the result obtained by Kuroda (2018) that analyzed using cross-sectional data after disclosure in Matsue City. There were several reasons why the impact was small compared to previous studies on school quality and the housing market. First, school quality might have already been capitalized in relation to housing rentals to some extent before disclosure. As mentioned above, there were several ways to obtain information on school quality besides through the official disclosure, although accuracy was not guaranteed, so real estate agents and parents might have made decisions based on that information before the disclosure. In column (2) of Table 3.3, the sum of the coefficients of the deviation value and the interaction term suggests that housing rents increased by 3.7%, with the increase of one standard deviation, which was consistent with the results of several previous studies indicating that one standard deviation was related to a 2 - 5% higher property price ((Black, 1999; Bayer, Ferreira, &

[19] The result of estimating the effect of change over time using single-person apartments is shown in Appendix 3.E. According to the results, rentals of single-person apartments showed a decreasing trend before disclosure, and the assumption of a parallel trend was not satisfied. Results using single-person apartments will be interpreted in detail in Section 3.5.2.1.

McMillan, 2007). Second, there might be strong heterogeneity among parents' behavior with respect to school quality, as previous studies suggested (Koning and van der Wiel, 2013; Ries and Somerville, 2010). This might lead to a small impact and large significance indicating that a certain minority of parents are very concerned about school quality, but the majority do not care about it. Third, since there were not many parents interested in education compared to those in large cities that were used in previous studies, the impact on the real estate market might be relatively small. Parents who are interested in education enough to care about elementary school quality tend to live in a metropolitan city where many schools are available that provide advanced elementary education. In fact, there are many high-quality private elementary schools, kindergartens, and cram schools for young children in large cities such as Tokyo, and supply and demand for advanced primary education are also high. Therefore, there may be relatively fewer parents who are interested in primary education for their children in smaller areas like Matsue City compared to large cities.

Table 3.3 Baseline Results

	(1)	(2)	(3)	(4)	(5)
Deviation value	.0026***	.0025***			
	(.0001)	(.0001)			
After-disclosure dummy	-.0710***	-.0642***	-.0281**	-.0358***	-.0245**
	(.0086)	(.0105)	(.0088)	(.0093)	(.0090)
Deviation value × After-disclosure dummy	.0012***	.0012***	.0006***	.0007***	.0005**
	(.0002)	(.0002)	(.0001)	(.0002)	(.0002)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6638	0.6668	0.7754	0.7782	0.7795

	(6)	(7)	(8)	(9)	(10)
School rank	-.0033***	.-0033***			
	(.0002)	(.0002)			
After-disclosure dummy	.0095*	.0186*	.0106	.0147*	.0096
	(.0039)	(.0076)	(.0058)	(.0059)	(.0058)
School rank × After-disclosure dummy	-.0018***	-.0018***	-.0008***	-.0010***	-.0007***
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6623	0.6655	0.7754	0.7783	0.7795

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Table 3.4 Elapsed Days

	(1)	(2)	(3)	(4)	(5)
Deviation value	$.0026^{***}$	$.0026^{***}$			
	(.0001)	(.0001)			
Number of elapsed days	$-1.584\times10^{-4***}$	$-.8402\times10^{-4}$	$-.2082\times10^{-4}$	$-.3701\times10^{-4}$	$-.2163\times10^{-4}$
	$(.1828\times10^{-4})$	$(.4599\times10^{-4})$	$(.3571\times10^{-4})$	$(.3599\times10^{-4})$	$(.3559\times10^{-4})$
Deviation value × Elapsed days	$2.678\times10^{-6***}$	$2.627\times10^{-6***}$	$1.234\times10^{-6***}$	$1.444\times10^{-6***}$	$1.134\times10^{-6***}$
	$(.3664\times10^{-6})$	$(.3630\times10^{-6})$	$(.3159\times10^{-6})$	$(.3421\times10^{-6})$	$(.3248\times10^{-6})$
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6636	0.6671	0.7755	0.7782	0.7796

	(6)	(7)	(8)	(9)	(10)
School rank	$-.0034^{***}$	$-.0034^{***}$			
	(.0002)	(.0002)			
Number of elapsed days	$2.802\times10^{-5***}$	$9.980\times10^{-5*}$	6.316×10^{-5}	6.092×10^{-5}	5.416×10^{-5}
	$(.8120\times10^{-5})$	(4.378×10^{-5})	(3.338×10^{-5})	(3.342×10^{-5})	(3.325×10^{-5})
School rank × Elapsed days	$-3.916\times10^{-6***}$	$-3.861\times10^{-6***}$	$-1.632\times10^{-6***}$	$-1.891\times10^{-6***}$	$-1.406\times10^{-6***}$
	$(.4931\times10^{-6})$	$(.4900\times10^{-6})$	$(.4252\times10^{-6})$	$(.4530\times10^{-6})$	$(.4255\times10^{-6})$
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6618	0.6657	0.7755	0.7782	0.7795

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Table 3.5 Changes in Effect Over Time

	Deviation value	School rank
	(1)	(2)
Deviation value / School rank		
×2012 Q2	.0008	-.0016
	(.0006)	(.0009)
×2012 Q3	.0015*	-.0025**
	(.0006)	(.0009)
×2012 Q4	.0004	-.0009
	(.0007)	(.0010)
×2013 Q1	.0005	-.0011
	(.0006)	(.0009)
×2013 Q2	.0006	-.0012
	(.0006)	(.0009)
×2013 Q3	.0007	-.0013
	(.0006)	(.0009)
×2013 Q4	.0004	-.0014
	(.0006)	(.0009)
×2014 Q1	.0013*	-.0027*
	(.0006)	(.0009)
×2014 Q2	.0011	-.0022*
	(.0006)	(.0009)
×2014 Q3	.0009	-.0017
	(.0006)	(.0009)
×2014 Q4 (disclosure)	.0007	-.0016
	(.0006)	(.0008)
×2015 Q1	.0010	-.0017*
	(.0006)	(.0009)
×2015 Q2	.0018**	-.0028**
	(.0006)	(.0009)
×2015 Q3	.0015*	-.0022**
	(.0006)	(.0008)
×2015 Q4	.0019***	-.0028***
	(.0006)	(.0008)
×2016 Q1	.0017**	-.0027**
	(.0006)	(.0008)
×2016 Q2	.0012	-.0020*
	(.0006)	(.0009)
×2016 Q3	.0014*	-.0023*
	(.0007)	(.0009)
×2016 Q4	.0017**	-.0024*
	(.0006)	(.0009)
N	7492	7492
Adjusted R2	0.7770	0.7771

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

※All control variables (house characteristics, area characteristics, year fixed effects, area fixed effects, urban/suburban trends, and north/south trends) were controlled.

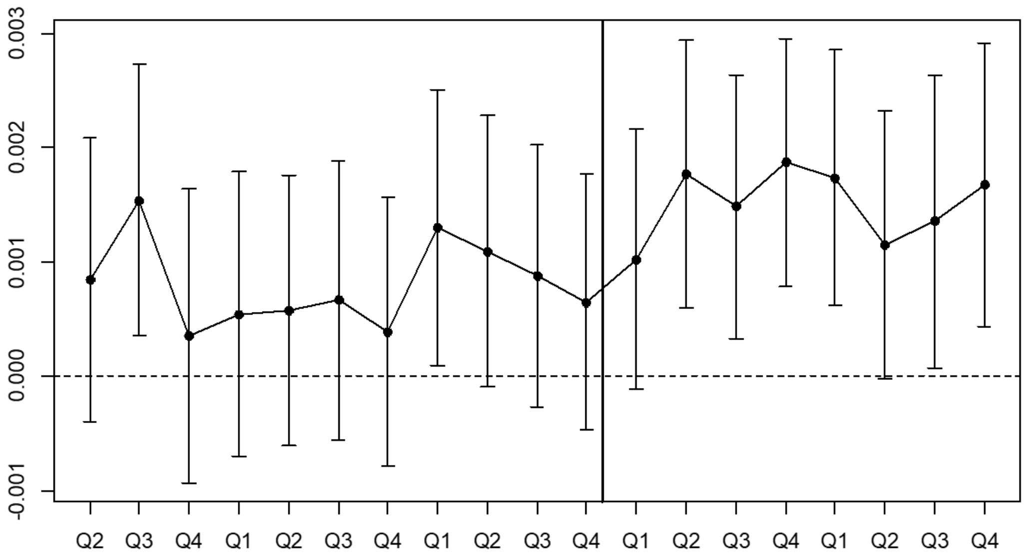


Table 3.5 - Column (1),
Changes in the effect of deviation value on rents of family-oriented apartments

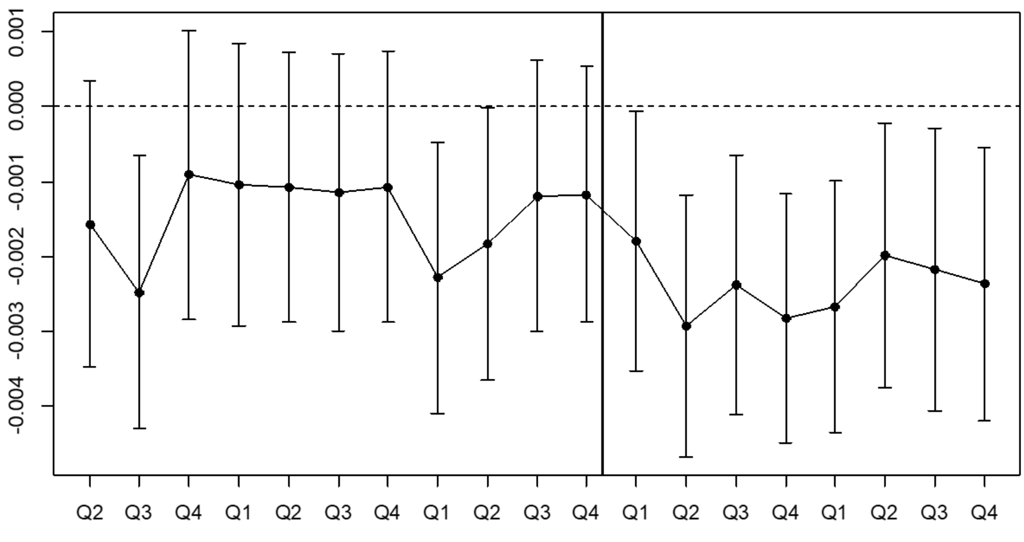


Table 3.5 - Column (2),
Changes in the effect of school rank on rents of family-oriented apartments

Figure 3.3 Changes in Effect Over Time

In summary, the main finding in this study showed that school quality indicators such as deviation value and school rank had a significantly positive effect on rents of family-oriented apartments after disclosure of school quality information. Even before disclosure, school quality might have had a positive effect on housing rents. In the following section, I also analyze information concerning the heterogeneity of properties and verify that the main results were certainly derived from disclosure of information on school quality.

3.5.2. Various concerns

3.5.2.1. Placebo test

To ensure that change in rents of apartments was caused from nothing else but disclosure of school quality information, I conducted a placebo test using rents of units other than family-oriented apartments. If events which could have affected housing rents occurred at the same time as disclosure, the rent of properties such as shops and offices or single-person apartments that would not have been affected intrinsically by school quality might also have been impacted. To address this concern, I obtained results using rental shops, offices, and single-person apartments by estimating the same equation used in the main estimation. Table 3.6 shows the results obtained using rental shops and offices, and these results suggest that all the main variables are statistically insignificant if controlling for various variables. Of course, I must note that the rental shops and offices were located mainly in commercial areas and the number of samples was smaller than that of the residential properties.

Therefore, I analyzed data using single-person apartments. These apartments are located widely in the city, and in my dataset, the number of samples was almost the same as that of family-oriented apartments (7,781 for families; 7,752 for singles). The results are shown in Table 3.7, and the basic specification was the same as the main estimation. Columns (1), (2), (6), and (7) show results not controlling for regional fixed effects and coefficients of interaction terms that were indicated consistently negative, although significances were low. However, the results after controlling for area fixed effects and urban/suburban trends are shown in columns (3), (4), (8), and (9). These results suggest that school quality has a significantly negative effect on housing rents after disclosure. However, controlling the northern/southern trends weakened the significance of coefficients of interaction terms, and in column (10), which shows the result obtained by using school rank, the coefficient of the interaction term was insignificant. Additionally, as a result of analyzing the changes of the effect over time using quarterly dummies, we could see that housing rents for single-person apartments tended to decrease in areas with high test scores even before disclosure. (The results are shown in Appendix 3.E.) In summary, the results in this section indicated that disclosure of school quality information had no significant effect on housing rents of single-person apartments, nor had any events occurred that affected the housing market at the same time as the disclosure.

As for what actually happens regarding single-person apartments, this can be inferred by considering the demanders of these units. University students can be cited as major users of single-person apartments in smaller cities in Japan. Shimane University, which has approximately 6,000 students, is located in Matsue City, and the residential area of the university's students overlaps with the attendance districts of two elementary schools which rank 1st and 2nd in test scores.[20] The number of enrolled students at Shimane University is decreasing every year, which may be one reason why rents of single-person apartments are decreasing in an area that has high-quality schools.[21] In fact, enrollments decreased by approximately 100 (from 1,602 to 1,507) between 2008 and 2016. Specifically, enrollments decreased by 43 (from 1,576 to 1,530) between 2013 and 2014 when housing rents of single-person apartments decreased significantly. Therefore, it seems that the downtrend of rents of single-person apartments might be due to the decreasing number of university students, and not the effect of disclosure.

[20] The definition of the residential area where the students of Shimane University live is based on the standards published by the Shimane University Cooperative.

[21] According to statistical information published by Matsue City, the populations of the "north" and "south" areas are almost the same (the north has 73,576 people, and the south has 72,595). However, the northern area where Shimane University is located has more than 800 people aged 18 to 22 than the southern area does. Therefore, the existence of Shimane University and the number of students can affect the housing market.

Table 3.6 Results using Shops and Offices

	(1)	(2)	(3)	(4)	(5)
Deviation value	-.0124	.-0216*			
	(.0094)	(.0085)			
After-disclosure dummy	.4320	.4751	.4888	.2837	.4013
	(.6519)	(.2917)	(.3919)	(.6089)	(.9596)
Deviation value × After-disclosure dummy	-.0076	.-0080*	-.0082	-.0047	.0063
	(.0099)	(.0038)	(.0055)	(.0086)	(.0139)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	474	455	448	429	414
Adjusted R2	0.8621	0.8785	0.8790	0.8811	0.8805

	(6)	(7)	(8)	(9)	(10)
School rank	.0169	.0390*			
	(.0181)	(.0169)			
After-disclosure dummy	-.1069*	-.0815	-.0810	-.0255	.0593
	(.0416)	(.1265)	(.1182)	(.0841)	(.0619)
School rank × After-disclosure dummy	.0022	.0115	-.0111	.0028	-.0126
	(.0062)	(.0061)	(.0082)	(.0139)	(.0202)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	474	455	448	429	414
Adjusted R2	0.8619	0.8781	0.8788	0.8810	0.8806

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Table 3.7 Results using Single-Person Apartments

	(1)	(2)	(3)	(4)	(5)
Deviation value	.0012***	.0011***			
	(.0002)	(.0002)			
After-disclosure dummy	.0629***	.0099	.0328*	.0364*	.0241
	(.0115)	(.0166)	(.0149)	(.0148)	(.0158)
Deviation value × After-disclosure dummy	-.0004	-.0004*	-.0007***	-.0008***	-.0006*
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7716	7697	7609	7590	7571
Adjusted R2	0.6161	0.6239	0.7537	0.7558	0.7560

	(6)	(7)	(8)	(9)	(10)
School rank	-.0020***	-.0020***			
	(.0003)	(.0003)			
After-disclosure dummy	.0377	-.0159	-.0126	-.0135	.0098
	(.0046)	(.0123)	(.0099)	(.0098)	(.0099)
School rank × After-disclosure dummy	.0003	.0003	.0007*	.0008**	.0004
	(.0003)	(.0003)	(.0003)	(.0003)	(.0003)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7716	7697	7609	7590	7571
Adjusted R2	0.6175	0.6255	0.7535	0.7556	0.7558

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

3.5.2.2. Estimation of divided samples

In this section, I analyzed data considering heterogeneity of effect regarding school quality and disclosure. The degree of effect of school quality might differ depending on house characteristics or location. As larger houses are better suited for families, people living in these dwellings are likely to have children and may be more concerned about school quality. Additionally, parents with higher education and income tend to live in larger houses, so rents of these units may be more affected by test scores. Furthermore, since the definition of an area suitable for occupation by a family (over 40 square meters) is arbitrary, I must also analyze data using occupied areas other than those meeting this definition. To address this concern, I estimated by dividing the sample according to occupied area.

Table 3.8 shows the result of estimation performed by dividing all the samples by every 10 square meters according to the occupied area. The upper part of the table shows the results obtained using deviation value, and the lower part shows the results obtained using school rank. Most of the intersection terms of interest were not significant, but the interaction terms in columns (3), (6), and (12) were significant. The result of column (3) suggests that rents of apartments of 30-40 square meters in size that were located in high-quality school districts decreased after disclosure of school quality information. However, as mentioned in the previous section, this result might be led by the effect of the decreasing number of university students, not disclosure. The results of columns (6) and (12) suggest that the rents of apartments of over 60 square meters in size that were located in high-quality school districts significantly increased after disclosure of school quality information. The results showed that the more housing units were intended to be lived in by families, the more they were affected by school quality. This tendency was consistent with the results of previous studies (Kuroda, 2018; Carrillo, Cellini, and Green, 2013). Additionally, this result also suggests that high income or highly educated parents that tend to live in larger apartments may care more about school quality.

The effect of school quality on housing rents might differ depending not only on the size of the apartment, but also on the area where the apartment is located. An apartment located in an area where there are many children may be more affected by test scores. Conversely, even apartments intended for families may not be affected by school quality if they are in areas with few children. Specifically, if disclosure of school quality information has a significant effect on housing rents even in areas with few children, this suggests the possibility that events affecting housing rents other than disclosure were occurring at the same time. To address this concern, I estimated by dividing the sample according to the number of children in each area.

Table 3.9 shows the result of estimation performed by dividing all samples according to the number of children in the area where each sample was located.[22][23] The upper part of the table shows the results obtained using deviation value, and the lower part shows the results obtained using school rank. Additionally, the results of the estimation obtained by using samples located in areas with a relatively high number of children are shown in columns on the table's left side. Conversely, the columns on the table's right side show the results of analysis performed using apartments located in areas with relatively few children. Columns (1) and (7) show the results estimated using apartments in areas where there were over 100 children, indicating that school quality significantly increased housing rents after disclosure. Columns (2) and (8) show the results estimated using apartments in areas where there were over 150 children, which indicated almost the same result as shown in columns (1) and (7). Columns (3) and (9) show the results obtained using apartments located in areas which had over 200 children, and these results also indicated that housing rents increased in high-quality school areas after disclosure, but the coefficients of the interaction terms became three times larger. This indicated that the apartments located in areas with especially high numbers of children were more affected by school quality after disclosure. These results might be derived from the large ratio of families with children in the total demanders of larger apartments. However, the results of using apartments located in areas with few children are shown in Columns (4)-(6) and (10)-(12), and all coefficients were not significant. This indicates that even family-oriented apartments are not affected by school quality in areas with relatively few children. The results in Table 3.9 were consistent with the results and discussions presented so far and emphasized that school quality information and its disclosure were certainly affecting families and children. Additionally, the results of this section suggest that the degree of effect of school quality is different depending on house characteristics and location.

[22] In this analysis, people under 12 years old were defined as "children."

[23] I also analyzed data by dividing all samples according to the child population density in the area where each sample was located; however, the results were almost the same as those obtained using the number of children in the area. The results are shown in Appendix 3.F.

Table 3.8 Sample Divided According to Occupied Area

	under 20	20 to 30	30 to 40	40 to 50	50 to 60	over 60
	(1)	(2)	(3)	(4)	(5)	(6)
After-disclosure dummy	.0589	-.0208	.0799**	.0130	-.0111	-.0469**
	(.0547)	(.0150)	(.0275)	(.0145)	(.0143)	(.0151)
Deviation value × After-disclosure dummy	-.0006	.0003	.-0009*	.0000	.0002	.0009***
	(.0009)	(.0002)	(.0004)	(.0003)	(.0002)	(.0003)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	918	5159	1263	2898	2586	1728
Adjusted R2	0.9271	0.7871	0.8446	0.7385	0.5722	0.9132

	under 20	20 to 30	30 to 40	40 to 50	50 to 60	over 60
	(7)	(8)	(9)	(10)	(11)	(12)
After-disclosure dummy	.0209	-.0008	.0210	.0100	.0052	.0155
	(.0244)	(.0097)	(.0115)	(.0092)	(.0095)	(.0098)
School rank × After-disclosure dummy	.0003	-.0005	.0007	.0001	-.0005	-.0012***
	(.0014)	(.0003)	(.0006)	(.0003)	(.0003)	(.0003)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	918	5159	1263	2898	2586	1728
Adjusted R2	0.9271	0.7872	0.8441	0.7385	0.5722	0.9132

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Table 3.9 Sample Divided According to the Number of Children in an Area

	over 100	over 150	over 200	under 100	under 150	under 200
	(1)	(2)	(3)	(4)	(5)	(6)
After-disclosure dummy	-.0291**	-.0295**	-.0898***	-.0362	-.0199	-.0102
	(.0106)	(.0114)	(.0162)	(.0254)	(.0180)	(.0141)
Deviation value × After-disclosure dummy	.0006**	.0006**	.0019***	.0008	.0005	.0003
	(.0002)	(.0002)	(.0003)	(.0005)	(.0003)	(.0002)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	6265	5394	4325	1128	2000	3068
Adjusted R2	0.7657	0.7294	0.7135	0.8900	0.8620	0.8612

	over 100	over 150	over 200	under100	under 150	under 200
	(7)	(8)	(9)	(10)	(11)	(12)
After-disclosure dummy	.0135*	.0119	.0375***	.0121	.0135	.0120
	(.0068)	(.0073)	(.0092)	(.0171)	(.0113)	(.0085)
School rank × After-disclosure dummy	-.0010***	-.0008**	-.0024***	-.0008	-.0008	-.0006
	(.0002)	(.0003)	(.0004)	(.0006)	(.0004)	(.0003)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	6265	5394	4325	1128	2000	3068
Adjusted R2	0.7658	0.7293	0.7133	0.8899	0.8620	0.8613

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

3.5.2.3. Considering the effect of the number of posted apartments

In this study, all the analysis employing property data used data that was posted on websites, which meant they did not indicate actual transactions. Therefore, during the analysis period, if many cheap apartments were posted at once in a specific area, it might seem as though housing rents had decreased in that area. Conversely, if a luxury condominium was built and many rooms were sold at the same time, it would seem as though housing rents had increased in the area. Thus, if the number of posted apartments in areas was biased, the result might also be biased.

To address this concern, I created panel data of the number of posted family-oriented apartments in each month and each area, and then estimated the effect of school quality and its disclosure on the number of samples in each month and each area. The results are shown in Table 3.10, and when controlling for several variables, all the coefficients of main variables were not significant. This result suggests that there is no significant relationship between disclosure of school quality information and the number of posted apartments and confirms that the main results of this study did not derive from the number of samples in a specific area.

Additionally, I performed an estimation using the intersection terms of each quarter dummy and school quality indicator to analyze the changes in effect of school quality on the number of apartments over time, and the results are shown in Table 3.11 and Figure 3.4.[24] In Figure 3.4, the horizontal axis represents time, the vertical axis represents the coefficient, the black dot represents the coefficients of interaction terms of each quarter dummy and school quality indicator, and each width represents a 95% confidence interval. This result shows that almost all the coefficients were insignificant and there was no specific trend during the analysis period. Additionally, there was no particular change observed before or after disclosure. Therefore, we confirmed that many apartments were not posted in areas with high-quality schools, and that the main results were obtained from the change in housing rents, not the number of posted samples.

[24] I conducted the same analysis using single-person apartments, and the results are shown in Appendix 3.G. As a result, there was no significant relationship between school quality and the number of posted single-person apartments, and no specific trends through time were observed.

Table 3.10 Number of Family-Oriented Apartments

	(1)	(2)	(3)	(4)	(5)
Deviation value	-.0309***	-.0309***			
	(.0038)	(.0038)			
After-disclosure dummy	.1880	.1607	.1607	.0332	-.0869
	(.3955)	(.6029)	(.2262)	(.2263)	(.2300)
Deviation value × After-disclosure dummy	-.0028	-.0028	-.0028	-.0005	.0018
	(.0061)	(.0062)	(.0029)	(.0029)	(.0030)
Control variables					
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	6836	6817	6705	6686	6667
Adjusted R2	0.0095	0.0102	0.8569	0.8577	0.8585

	(6)	(7)	(8)	(9)	(10)
School rank	.0521***	.0521***			
	(.0062)	(.0062)			
After-disclosure dummy	-.0205	-.0479	-.0479	-.0146	-.0172
	(.0635)	(.4365)	(.1493)	(.1488)	(.1480)
School rank × After-disclosure dummy	.0054	.0054	.0054	.0022	.0008
	(.0100)	(.0100)	(.0042)	(.0042)	(.0043)
Control variables					
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	6836	6817	6705	6686	6667
Adjusted R2	0.0146	0.0152	0.8569	0.8577	0.8585

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the school district level.

Table 3.11 Changes in Effect Over Time (Number of Samples)

	Deviation value	School rank
	(1)	(2)
Deviation value / School rank		
×2012 Q2	.0112	-.0141
	(.0078)	(.0118)
×2012 Q3	.0149	-.0212
	(.0082)	(.0125)
×2012 Q4	.0219*	-.0273*
	(.0089)	(.0131)
×2013 Q1	.0232**	.0306*
	(.0083)	(.0124)
×2013 Q2	-.0098	.0187
	(.0091)	(.0135)
×2013 Q3	.0045	-.0033
	(.0085)	(.0125)
×2013 Q4	.0008	-.0013
	(.0081)	(.0119)
×2014 Q1	-.0045	.0076
	(.0087)	(.0130)
×2014 Q2	-.0041	.0097
	(.0079)	(.0114)
×2014 Q3	.0135	-.0212
	(.0099)	(.0141)
×2014 Q4 (disclosure)	.0049	-.0013
	(.0088)	(.0126)
×2015 Q1	.0012	.0001
	(.0074)	(.0108)
×2015 Q2	-.0003	.0076
	(.0098)	(.0145)
×2015 Q3	-.0002	-.0011
	(.0105)	(.0156)
×2015 Q4	.0089	-.0114
	(.0090)	(.0134)
×2016 Q1	.0093	-.0110
	(.0087)	(.0131)
×2016 Q2	.0194*	.0226*
	(.0076)	(.0111)
×2016 Q3	.0226**	-.0256*
	(.0083)	(.0120)
×2016 Q4	.0074	-.0072
	(.0081)	(.0118)
N	6650	6650
Adjusted R2	0.8588	0.8589

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.
※Standard errors are adjusted for clustering at the school district level.
※All control variables (time fixed effects, area fixed effects, urban/suburban trends, and north/south trends) were controlled.

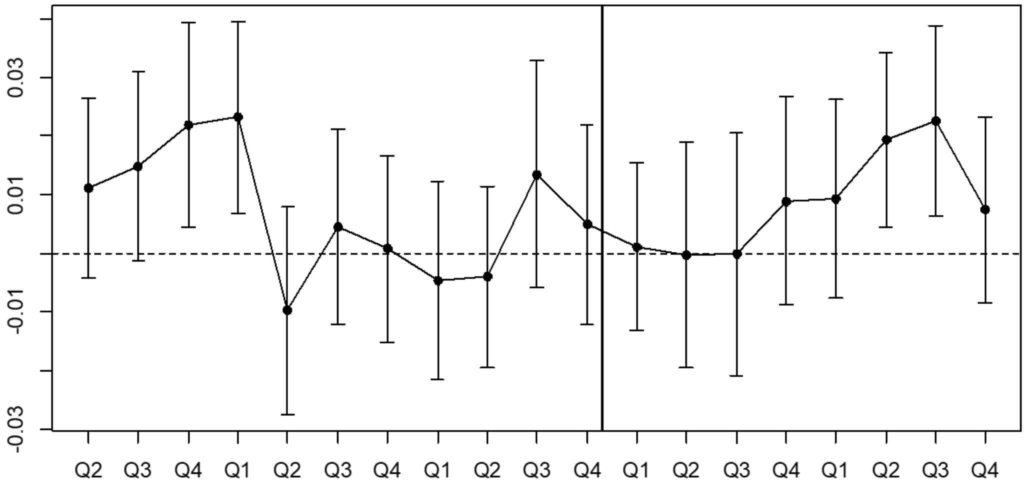


Table 3.11 - column (1),
Changes in the effect of deviation value on the number of family-oriented properties

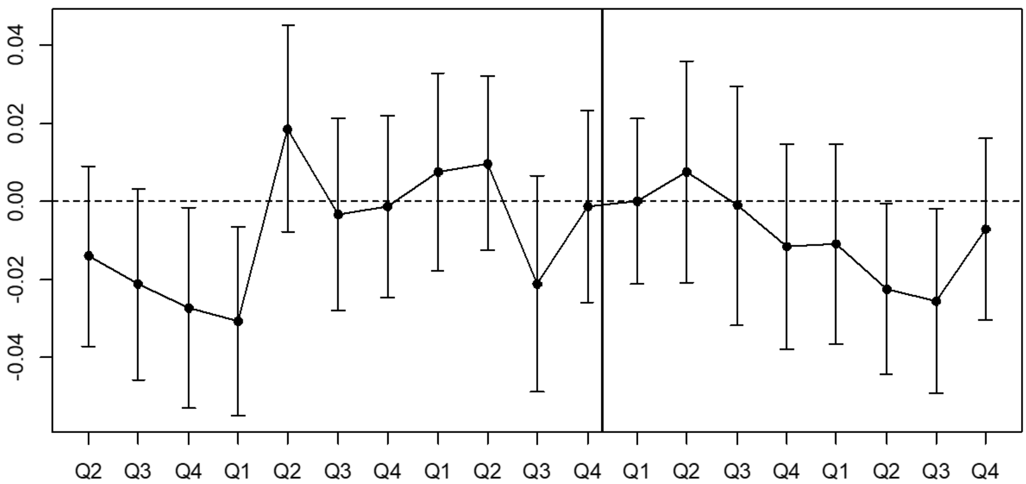


Table 3.11 - column (2),
Changes in the effect of school rank on the number of family-oriented properties

Figure 3.4 Changes in Effect Over Time (Number of Samples)

3.5.3. Results for enrollment and population

So far, it has been shown that rents of family-oriented apartments increased after disclosure of school quality information. However, as pointed out in previous studies, we should consider whether the changes in housing rents actually reflect parents' willingness to pay for their children's education, or whether they were simply caused from advertisement behavior of real estate agents (Carrillo, Cellini, and Green 2013; Haisken-DeNew et.al, 2018). If population did not change despite the number of housing rents increasing in areas with high-quality schools after disclosure, this might only indicate that real estate agencies advertised high-quality schools and set high rental prices. However, if the number of children increased in high-quality school districts after disclosure, this could suggest that not only real estate agencies' but also parents' behavior was changed by the disclosure. Therefore, in this section, I discuss the results focusing on school and residential choice behavior of parents and children. Here, I analyze changes in the number of enrolled students at each school and the population in each area. Analysis using the number of enrolled students can more accurately capture the change in parental behavior caused by disclosure; however, a problem exists in that the sample is very small because it is based on yearly data. Therefore, I conducted a more detailed analysis by using data that included population by each age in each area.

Parents have incentives to send their children to better schools, so disclosure of school quality information may increase the number of students enrolled in high-quality schools (Hastings and Weinstein, 2008; Koning and van der Wiel, 2013; Nunes, Reis, and Seabra, 2015). To confirm this effect, I will discuss the results of analyzing the effect of school quality information and its disclosure on the number of enrolled students, using the data of elementary school entrants. Table 3.12 shows the results, with the upper part of the table representing the results obtained using deviation value and the lower part representing the results obtained using school rank. Additionally, the table's left half shows the results obtained using data from 2012 to 2016, and the right half shows the results obtained using data from 2011 to 2018. These results indicate that regardless of which control variables were used, disclosure of school quality information would not significantly affect the number of enrolled students. Although this effect was not statistically significant, the disclosure of school quality tended to have a consistently positive effect on the number of enrolled students. In this analysis, even if the analysis period was expanded, we had to consider that the sample size was still small. Therefore, to address this concern, I analyzed the effect of school quality and its disclosure on the population of each area by age.

Columns (1) and (6) of Table 3.13 show the results estimated by using the population of children who were seven years old for each month in each area as explained variables. In Japan, since children entering elementary school must be seven years of age, the population of seven-year-olds represents the number of first-year elementary students in that area (i.e., the number of enrolled students). According to the results of columns (1) and (6), the number of first graders in elementary school has increased significantly in areas with high-quality schools after disclosure of information. Considering the error range of one year which was caused due to variations in school year and birthdays, columns (3) and (8) show the results using the total population of six- to eight-year-old children instead of only seven-year-olds, and the interaction terms indicated a significantly positive result similar to those shown in columns (1) and (6). Additionally, to address the concern that not only the first-grade but also the entire population was fluctuating, I conducted an analysis using the three- to five-year-old population and the nine- to eleven-year-old population for comparison. According to the results of columns (2) and (7), the number of kindergarten children might increase in areas with high-quality primary schools after disclosure, but the effect was not significant. Columns (4) and (8) show the results obtained using nine- to eleven-year-old students who had selected elementary schools before disclosure, and there was no significant relationship between the number of children and school quality after disclosure. This suggests reasonable results indicating that change in population can be seen only when residential choice is timed according to elementary school entry, when it is easy to move. Furthermore, columns (5) and (10) show the results of using a population aged 18 to 22, which is the age of university students. The coefficients of the interaction terms were negative and significant, which was consistent with the information indicating that the number of enrolled students at the university was decreasing, which I mentioned in the above section. Additionally, the decrease of the population of university-aged students was considered to be one reason for the declining trends of rentals of single-person apartments in high-quality school areas.[25]

[25] I also analyzed information regarding the ages of the parent generation, but consistent results were not obtained. Unlike young students, adults have various socioeconomic characteristics, so it is difficult to capture specific effects.

Table 3.12 Number of Enrolled Students

	2012 ~ 2016			2011 ~ 2018		
	(1)	(2)	(3)	(4)	(5)	(6)
Deviation value × After-disclosure dummy	.1330	.1699	.1522	.1940	.2176	.1738
	(.2331)	(.2345)	(.2342)	(.2005)	(.2033)	(.1961)
Control variables						
School fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends		YES	YES		YES	YES
North/south trends			YES			YES
N	75	71	67	132	125	118
Adjusted R2	0.9529	0.9533	0.9539	0.9441	0.9436	0.9481

	2012 ~ 2016			2011 ~ 2018		
	(7)	(8)	(9)	(10)	(11)	(12)
School rank × After-disclosure dummy	-.0516	-.0938	-.0850	-.0686	-.0944	-.0748
	(.1720)	(.1751)	(.1742)	(.1481)	(.1521)	(.1459)
Control variables						
School fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends		YES	YES		YES	YES
North/south trends			YES			YES
N	75	71	67	132	125	118
Adjusted R2	0.9528	0.9531	0.9538	0.9438	0.9433	0.9479

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

Table 3.13 Population in Area by Age

	7 years old	3-5 years old	6-8 years old	9-11 years old	18-22 years old
	(1)	(2)	(3)	(4)	(5)
After-disclosure dummy	-1.461**	-.7565	-2.144**	.7573	4.136***
	(.0106)	(.6445)	(.6685)	(.6011)	(.8005)
Deviation value × After-disclosure dummy	.0307***	.0140	.0407***	-.0159	-.0791***
	(.0062)	(.0096)	(.0097)	(.0102)	(.0131)
Control variables					
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES
N	7373	7373	7373	7373	7373
Adjusted R2	0.9856	0.9856	0.9832	0.9800	0.9895

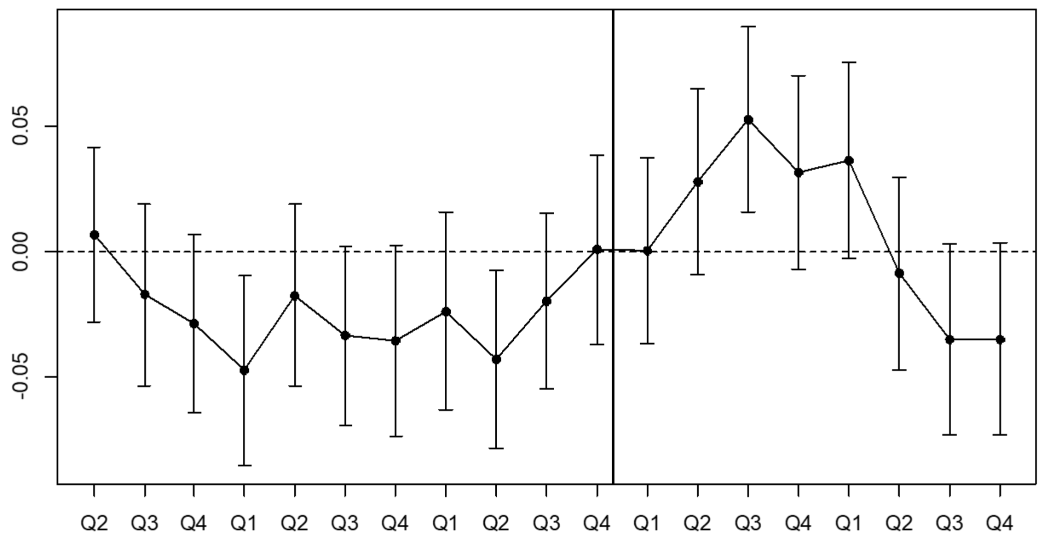
	7 years old	3-5 years old	6-8 years old	9-11 years old	18-22 years old
	(6)	(7)	(8)	(9)	(10)
After-disclosure dummy	.6118	.1268	.5585	-.2204	-1.046*
	(.3285)	(.3912)	(.3259)	(.3231)	(.4353)
School rank × After-disclosure dummy	-.0336***	-.0107	-.0411***	.1042	.0751***
	(.0070)	(.0108)	(.0108)	(.0116)	(.0148)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES
N	7373	7373	7373	7373	7373
Adjusted R2	0.9377	0.9856	0.9832	0.9800	0.9895

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

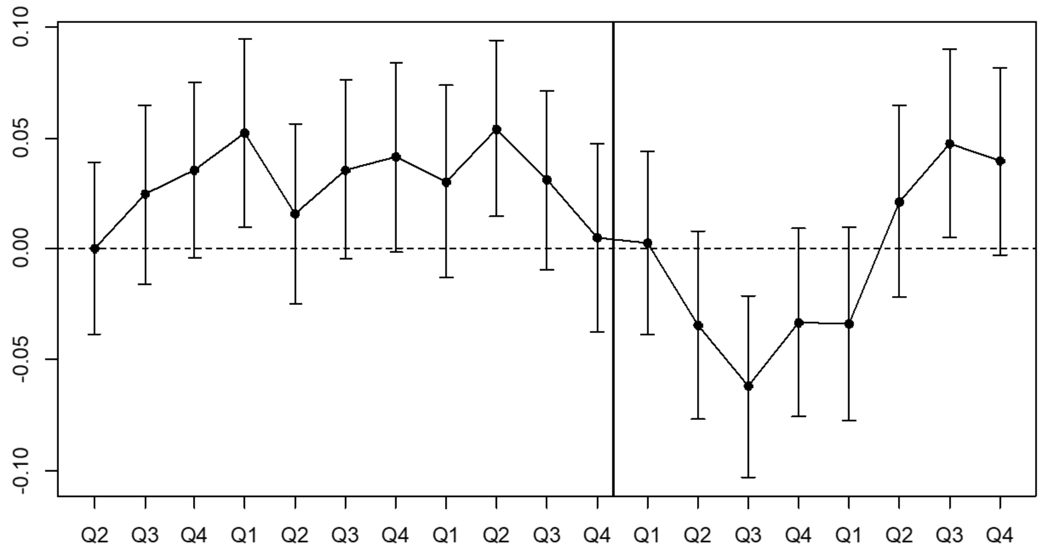
※Standard errors are adjusted for clustering at the area level.

Figure 3.5 shows the results using the seven-year-old population of each month in each area as an independent variable and using the intersection terms of the quarterly dummies and the school quality indicators. This result showed that there was no significant difference in the seven-year-old population between high-quality and low-quality school areas before disclosure, but the seven-year-old population was increasing significantly after disclosure. Furthermore, its impact was large for one year after disclosure, which was similar to the effect on housing rents (see Figure 3.3).

In summary, the population of first graders of elementary schools in areas with high-quality schools increased after disclosure of information on school quality. This suggests that parents with children chose their residential area by referring to recently disclosed school quality information.



Number of seven-year-old children, Deviation Value



Number of seven-year-old children, School Rank

Figure 3.5 Changes in Effect Over Time (Seven-Year-Old Children)

3.5.4. Disparity in academic achievement

Finally, I confirmed whether disparity of academic achievement among schools had increased as a result of disclosure of school quality information. Through disclosure of this information, parents will be able to choose good schools, and housing rents in areas with good school quality will increase. Therefore, parents with more willingness to pay for their children's education will be able to send their children to better schools. Additionally, such parents tend to have high educational backgrounds and income, or enthusiasm for their children, so the academic ability of their children also tends to be higher. Therefore, good (bad) students tend to gather at good (bad) schools, and the sorting of students may occur due to disclosure. As a result, good schools will be better, bad schools will be worse, and disparity in academic performance between schools can expand.

Table 3.14 shows the results of average test scores and indicators of disparity by school from 2014 to 2017.[26] The test in 2014 was administered before disclosure, and the tests after 2015 were conducted subsequent to disclosure. This table shows that the relative standard deviation was 0.048 before disclosure, but it increased consistently to about 0.06 after disclosure. Additionally, we can see that the difference between better and worse schools has also expanded after disclosure of school quality information. These results suggest that disparity between schools may be expanding through the sorting of students due to disclosure of information on school quality.

Although it has been confirmed that disparity has expanded, we must compare the results with other municipalities in which information on school quality has not been disclosed and confirm that the expansion is caused from disclosure. However, because the data of other municipalities regarding school quality information have not been disclosed and cannot be used, this point indicates a limitation of this study.

Additionally, it is also important to analyze the performance of students enrolled after disclosure. If high-quality schools gather high-quality students due to disclosure of school quality information, it might cause a widening of disparities. Such data will be available in a few years, so this is a task for future research.

[26] Regarding examination in 2017, fourth graders were not administered the exam because of the change of the institution, and the results show the average test scores of fifth and six graders. All the test scores before 2016 show the average of fourth, fifth, and sixth grade students.

Table 3.14 Disparity in Academic Achievement

	Before disclosure	After disclosure		
	2014	2015	2016	(2017)
Mean	66.613	61.324	64.604	63.247
Standard deviation	3.202	3.914	4.027	3.839
Relative standard deviation	0.048	0.064	0.062	0.061
Max	72.750	71.850	70.663	70.833
Min	59.525	52.850	55.150	56.000
(Max - Min) / Mean	0.199	0.310	0.240	0.235
Average of upper half	69.102	64.431	67.957	66.244
Average of lower half	63.957	58.217	61.252	60.036
(Avg. of upper half - Avg. of lower half) / Mean	0.077	0.101	0.104	0.098
Average of top 5	71.430	66.943	69.590	68.433
Average of bottom 5	61.618	55.608	57.580	57.467
(Avg. of top 5 - Avg. of bottom 5) / Mean	0.147	0.185	0.186	0.173

3.6. Conclusion

This study investigated the effect of disclosure of school quality information on housing rents, population by age, and disparity in the academic ability of students between schools. I found that school quality indicators such as deviation value and school rank had a significantly positive effect on rents of family-oriented apartments after disclosure of school quality information. Additionally, the more that units were intended to be lived in by families, the more they were affected by school quality. However, even if an apartment was family-oriented, it was not affected by school quality in areas with relatively few children. These results were consistent with results obtained from previous studies.

I also found that disclosure significantly increased the population of elementary school-aged children within the attendance district of schools with high test scores. This suggests that parents with children chose their residential area by referring to the school quality information that had just been disclosed. As in the case of rent, although the significance was high, the impact is not. This might be because a minority of parents are very concerned about school quality, but the majority do not care about it. In this study, I could not identify whether parents were directly affected by the disclosure of school quality information or indirectly affected by the advertisement of real estate agencies. Even if this result might be caused from real estate agency advertisements, as noted in previous studies, it is still important to identify if parents are actually moving since there is a possibility that sorting of students may occur by the gathering of people in high-quality school districts. Whether sorting has occurred can also be observed by examining changes in academic performance by school.

Finally, I found that the relative standard deviation of test scores after disclosure became larger than before disclosure. These results suggest that disparity between schools may be expanding due to disclosure, and this may have been caused by the sorting of students. Specifically, this result may suggest that children with high abilities who have parents with more willingness to pay for their education are gathered at high-quality schools as a result of disclosure of school quality information.

To summarize the results in this study, the following findings were obtained. Due to disclosure of school quality information, rents of apartments located in high-quality school districts increased. At the same time, the number of elementary school first graders increased in high-quality school districts. As a result, student sorting appeared to occur, and therefore disparity of academic achievement between schools increased. In conclusion, through disclosure of school quality information, it is suggested that disparity of academic achievement between schools may increase through changes in the property market and residential choice.

However, I have concern that the analysis in disparity is simply a comparison between data before and after disclosure, and it is not possible to mention causality. Therefore, I must compare the results with other municipalities that have not been discussed and confirm that the expansion is caused from disclosure. Additionally, from the point of view concerning disparity among schools, I must investigate whether high-quality schools accumulate high-quality students after disclosure of school quality information using future data.

Appendix 3.A Summary Statistics (Single-Person Apartment, Rental Shop/Office)

	Single-person apartment				Rental shop and office			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
House characteristics								
Housing rent (YEN)	43374	6605	15000	66100	144164	111968	25000	486000
After-disclosure dummy	0.412	0.492	0	1	0.310	0.463	0	1
Elapsed days after disclosure	161.400	239.370	0	800	120.000	222.884	0	798
Number of floors	2.475	1.090	1	10	5.938	3.520	1	12
Located floor	2.000	0.934	1	9	3.254	2.773	1	10
Occupied area	25.090	4.868	11	39.750	101.570	58.033	19.15	311.970
Age of building	13.170	8.991	0	69	28.170	5.827	9	48
Rental apart dummy	0.796	0.403	0	1	NA			
Rental town house dummy	NA				NA			
Rental mansion dummy	0.204	0.403	0	1	NA			
Structure ALC dummy	0.003	0.053	0	1	NA			
Structure PC dummy	NA				NA			
Structure RC dummy	0.121	0.326	0	1	0.156	0.363	0	1
Structure SRC dummy	NA				0.402	0.491	0	1
Structure block dummy	NA				NA			
Structure light steel dummy	0.158	0.364	0	1	NA			
Structure steel dummy	0.191	0.393	0	1	0.318	0.466	0	1
Structure wooden dummy	0.527	0.499	0	1	0.124	0.330	0	1
N	7752				532			

Appendix 3.B Results Using All Apartments (Deviation Value)

	(1)	(2)	(3)	(4)	(5)
Deviation value	.0015***	.0014***			
	(.0001)	(.0001)			
After-disclosure dummy	-.0275***	-.0470***	-.0037	-.0041	.0063
	(.0080)	(.0106)	(.0097)	(.0095)	(.0100)
Deviation value × After-disclosure dummy	.0008***	.0008***	.0001	.0001	-.0001
	(.0002)	(.0002)	(.0001)	(.0001)	(.0002)
House characteristics					
Mansion dummy	.0228***	.0234***	.0327***	.0322***	.0315***
	(.0032)	(.0032)	(.0033)	(.0033)	(.0033)
Number of floors	.0141***	.0138***	.0078***	.0083***	.0083***
	(.0016)	(.0016)	(.0020)	(.0020)	(.0020)
Located floor	.0022	.0022	.0017	.0018	.0017
	(.0012)	(.0012)	(.0011)	(.0011)	(.0011)
Structure ALC dummy	-.1408***	-.1347***	-.1363***	-.1364***	-.1380***
	(.0196)	(.0191)	(.0213)	(.0213)	(.0216)
Structure PC dummy	.1089***	.1079***	.1149***	.1148***	.1153***
	(.0091)	(.0101)	(.0064)	(.0065)	(.0065)
Structure RC dummy	.0136**	.0145**	.0072*	.0070	.0073
	(.0045)	(.0045)	(.0043)	(.0043)	(.0043)
Structure SRC dummy	-.1125***	-.1121***	.0274***	.0273	.0173
	(.0169)	(.0164)	(.0128)	(.0130)	(.0132)
Structure light steel dummy	.0402***	.0416***	.0342***	.0345***	.0350***
	(.0024)	(.0024)	(.0028)	(.0028)	(.0028)
Structure steel dummy	-.0111***	-.0107***	-.0137***	-.0139***	-.0137***
	(.0023)	(.0023)	(.0025)	(.0025)	(.0025)
Occupied area	.0208***	.0208***	.0238***	.0237***	.0238***
	(.0005)	(.0005)	(.0005)	(.0005)	(.0005)
Occupied area squared	-.0001***	-.0001***	-.0001***	-.0001***	-.0001***
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Age of building	-.0121***	-.0121***	-.0119***	-.0120***	-.0121***
	(.0004)	(.0004)	(.0004)	(.0004)	(.0004)
Natural log of age of building	.0347***	.0354***	.0362***	.0369***	.0380***
	(.0041)	(.0042)	(.0044)	(.0044)	(.0044)
Area characteristics					
Number of households	.0003***	.0003***	-.0004***	-.0003***	-.0003***
	(.0000)	(.0000)	(.0001)	(.0001)	(.0001)
Population	-.0002***	-.0002***	.0001*	.0001*	.0001
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Average household size	.0216***	.0228***	-.0691**	-.0620**	-.0546*
	(.0060)	(.0061)	(.0216)	(.0219)	(.0214)
Number of children	.0004***	.0004***	-.0001	-.0001	-.0001
	(.0000)	(.0000)	(.0000)	(.0000)	(.0001)
Number of elementary students	-.0001***	-.0001***	-.0001***	-.0001***	-.0001***
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Average age	.0025***	.0026***	-.0063***	-.0061***	-.0059***
	(.0003)	(.0003)	(.0016)	(.0016)	(.0016)
Number of samples (family)	.0003*	.0003**	-.0004*	-.0004*	-.0005**
	(.0001)	(.0001)	(.0002)	(.0002)	(.0002)
Number of samples (single)	.0005***	.0008***	-.0001	-.0001	-.0001
	(.0001)	(.0001)	(.0002)	(.0002)	(.0002)
Urban dummy	.0633***	.0628***			
	(.0047)	(.0047)			
North dummy	-.0318***	-.0304***			
	(.0027)	(.0027)			
Control variables					
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	15357	15338	15228	15209	15190
Adjusted R2	0.7993	0.8003	0.8527	0.8529	0.8532

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.
※Standard errors are adjusted for clustering at the area level.

Appendix 3.C Results Using All Apartments (School Rank)

	(1)	(2)	(3)	(4)	(5)
School rank	-.0021***	-.0021***			
	(.0002)	(.0002)			
After-disclosure dummy	.0322***	.0110	.0045	.0044	.0014
	(.0033)	(.0077)	(.0067)	(.0067)	(.0067)
School rank × After-disclosure dummy	-.0015***	-.0014***	-.0003	-.0003	-.0001
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
House characteristics					
Mansion dummy	.0217***	.0223***	.0328***	.0322***	.0316***
	(.0032)	(.0032)	(.0033)	(.0033)	(.0033)
Number of floors	.0141***	.0139***	.0078***	.0083***	.0084***
	(.0016)	(.0016)	(.0020)	(.0020)	(.0020)
Located floor	.0023	.0023	.0017	.0018	.0017
	(.0012)	(.0012)	(.0011)	(.0011)	(.0011)
Structure ALC dummy	-.1419***	-.1357***	-.1362***	-.1363***	-.1375***
	(.0198)	(.0193)	(.0213)	(.0212)	(.0216)
Structure PC dummy	.1098***	.1088***	.1150***	.1149***	.1153***
	(.0092)	(.0102)	(.0065)	(.0065)	(.0065)
Structure RC dummy	.0155**	.0165**	.0072	.0070	.0073
	(.0046)	(.0045)	(.0043)	(.0043)	(.0043)
Structure SRC dummy	-.1111***	-.1106***	.0270*	.0239	.0169
	(.0170)	(.0164)	(.0128)	(.0130)	(.0131)
Structure light steel dummy	.0408***	.0421***	.0342***	.0346***	.0351***
	(.0024)	(.0024)	(.0028)	(.0028)	(.0028)
Structure steel dummy	-.0099***	-.0095***	-.0137***	-.0139***	-.0137***
	(.0023)	(.0023)	(.0025)	(.0025)	(.0025)
Occupied area	.0209***	.0208***	.0238***	.0237***	.0237***
	(.0004)	(.0004)	(.0005)	(.0005)	(.0005)
Occupied area squared	-.0001***	-.0001***	-.0001***	-.0001***	-.0001***
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Age of building	-.0121***	-.0122***	-.0120***	-.0120***	-.0121***
	(.0004)	(.0004)	(.0004)	(.0004)	(.0004)
Natural log of age of building	.0342***	.0349***	.0363***	.0370***	.0380***
	(.0041)	(.0042)	(.0044)	(.0044)	(.0044)
Area characteristics					
Number of households	.0004***	.0004***	-.0003***	-.0003***	-.0003***
	(.0000)	(.0000)	(.0001)	(.0001)	(.0001)
Population	-.0002***	-.0002***	.0001*	.0001*	.0001
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Average household size	.0177**	.0187**	-.0712***	-.0640**	-.0584**
	(.0060)	(.0061)	(.0216)	(.0218)	(.0215)
Number of children	.0004***	.0004***	-.0001	-.0001	-.0001
	(.0000)	(.0000)	(.0000)	(.0000)	(.0001)
Number of elementary students	-.0001***	-.0001***	-.0001***	-.0001***	-.0001***
	(.0000)	(.0000)	(.0000)	(.0000)	(.0000)
Average age	.0023***	.0024***	-.0063***	-.0061***	-.0058***
	(.0003)	(.0003)	(.0016)	(.0016)	(.0016)
Number of samples (family)	.0003**	.0004**	-.0004*	-.0004*	-.0005**
	(.0001)	(.0001)	(.0002)	(.0002)	(.0002)
Number of samples (single)	.0005***	.0008***	-.0001	-.0000	-.0001
	(.0001)	(.0001)	(.0002)	(.0002)	(.0002)
Urban dummy	.0659***	.0655***			
	(.0047)	(.0047)			
North dummy	-.0326***	-.0312***			
	(.0027)	(.0027)			
Control variables					
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	15357	15338	15228	15209	15190
Adjusted R2	0.8002	0.8013	0.8528	0.8529	0.8532

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.
※Standard errors are adjusted for clustering at the area level.

Appendix 3.D Results Using Housing Rents per Square Meter

	(1)	(2)	(3)	(4)	(5)
Deviation value	.0026***	.0026***			
	(.0001)	(.0001)			
After-disclosure dummy	-.0717***	-.0647***	-.0279**	-.0354***	-.0245**
	(.0086)	(.0105)	(.0088)	(.0093)	(.0090)
Deviation value × After-disclosure dummy	.0012***	.0012***	.0005***	.0007***	.0005**
	(.0002)	(.0002)	(.0001)	(.0002)	(.0002)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6556	0.6586	0.7700	0.7730	0.7742

	(6)	(7)	(8)	(9)	(10)
School rank	.-0033***	.-0033***			
	(.0002)	(.0002)			
After-disclosure dummy	.0092*	.0185*	.0101	.0142*	.0092
	(.0039)	(.0076)	(.0059)	(.0059)	(.0059)
School rank × After-disclosure dummy	-.0018***	-.0018***	-.0008***	-.0010***	-.0007***
	(.0002)	(.0002)	(.0002)	(.0002)	(.0002)
Control variables					
House characteristics	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES
Time fixed effects		YES	YES	YES	YES
Area fixed effects			YES	YES	YES
Urban/suburban trends				YES	YES
North/south trends					YES
N	7617	7598	7513	7494	7475
Adjusted R2	0.6539	0.6572	0.7701	0.7730	0.7742

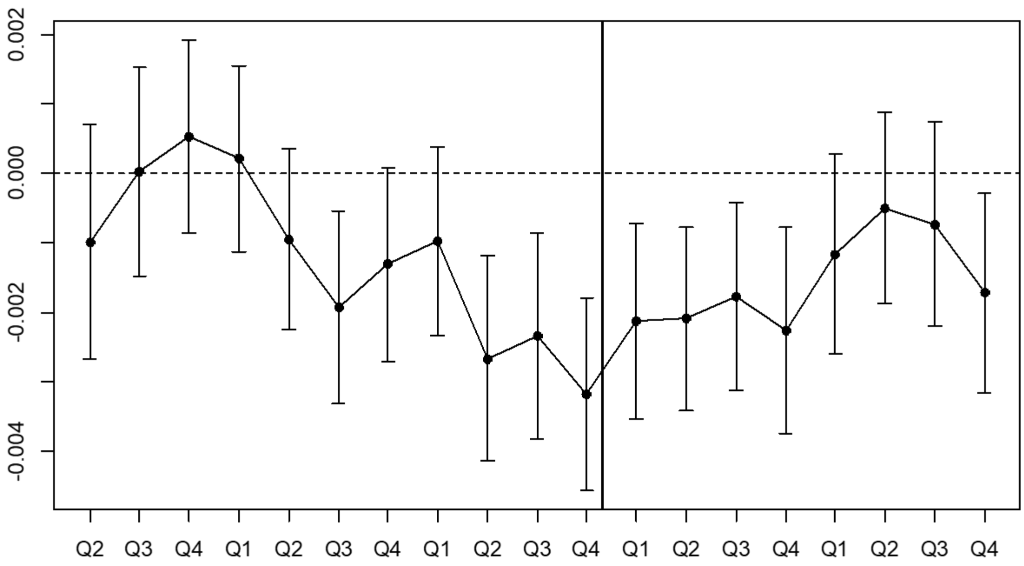
※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

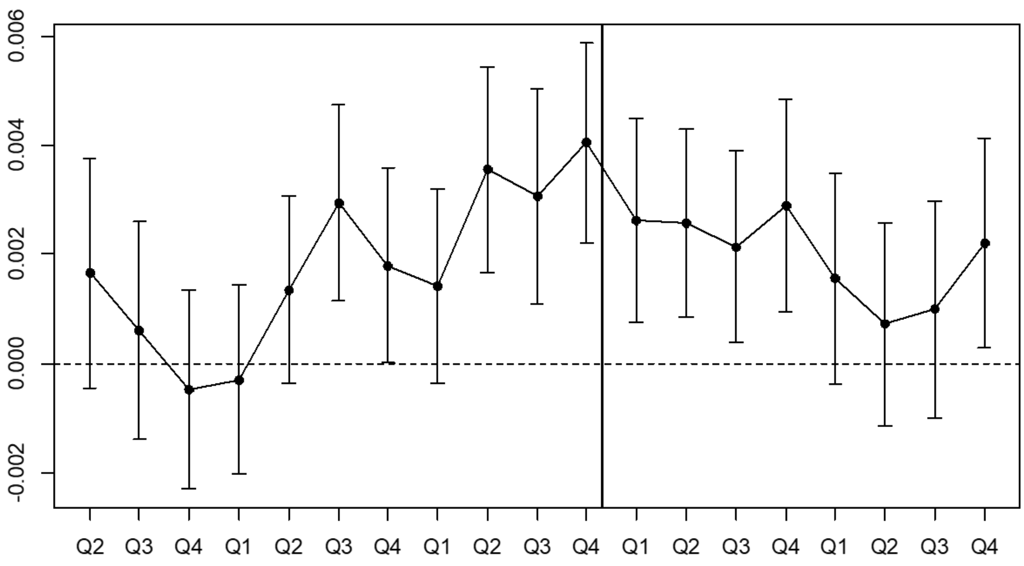
Appendix 3.E Changes in Effect Over Time (Single-Person Apartments)

	Deviation value	School rank
	(1)	(2)
Deviation value / School rank		
×2012 Q2	-.0010	.0017
	(.0009)	(.0011)
×2012 Q3	.0000	.0006
	(.0008)	(.0010)
×2012 Q4	.0005	-.0005
	(.0007)	(.0009)
×2013 Q1	.0002	-.0003
	(.0007)	(.0009)
×2013 Q2	-.0009	.0014
	(.0007)	(.0009)
×2013 Q3	-.0019**	.0029**
	(.0007)	(.0009)
×2013 Q4	-.0013	.0018*
	(.0007)	(.0009)
×2014 Q1	-.0010	.0014
	(.0007)	(.0009)
×2014 Q2	-.0027***	.0035***
	(.0007)	(.0010)
×2014 Q3	-.0023**	.0031**
	(.0008)	(.0010)
×2014 Q4 (disclosure)	-.0032***	.0040***
	(.0007)	(.0009)
×2015 Q1	-.0021**	.0026**
	(.0007)	(.0010)
×2015 Q2	-.0021**	.0026**
	(.0007)	(.0010)
×2015 Q3	-.0018**	.0021*
	(.0007)	(.0009)
×2015 Q4	-.0023**	.0029**
	(.0008)	(.0010)
×2016 Q1	-.0012	.0016
	(.0007)	(.0010)
×2016 Q2	-.0005	.0007
	(.0007)	(.0009)
×2016 Q3	-.0007	.0010
	(.0008)	(.0010)
×2016 Q4	-.0017*	.0022*
	(.0007)	(.0010)
N	7588	7588
Adjusted R2	0.7568	0.7561

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.
※Standard errors are adjusted for clustering at the area level.
※All control variables (house characteristics, area characteristics, year fixed effects, area fixed effects, urban/suburban trends, and north/south trends) were controlled.



Appendix 3.E - Column (1),
Changes in the Effect of Deviation Value on Rents of Single-Person Apartments



Appendix 3.E - Column (2),
Changes in the Effect of School Rank on Rents of Single-Person Apartments

Appendix 3.F Sample Divided according to the Child Population Density in an Area

	over 100	over 300	over 500	under 100	under 300	under 500
	(1)	(2)	(3)	(4)	(5)	(6)
After-disclosure dummy	-.0261*	-.0487***	-.0709***	-.0312	-.0054	-.0053
	(.0101)	(.0136)	(.0162)	(.0201)	(.0136)	(.0131)
Deviation value × After-disclosure dummy	.0005**	.0009***	.0013***	.0007	.0002	.0001
	(.0002)	(.0002)	(.0003)	(.0005)	(.0003)	(.0003)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	6589	4374	1980	790	2999	5385
Adjusted R2	0.7649	0.7501	0.8858	0.8308	0.8254	0.7243

	over 100	over 300	over 500	under 100	under 300	under 500
	(7)	(8)	(9)	(10)	(11)	(12)
After-disclosure dummy	.0084	.0163*	.0202	.0131	.0100	.0014
	(.0062)	(.0079)	(.0104)	(.0174)	(.0089)	(.0079)
School rank × After-disclosure dummy	-.0007***	-.0014***	-.0020***	-.0009	-.0003	-.0001
	(.0002)	(.0003)	(.0004)	(.0007)	(.0004)	(.0003)
Control variables						
House characteristics	YES	YES	YES	YES	YES	YES
Area characteristics	YES	YES	YES	YES	YES	YES
Time fixed effects	YES	YES	YES	YES	YES	YES
Area fixed effects	YES	YES	YES	YES	YES	YES
Urban/suburban trends	YES	YES	YES	YES	YES	YES
North/south trends	YES	YES	YES	YES	YES	YES
N	6589	4374	1980	790	2999	5385
Adjusted R2	0.7650	0.7501	0.8860	0.8306	0.8254	0.7243

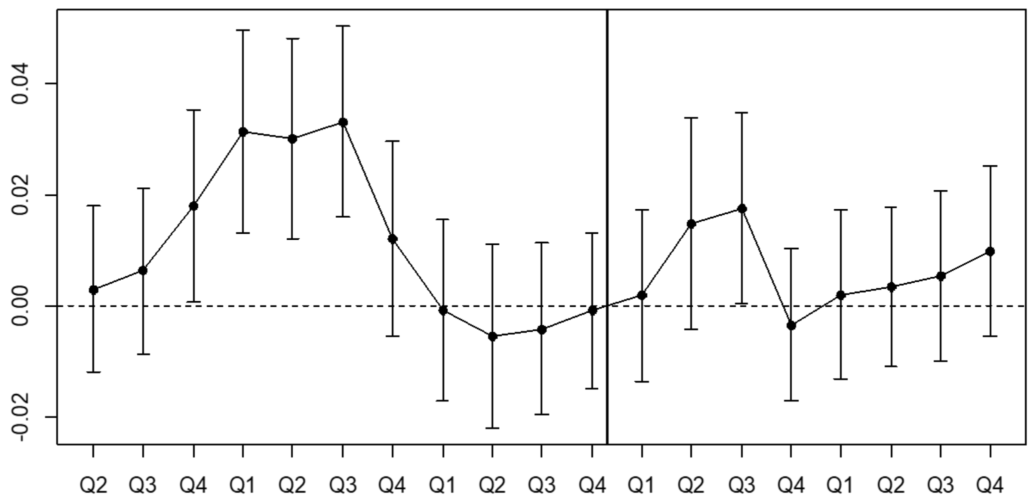
※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

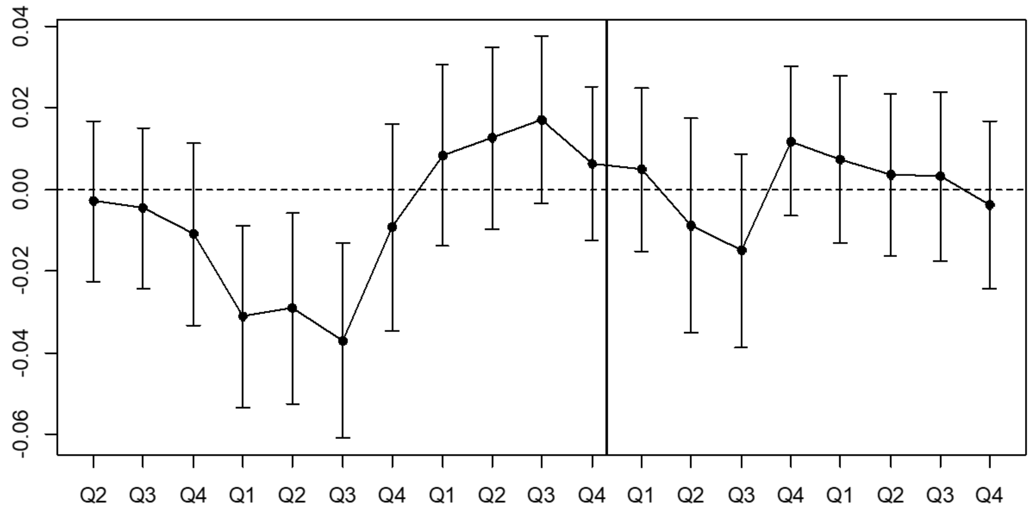
Appendix 3.G Changes in Effect Over Time (Number of Samples, Single-Person)

	Deviation value	School rank
	(1)	(2)
Deviation value / School rank		
×2012 Q2	.0031	-.0029
	(.0077)	(.0100)
×2012 Q3	.0064	-.0045
	(.0077)	(.0100)
×2012 Q4	.0181*	-.0110
	(.0089)	(.0114)
×2013 Q1	.0313***	-.0312**
	(.0093)	(.0114)
×2013 Q2	.0302**	-.0291*
	(.0092)	(.0120)
×2013 Q3	.0332***	-.0370**
	(.0088)	(.0122)
×2013 Q4	.0122	-.0092
	(.0090)	(.0130)
×2014 Q1	-.0007	.0083
	(.0083)	(.0114)
×2014 Q2	-.0054	.0125
	(.0084)	(.0115)
×2014 Q3	-.0041	.0171
	(.0079)	(.0104)
×2014 Q4 (disclosure)	-.0008	.0064
	(.0071)	(.0096)
×2015 Q1	.0019	.0048
	(.0079)	(.0102)
×2015 Q2	.0148	-.0088
	(.0097)	(.0134)
×2015 Q3	.0177*	-.0150
	(.0088)	(.0121)
×2015 Q4	-.0034	.0118
	(.0070)	(.0093)
×2016 Q1	.0021	.0072
	(.0078)	(.0105)
×2016 Q2	.0034	.0036
	(.0074)	(.0101)
×2016 Q3	.0054	.0031
	(.0078)	(.0106)
×2016 Q4	.0099	-.0038
	(.0078)	(.0105)
N	6650	6650
Adjusted R2	0.6918	0.6913

※*, **, and *** indicate statistical significance at 5%, 1%, and 0.1%, respectively.
※Standard errors are adjusted for clustering at the school district level.
※All control variables (time fixed effects, area fixed effects, urban/suburban trends, and north/south trends) were controlled.



Appendix 3.G - Column (1),
Changes in the Effect of Deviation Value on the Number of Single-Person Properties



Appendix 3.G - Column (2),
Changes in the Effect of School Rank on the Number of Single-Person Properties

Chapter 4

The Effect of a Partial Relaxation of the School-District System on Land Prices and Academic Performance: An Empirical Analysis in Japan[1]

4.1. Introduction

There have been many discussions about abolishing the school-district system and introducing a system of school choice; commentators have argued that adding market mechanisms to public education will allow it to operate more efficiently (Ladd, 2002). Several studies have explored the effect of changes in the school-district system on school-choice behavior, the educational market, and academic performance (e.g., Belfield and Levin, 2002; Rouse and Barrow, 2009). In addition, since public services, including public schools, are closely associated with residential-choice behavior, there have been many studies on the relationship between the school-district system and the property market (Black and Machin, 2011; Nguyen-Hoang and Yinger, 2011). However, relatively few studies have investigated the effect of changes to the school-district system on the property market.

Since abolishing the school-district system and introducing school choice reduces the importance of living in school districts with high-quality schools, the relationship between school quality and property prices may weaken. Fack and Grenet (2010) have investigated the relationship between school quality and house prices in the city of Paris. Their results suggest that an increase in one standard deviation of public-school performance raises housing prices by 1.4 to 2.4%; this effect decreases as more private schools become available in the neighborhood. Machin and Salvanes (2015) have shown that an abolition of the school-district system in Oslo County will reduce the impact of school quality on housing prices by less than half. Chung (2015) has explored the impact of school-choice reforms on housing prices in the Seoul metropolitan area. He found that school-choice systems reduce housing prices in high-quality school districts, relative to housing prices in low-quality school districts.

These empirical studies show consistent results: relaxing the school-district system weakens the

[1] I would like to thank my advisor Kentaro Nakajima, as well as Midori Wakabayashi and Akira Hibiki. All remaining errors are my own.

relationship between school quality and property prices, and reduces the value of property in school districts with high-quality schools. However, since various types of school systems have been analyzed, producing a range of different impacts, various areas and systems are necessary for policy evaluation. Therefore, this study aims to investigate the effect of a partial relaxation of the school-district system on the relationship between property prices and student academic performance.

This study focuses on the school district of Matsue City, Japan, where the system was partially relaxed, to explore the extent to which this change affected the relationship between school quality and land price. Before 2008, Matsue City strictly prohibited students at general public schools outside the city school district from enrolling in an academic high school that specialized in preparing students for university. In 2008, however, the school-district system was eliminated for some high-level pre-university courses. Even in general courses, approximately 5% of students could be admitted from outside the school district. In 2016, the percentage of outside students was raised to 20%. This institutional change may weaken the relationship between high-school quality and land prices and may decrease the value of property in school districts with particularly good schools.

To estimate the impact of this change, I have drawn on hedonic models of land prices using the fixed-effect approach and panel data from 2003 to 2018, as well as a regression discontinuity approach focusing on the school-district boundary. Using land-price panel data and a controlled fixed effect avoids the problem of unobserved confounding factors. Furthermore, following Black (1999), this study controls for unobserved neighborhood characteristics by comparing land near the boundary of the school district.

This study, in line with previous studies, shows that land prices decrease significantly when the school-district system is relaxed. As a regression discontinuity design, focusing on the school-district boundary, produces the same result, the main result is clearly robust. These findings also show that partially relaxing the school-district system will expand the disparity of the ratio of applicants successfully applying to prestigious universities, but not of applicants to other universities, including national universities. This implies that relaxing the school-district system may only affect particularly good students because the change is partial.

In relation to previous research, this study makes several contributions to the literature. First, it analyzes the impact on specific groups of students, focusing both on partial changes to the school-district system and on the number of successful university candidates. If school-district system is completely eliminated, many types of students are affected simultaneously. It is therefore difficult to identify which types of students have improved their academic performance, even when overall school performance has improved. In addition, previous studies have used variables based on average school quality, such as test scores or deviation values; such studies are unable to pinpoint the types of students actually affected. To provide more precise data, the present study focuses on a partial relaxation of the school-district system, affecting a limited group of students. Thus, we are able to compare affected and unaffected students, deriving a more precise estimate of the impact of relaxing the school-district system. Furthermore, by using the ratio of successful candidates admitted to each university from each high school as an index of high-school quality, the present study clearly shows that only specific students have been affected.

Second, this study deals with various potential concerns by focusing on a city in which the school district includes multiple public schools in a narrow area, with no high-quality private schools. In cases where the school district is expansive or there are few modes of transportation, eliminating the school-district system may have no effect on student behavior. When commuting is very expensive, students may attend schools close to home, even if they are offered a choice in the matter. The present study therefore focuses on a small school district with many different forms of transportation, avoiding the need to address commuting costs and similar concerns. As there are no excellent private schools, the effect of changing the school-district system is not diluted by private schools in the targeted area.

The structure of this paper is as follows: Section 2 reviews the previous literature and explains the contribution made by this study. Section 3 provides institutional background and Section 4 describes empirical strategies. Section 5 discusses the school-district system and the data. After Section 6 presents the results and discussion, Section 7 concludes the paper.

4.2. Literature review

Many studies have considered the effect of school quality on the property market; consistent results have indicated that school quality has a significant positive effect on the price of housing or land (Black and Machin, 2011; Nguyen-Hoang and Yinger, 2011). Consistent results have also been obtained in Japan; in areas with school district systems, school quality is capitalized by property prices (Kuroda, 2018; Yoshida, Zhang and Ushijima, 2008). Izumi (2010) has investigated the Matsue City high-school district used in this study, showing that land prices in a district with high-quality schools are high, even after controlling for fixed effects.

Among studies that have investigated the impact of eliminating school districts or introducing a school-choice system on residential choice behavior or the property market, most studies have been theoretical, using a general equilibrium model (e.g., Nechyba, 2000; Ferreyra, 2007). In recent years, however, empirical research has also accumulated. Reback (2005) has explored the declining importance of the school district, following the adoption of a school-choice program in Minnesota. He has shown that residential property values increase in areas where students can transfer to outside school districts, while significantly decreasing in school districts that accept transfer students. Brunner, Cho, and Reback (2012) have also shown that introducing school choice increases population density in previously low-quality areas and reduces population density in previously high-quality areas. Chung (2015) has investigated the impact of school-choice reforms on housing prices in the Seoul metropolitan area, discovering that school choice reduces house prices in high-quality school districts, relative to house prices in low-quality school districts, by approximately 10-27%.

As these studies show, school choice reduces the importance of living in a high-quality school district. Specifically, Machin and Salvanes (2015) have found that the effect of school quality on housing prices dropped to less than half its previous level when the school-district system was abolished in Oslo County. Schwartz, Voicu, and Horn (2014) have shown that introducing a choice school reduces the value of schools capitalized to housing values to one-third of the previous amount. Fack and Grenet (2010) have focused on private schools instead of school-choice system, using Parisian data. They have shown that increasing the standard deviation of public-school quality increases house prices by 1.4–2.4%, although this effect decreases as more nearby private schools become available.

Some studies have analyzed the effect of school-choice system using Japanese data. Yoshida, Zhang, and Ushijima (2008) have shown that introducing school choice weakens the effect of school quality on land prices. Nakamura (2009), Yoshida, Kogure, and Ushijima (2009) have analyzed the extent to which introducing public-school choice affects student sorting and academic performance. Their study did not obtain consistent results on the effect of school-choice systems on academic ability; they also find that disparity between schools did not expand. However, their results may have been weakened by the large number of private schools in Tokyo, a subject analyzed by previous Japanese studies.

The present study makes the following contributions to the literature. First, it analyzes the effect of school choice on specific groups of students, using both partial changes to the school-district system and the number of successful university candidates. If a school-district system is completely eliminated, all the students are affected simultaneously, making it impossible to tell which groups of students have improved in relation to the school's overall improved performance. To address this problem, the present study uses the partial relaxation of the school-district system, which affects a limited number of students. In this study, only academically advanced students had access to school choice; many average students were not affected. Previous studies have used variables that measure overall school quality, such as test scores or deviation values; these cannot identify the types of students affected. By contrast, this study uses the ratio of candidates who successfully apply to prestigious universities from each high school as an index of high-school quality. It identifies different reactions in relation to the students' level of academic achievement, distinguishing students who are affected and unaffected by the partial relaxation of the school-district system and enabling a precise estimate of the effect.

Second, the present study deals with various potential concerns by focusing on a city in which the school district includes multiple public schools in a narrow area, with no high-quality private schools. In areas where the school district is expansive, or transportation is scarce, eliminating the school-district system may have no effect on student behavior. When the commuting costs are high, students may not attend schools which far from their home, even if they are allowed to choose. This study therefore focuses on small school district with abundant means of transportation, eliminating the need to address commuting costs. Moreover, as this area has no private schools to compete with targeted public schools, they cannot weaken the school-district system. Additionally, by focusing on public high schools, it is likewise unnecessary to consider differences in school fees. It is therefore relatively straightforward to estimate the impact of changing the school-district system.

4.3. Institutional backgrounds

This section explains the school-district system in the targeted area. Matsue City is a regional city in southwest Japan. As of 2018, the population is approximately 200,000 and the density is approximately 390 per square meters. There are three general high schools[2] in this city, which is divided into Kita (north), Minami (south), and Higashi (east) high-school districts. High-school enrolment has been determined by residential area. Following the establishment of the third high school in 1983, this school-district system was fully maintained until 2008. With the merger of municipalities around 2000, the authorities discussed a plan to reorganize or abolish the school-district system. They agreed on a compromise plan: to partially relax the school-district system. The system was abolished altogether for "science and mathematics courses."[3] In general courses, it was decided that 5% of students would come from outside the school district. There were two mathematics and science courses, one each in the Kita and Minami High Schools; each class had 40 students. Approximately 900 students enroll in general courses at ordinary high schools. Of these, 5% come from outside the school district, corresponding to approximately 45 students. In fiscal 2016, the ceiling for enrollment from outside the school district rose to 20%, equivalent to 180 students. Figure 4.1 shows the school districts of general high schools in Matsue City. It is easy to commute within this area; if the school district is abolished, will be possible for students from any area to

2 In Japan, general high schools aim to prepare students to go to college after graduation; their role differs from that of vocational (e.g., industrial, commercial, or agricultural) high schools, which try to help students find employment after graduating.

3 Although this course focuses on science and mathematics, the students do not necessarily go to science-based universities after graduating. In Japanese local cities, this course is recognized as helping students attend prestigious universities.

attend any high school.

As this paper will describe later, students at Kita High School have particularly high-level academic ability, while those at Higashi and Minami High Schools are roughly the same. For this reason, the Kita high-school district may attract more demand than the other two school districts. In Matsue City, some real-estate agencies advertise "Kita high-school district" as a strong point when selling property. In the Kita district, property may have been more expensive than in the Minami and Higashi school districts. However, due to the relaxation of the school-district system, students wishing to attend Kita High School do not necessarily have to live in the district. It follows, therefore, that relaxing the school-district system is likely to reduce land prices in the Kita high-school district.

In this case, since the school district system has been partially, rather than completely, relaxed, the effect may be relatively weak. The students affected will have exceptional academic ability and may also have high-income families with an academic background or enthusiasm for education. Yoshida, Kogure, and Ushijima (2009) have suggested that households with stronger educational backgrounds and higher incomes may exhibit more selective behavior in relation to education. If so, the impact on land prices will be significant, even in the case of a partial relaxation.

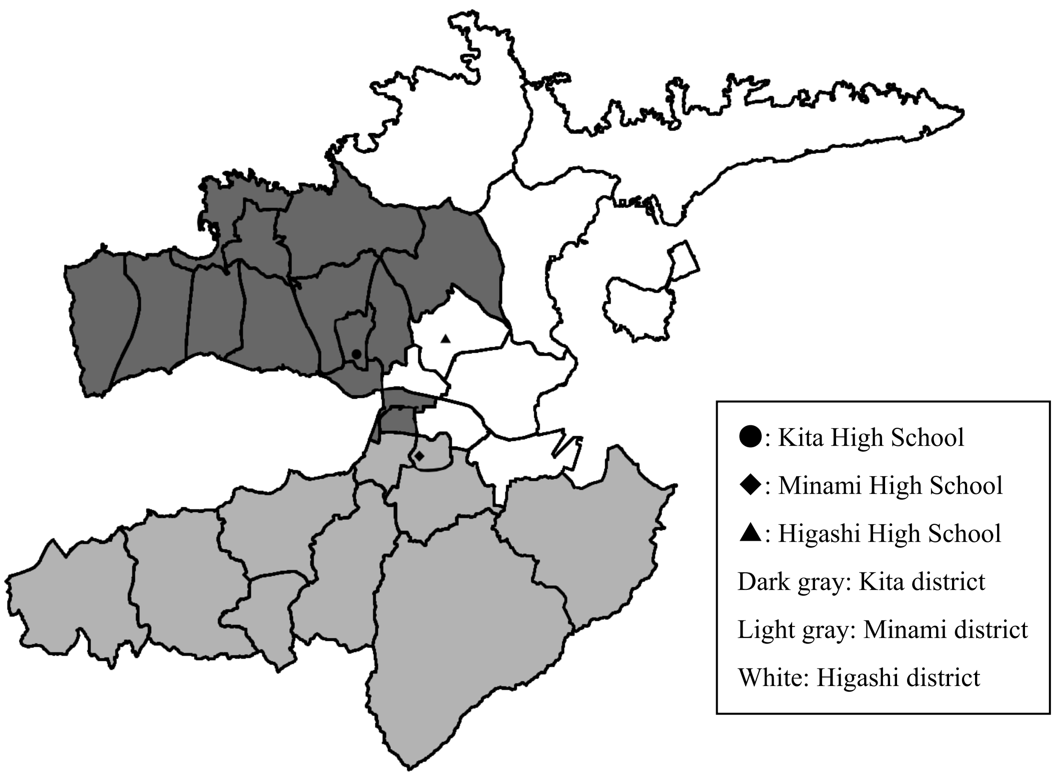


Figure 4.1 High School Districts in Matsue City

4.4. Empirical strategies

The effect of school quality on land prices is estimated via a hedonic regression, using the fixed effect approach on panel data from 2003 to 2018. The interaction terms, "school district dummy" and "institution change dummy" are regressed on land prices, with various control variables included. The basic estimate equation is as follows:

$$\ln P_{itaj} = \alpha + \sum_{a=1}^{2} \beta_{1a}\, School_a \cdot Change_t + \sum_{a=1}^{2} \beta_{2a}\, School_a + \sum_{n=1}^{2} \beta_{3n}\, Change_{nt} + \gamma X_i + \delta Y_t + \mu W_{tj} + \varepsilon_{ita}$$

where P_{ita} is the price of land i in high-school district a in year t. The vector X_i includes characteristics of the land, such as the distance from the nearest station or the floor-area ratio, or it indicates land fixed effects that control time-invariant unobserved characteristics. Vector Y_t indicates the year fixed effects; W_{tj} controls the unique trend of central urban area j; $School_a$ is a dummy variable representing the school districts of three public schools in Matsue City, and indicates 1 if the land located within the school district. Three high schools in Matsue City focus on preparing students to apply to university. One of them (Kita High School) is excellent, while the other two (Higashi High School and Minami High School) are comparable and less academic. The present study analyzes the coefficients of "Kita" and "Minami" high school dummies, with Higashi High School as the baseline. $Change_{nt}$ is a dummy variable representing 1 after changing the school-district system, $n = 1$ indicates change in 2008, $n = 2$ indicates change in 2016. In 2008, school choice was added for one high-level pre-university course (the "science and mathematics course." In the general course, 5% of all students could be enrolled from outside the school district after 2008. This enrolment ceiling was raised to 20% in 2016. In other words, the coefficient β_{1a} of the interaction term shows how the price of land in each school district changed, following changes to the school-district system.

The present study also applies a regression discontinuity design to deal with unobservable characteristics that cannot be controlled by land fixed effects. The vector of observed characteristics is replaced with boundary dummies, which indicate land that shares a boundary and uses restricted data. The sample was limited to land that was close to a boundary. Specifically, I created a subset of apartments located within less than 1000 m, 750 m, and 500 m from the boundary of a school district. Land within the same boundary is assumed to have similar characteristics, such as access to public facilities and amenities. The boundary dummy variables control for any unobserved neighborhood characteristics shared by land on either side of the boundary. They make it possible to compare land that has very similar geographical information. Differences in the value of land are thought to be caused by having a choice of public high school.

4.5. Data

In this study, I mainly use land-price data and the high-school data. This section explains the data.

4.5.1. Land-price data

In this study, "published land prices" and "prefectural land-price research" are used to provide data on land prices. These are appraisal evaluations carried out by real-estate appraisers; as such, they are objective land assessments, independent of sellers and buyers. The same places are evaluated annually and the data include various types of information, such as price-per-square meter, address, and distance from the nearest station. The values reported in published land prices reflect the value of the land on January 1st each year, as estimated by two real estate appraisers. The values reported in prefectural land-price research are estimated on July 1st each year by one real estate appraiser. Although these are different investigations, they use the same the indicators and show almost the same prices at the same points; for this reason, the present study combines these two data sources.

The land data derives from 2002–2018. There is a total of 160 observation points. However, the panel data are unbalanced because they contain several defects. Summary statistics of land data are shown in Table 4.1, divided into all land and land currently used for residential purposes.[4] The "5% period dummy" is a dummy variable that ranges from 2008 to 2016 (from the first school-district change to the second). The "20% period dummy" is a dummy variable that corresponds to the time period after the second school-district change in 2016. The dummy variable corresponding to the period after the first school-district change in 2008 is the "After 5% dummy." For the land characteristics, this study uses the distance from the nearest station, acreage, an irregular shape dummy, road width, the building coverage ratio, and the floor-area ratio. Each piece of land has its own use restrictions, known as "Land-Use Zones." Dummy variables have been set for each regulation. To address the concern that land prices may have different trends around the central urban area and suburbs, I have set a "central urban dummy."[5] Unobserved characteristics that change over time are controlled by using the interaction terms of the central urban dummy and yearly dummies. Finally, additional dummy variables indicate which school district the land is

[4] The summary statistics involving samples limited to the school-district boundary are shown in Appendix 4.A.

[5] The definitions of "central urban" and "suburban" are based on the "Matsue City Central Area Revitalization Basic Plan" published by Matsue City.

located in. Matsue City is divided into three equal divisions by three school districts; there is no extreme bias in the observation point. The Higashi school district provides the baseline.[6]

Table 4.1 Summary Statistics

	Full sample				Residential land use			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Land price	60823	44142	8200	545000	53910	29560	8200	223000
5% period dummy	0.577	0.494	0	1	0.585	0.493	0	1
20% period dummy	0.100	0.300	0	1	0.098	0.297	0	1
After 5% dummy	0.677	0.468	0	1	0.682	0.466	0	1
Land characteristics								
Distance from nearest station (kilometer)	1.848	1.657	0	10.000	1.983	1.740	0	10.000
Acreage (square meter × 1/1000)	1.118	4.749	0.099	40.084	0.304	0.165	0.104	1.710
Irregular shape dummy	0.028	0.164	0	1	0.015	0.122	0	1
Road width (meter)	7.750	4.476	0.800	31.500	6.535	2.887	3.000	22.000
Building Coverage Ratio (%)	0.533	0.250	0	0.800	0.509	0.243	0	0.800
Floor-Area Ratio (‰)	0.186	0.118	0	0.500	0.163	0.099	0	0.500
Land use zones dummies								
Category 1 residential zone dummy	0.230	0.421	0	1	0.289	0.453	0	1
Category 2 residential zone dummy	0.065	0.247	0	1	0.074	0.263	0	1
Category 1 low-rise residential zone dummy	0.094	0.292	0	1	0.119	0.323	0	1
Category 1 mid/high-rise residential zone dummy	0.060	0.237	0	1	0.079	0.271	0	1
Category 2 mid/high-rise residential zone dummy	0.075	0.263	0	1	0.080	0.272	0	1
Commercial zone dummy	0.123	0.329	0	1	0.055	0.228	0	1
Neighborhood commercial zone dummy	0.048	0.214	0	1	0.021	0.143	0	1
Quasi-fire prevention zone dummy	0.125	0.331	0	1	0.056	0.229	0	1
Area characteristics								
Central urban dummy	0.227	0.419	0	1	0.176	0.381	0	1
School district dummy								
Kita dummy	0.351	0.477	0	1	0.315	0.465	0	1
Minami dummy	0.316	0.465	0	1	0.361	0.481	0	1
Higashi dummy	0.334	0.472	0	1	0.324	0.468	0	1
Number of observation points	160				113			
Number of samples	1847				1384			

4.5.2. School data

To create an academic-achievement index by high school, the present study uses data from the "Sunday Mainichi Bessatsu: Koukou no Jitsuryoku (Sunday Mainichi Extra Issue: High School Performance)" issued by The Mainichi Newspapers Co., Ltd. This data set shows the total number of successful applicants from each high school who enroll in each university every year; 2003–2018 data have been used in this study. These data represent successful applicants, not a student who enter to school. If a student is accepted by several universities, he or she is counted more than once. Only university-level information is listed; there is no information on major.

[6] Summary statistics for residential land divided by school district are shown in Appendix 4.B.

In This study, following Kondo (2014), I use the number of successful candidates in specific university groups. This makes it possible to analyze the impact on a specific student, something that cannot be done using a school-average index, such as the deviation value. In particular, I have identified high-ranking universities and the number of students accepted by each university. The definition of this group is shown in Table 4.2; and the results by high school are shown in Table 4.3. As mentioned above, Table 4.3 shows that Kita high-school students have a particularly high rate of acceptance by high-ranking universities; Minami and Higashi have approximately the same lower rate of acceptance.

Table 4.2 List of the Universities Included in the Each Group

Group	University
Group A (most prestigious universities)	The University of Tokyo
	Kyoto University
	Osaka University
	Nagoya University
	Tohoku University
	Hokkaido University
	Kyushu University
	Hitotsubashi University
	Tokyo Institute of Technology
	Waseda University
	Keio University
Group B (prestigious private universities)	Meiji University
	Aoyama Gakuin University
	Rikkyo University
	Chuo University
	Hosei University
	Gakushuin University
	Sophia University
Group C (prestigious universities in the Kansai region)	Kansai University
	Kwansei Gakuin University
	Doshisha University
	Ritsumeikan University

Table 4.3 Results of the University Entrance Examination

	Mean	S.D.	Min	Max
Kita high school				
Number of graduates	325.813	30.709	287	398
Number of successful candidates at group A universities	46.563	14.979	25	81
Number of successful candidates at group B universities	17.625	6.726	4	31
Number of successful candidates at group C universities	89.438	23.685	59	158
Number of successful candidates at national universities	213.750	45.128	132	298
Number of successful candidates at private universities	386.688	62.498	288	559
Total number of successful candidates	600.438	89.803	485	842
Minami high school				
Number of graduates	315.125	28.275	275	368
Number of successful candidates at group A universities	12.750	4.576	6	20
Number of successful candidates at group B universities	7.813	5.581	2	21
Number of successful candidates at group C universities	50.063	18.454	26	85
Number of successful candidates at national universities	176.438	28.116	95	232
Number of successful candidates at private universities	351.313	33.295	300	439
Total number of successful candidates	527.750	51.886	443	671
Higashi high school				
Number of graduates	247.750	31.717	188	303
Number of successful candidates at group A universities	8.625	5.476	1	16
Number of successful candidates at group B universities	6.563	4.107	1	17
Number of successful candidates at group C universities	28.125	9.232	16	47
Number of successful candidates at national universities	100.250	39.358	10	167
Number of successful candidates at private universities	219.813	33.777	170	290
Total number of successful candidates	320.063	45.984	180	380
Year		16		

4.6. Results and Discussions

4.6.1. Effect on land prices

Table 4.4 shows the estimated results using residential land.[7] Column (1) shows the estimated results without the dummy variables related to school-district-system changes; it simply indicates the relationship between school quality and land prices. The coefficient of the Kita dummy is positive and significant, which means that a school district where the school caters to students of high academic ability has high land prices. This result is consistent with Izumi (2010). The Minami dummy also shows a positive and significant effect, but the coefficient is small. This result is

[7] The results of all samples are shown in Appendix 4.C. Since full samples contain industrial sites etc. that are not related to school quality, these results are insignificant. In this study, therefore, land used for residential is mainly used.

consistent with the fact that Minami High School is slightly better than Higashi High School. Column (2) shows the result of using the After 5% dummy, showing the effect of the first change of school-district system in 2008. Column (3) shows the result of using the 5% period dummy and the 20% period dummy, showing the effect of the two system changes in 2008 and in 2016. Columns (2) and (3) suggest that land prices in the Kita high-school district are high and unaffected by the system change. However, the fixed effects of the observation points are not controlled; thus, these results may be biased by unobserved characteristics. For this reason, they have also been analyzed with the land fixed effect controlled. Column (4) shows the result of considering the first system change and controlling the land fixed effects: the intersection term of the Kita dummy and the After 5% dummy show a significant and negative effect, suggesting that relaxing the school-district system decreased the price of land in Kita high-school district. Column (5) incorporates changes to the school-district system in 2008 and 2016, controlling for land fixed effects. This result indicates that land-price decreased significantly when the school-district system was relaxed by 5% in 2008; similarly, land prices decreased again when the system was further relaxed. To summarize the above, high-quality schools have the effect of raising land prices; the effect of school quality on land prices is reduced if the-school district system is relaxed. This result is consistent with various previous studies (e.g., Chung, 2015; Machin and Salvanes, 2015; Schwartz, Voicu, and Horn, 2014).

As for the impact of the main results, the results in Table 4.4 suggest that the effect of a high-quality school is reduced by about 3% after a change in the school-district system. Considering that land prices in the Kita high-school district were originally 15% higher than other areas, this suggests that the impact of school quality on land prices declined by 20% when the school-district system was relaxed. This seems reasonable; Chung (2015) similarly suggested a decrease of 10–27%.

This result also suggests that even partially relaxing, rather than completely abolishing, school districts can have a significant impact. There are several possible reasons. First, as previously mentioned, people with high levels of academic ability are more likely to focus on school quality and choosing the right school. Whether the school district is completely abolished or not, if certain groups of people take selective actions, it follows that partially eliminating the school district will have a significant effect. Second, because Kita High School has an excellent academic reputation, sending more than 10% of students to prestigious universities every year, it is very expensive to live in Kita district; land prices in Kita high-school district may have increased excessively during the school-district period. There were no other noteworthy amenities, such as a main station or commercial area in the Kita high-school district; the main attraction was being able to go to Kita High School. For this reason, relaxing the school-district system may have had a very large impact.

Table 4.4 Baseline Results

	(1)	(2)	(3)	(4)	(5)
Kita dummy	.1482***	.1408***	.1407***		
	(.0209)	(.0325)	(.0325)		
Minami dummy	.0540*	.0942*	.0941*		
	(.0251)	(.0422)	(.0423)		
After 5% (5% period) dummy		-.0242	-.0215	.0044	.0046
		(.0741)	(.0743)	(.0089)	(.0089)
Kita dummy × After 5% (5% period) dummy		.0121	.0042	-.0302***	-.0295***
		(.0385)	(.0394)	(.0089)	(.0089)
Minami dummy × After 5% (5% period) dummy		-.0586	-.0585	-.0020	-.0021
		(.0500)	(.0511)	(.0080)	(.0079)
20% period dummy			-.0295		.0135
			(.1067)		(.0165)
Kita dummy × 20% period dummy			.0585		-.0352*
			(.0696)		(.0155)
Minami dummy × 20% period dummy			-.0586		-.0012
			(.0848)		(.0145)
Land characteristics					
Distance from nearest station (kilometer)	.0638***	.0634***	.0633***		
	(.0080)	(.0080)	(.0080)		
Acreage (square meter × 1/1000)	-.2516***	-.2531***	-.2529***		
	(.0663)	(.0666)	(.0668)		
Irregular shape dummy	-.1008	-.1055	-.1055		
	(.0768)	(.0772)	(.0771)		
Road width (meter)	.0364***	.0362***	.0363***		
	(.0040)	(.0040)	(.0040)		
Building Coverage Ratio (% × 100)	.2955**	.2957**	.2953**		
	(.1104)	(.1109)	(.1110)		
Floor-Area Ratio (% × 1000)	-.4683	-.4617	-.4574		
	(.4587)	(.4615)	(.4621)		
Category 1 residential dummy	.8291***	.8293***	.8291***		
	(.0480)	(.0481)	(.0481)		
Category 2 residential dummy	1.196***	1.192***	1.195***		
	(.0518)	(.0520)	(.0521)		
Category 1 low-rise dummy	.8126***	.8119***	.8123***		
	(.0333)	(.0334)	(.0334)		
Category 1 mid/high-rise dummy	.6930***	.6931***	.6929***		
	(.0565)	(.0566)	(.0566)		
Category 2 mid/high-rise dummy	1.089***	1.084***	1.084***		
	(.0522)	(.0525)	(.0526)		
Commercial dummy	1.100***	1.099***	1.098***		
	(.1380)	(.1385)	(.1387)		
Neighborhood commercial dummy	.8283***	.8291***	.8287***		
	(.0511)	(.0511)	(.0511)		
Quasi-fire prevention dummy	-.0945**	-.0952*	-.0952*		
	(.0436)	(.0435)	(.0436)		
Central urban dummy	.4985***	.5147***	.5148***		
	(.0818)	(.0821)	(.0821)		
Control variables					
Year fixed effects	YES	YES	YES	YES	YES
Central urban trends	YES	YES	YES	YES	YES
Land fixed effects				YES	YES
N	1336	1333	1330	1238	1235
Adjusted R2	0.7685	0.7684	0.7680	0.9948	0.9948

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Table 4.5 shows the estimated results when the sample is restricted to the boundary of the school district and the individual fixed effect is controlled.[8] Columns (1) and (2) show the results estimated using samples within 1000 meters of the school-district boundary. Like the baseline results, land prices near Kita High School decreased by about 3.5%, due to the relaxation of the school-district system. Although the effect of the second change was not significant, it had a negative effect on land prices in Kita high-school district. Columns (3) and (4) show the estimated results using samples within 750 meters of the school-district boundary. These also show that land prices in Kita high-school district are decreasing, due to the relaxation of the school-district system; the coefficient is about 5.5%. In Column (4), the coefficient of the interaction terms, Kita dummy and 20% period dummy, is significantly negative; the impact is larger than after the first change of the school-district system. This suggests that the 5% relaxation of the school district decreased land prices in the Kita high-school district, and land prices decreased additionally when the system was further relaxed. Columns (5) and (6) show the estimated results using samples within 500 meters of the school-district boundary. This result is consistent with the other results, suggesting that land prices in Kita high-school district decreased by about 5% when the school-district system was first relaxed; they decreased by an additional 2% after the second change. In summary, relaxing the school-district system significantly reduced land prices in Kita high-school district, even after controlling for unobserved characteristics by focusing on the school-district boundaries. This indicates that the value of property around Kita High School has decreased, due to the relaxation of the school-district system. The results also suggest that even partial relaxation will have a significant impact on land prices.

[8] The results estimated using the school-district boundary dummy, without controlling for the land fixed effect, are shown in Appendix 4.D. The intersection terms between the Kita dummy and the system change dummy, the main variables, are not significant but show a consistent negative effect. This result is the same as the fixed effect result.

Table 4.5 Results Focusing on School-District Boundaries

	1000 meters		750 meters		500 meters	
	(1)	(2)	(3)	(4)	(5)	(6)
After 5% (5% period) dummy	.0080	.0084	.0166	.0165	.0048	.0048
	(.0099)	(.0099)	(.0129)	(.0127)	(.0114)	(.0114)
Kita dummy × After 5% (5% period) dummy	-.0357**	-.0352**	-.0575***	-.0560***	-.0520**	-.0493**
	(.0118)	(.0118)	(.0144)	(.0144)	(.0186)	(.0187)
Minami dummy × After 5% (5% period) dummy	.0057	.0056	.0089	.0085	-.0073	-.0065
	(.0092)	(.0092)	(.0118)	(.0118)	(.0132)	(.0134)
20% period dummy		.0250		.0381		.0384
		(.0189)		(.0256)		(.0262)
Kita dummy × 20% period dummy		-.0399		-.0698*		-.0735*
		(.0207)		(.0271)		(.0344)
Minami dummy × 20% period dummy		.0106		.0148		.0106
		(.0164)		(.0211)		(.0221)
Control variables						
Year fixed effects	YES	YES	YES	YES	YES	YES
Central urban trends	YES	YES	YES	YES	YES	YES
Land fixed effects	YES	YES	YES	YES	YES	YES
N	522	519	389	386	270	267
Adjusted R2	0.9844	0.9843	0.9840	0.9840	0.9798	0.9797

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

4.6.2. Effect on enrollment rate

The results in the previous section show that relaxing the school-district system significantly reduces land prices. In this section, I analyze the extent to which high-school students' results on their university examinations were affected by a partial relaxation of the school-district system. Since the first change took place in 2008, the students affected by that change took their examinations in 2011. As no data are yet available on the students who enrolled after the second change in 2016, this study analyzes only the impact of the first change.

Figure 4.2 shows the passing rate for each of the three schools, for students applying to all universities. Figure 4.2 shows that Kita and Minami High Schools experienced no significant changes before and after the school-district system relaxation. Although the Higashi High School passing rate gradually improved, this trend seems unrelated to the change of school-district system.

Figure 4.3 shows the passing rate of national universities.[9] At Kita and Minami High Schools, there was no major difference before and after the system change; in Higashi High School, the passing rate declined after the system change. This suggests that students hoping to go to national universities may have clustered at better high schools by relaxation of the school district system.

[9] In 2006, Higashi High School had an extremely small number of successful candidates, compared to other years (whereas the average number of successful candidates was about 106, in 2006, there were only 10). This figure has been excluded from the analysis as an outlier, given the possibility of typographical error.

Figure 4.4 shows the passing rate for Group B and C universities. According to this graph, the passing rates for Minami and Higashi High School, in relation to prestigious private universities, decreased after the school-district system was relaxed. This result suggests that excellent students aspiring to attend prestigious universities may have gathered at Kita High School.

Figure 4.5 shows the passing rate for Group A (the most prestigious universities). Before relaxing the school-district system, Kita High School had a stable passing rate of about 15%; Minami and Higashi High Schools were stable at about 5%. However, the passing rate of Minami and Higashi High School fell dramatically after the school-district system was relaxed. At Higashi High School, the passing rate fell to 1% or less. This suggests that excellent students who lived in Higashi district may have chosen Kita High School or Minami High School. However, Figure 4.5 shows an overall downward trend, suggesting that the school-district change may have negatively affected the whole area. To analyze the effect of the school-district change on student performance, these results need to be compared with those of other cities, that did not undergo a system change.

In summary, partially relaxing the school district does not affect student achievement in all university entrance examinations; however it may have a strong effect on the higher academic tiers. It should be noted that some students in Japanese local cities choose to study medicine at local universities rather more difficult, high-status universities. Since the data used in this study do not include information on faculties, this is a limitation of the present study.

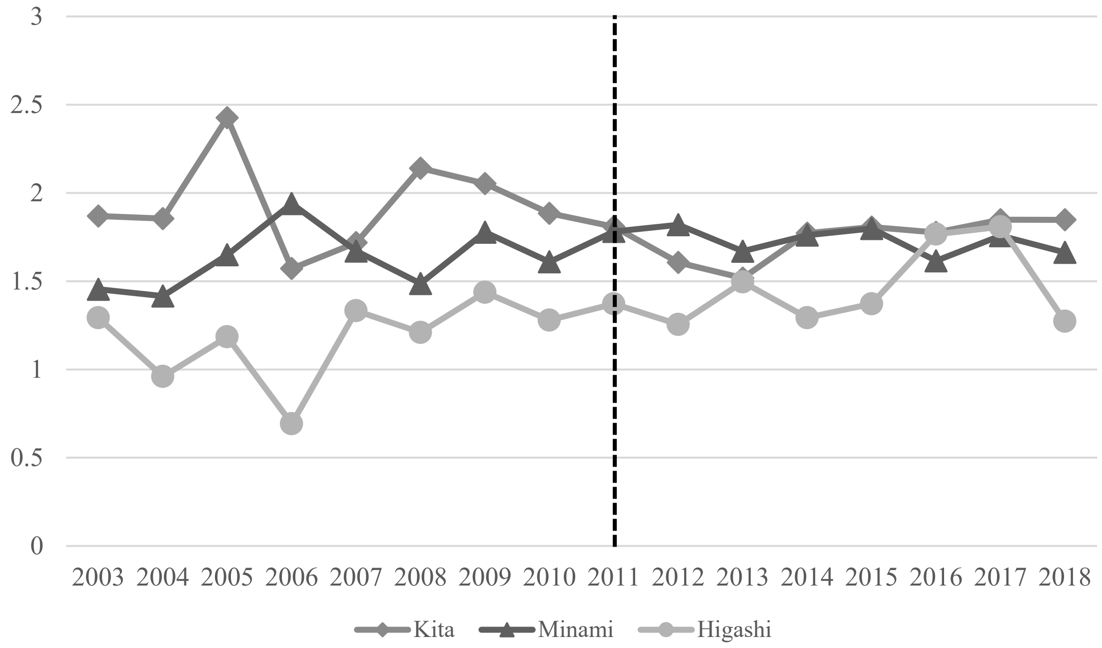


Figure 4.2 Ratio of Successful Applicants to All Universities

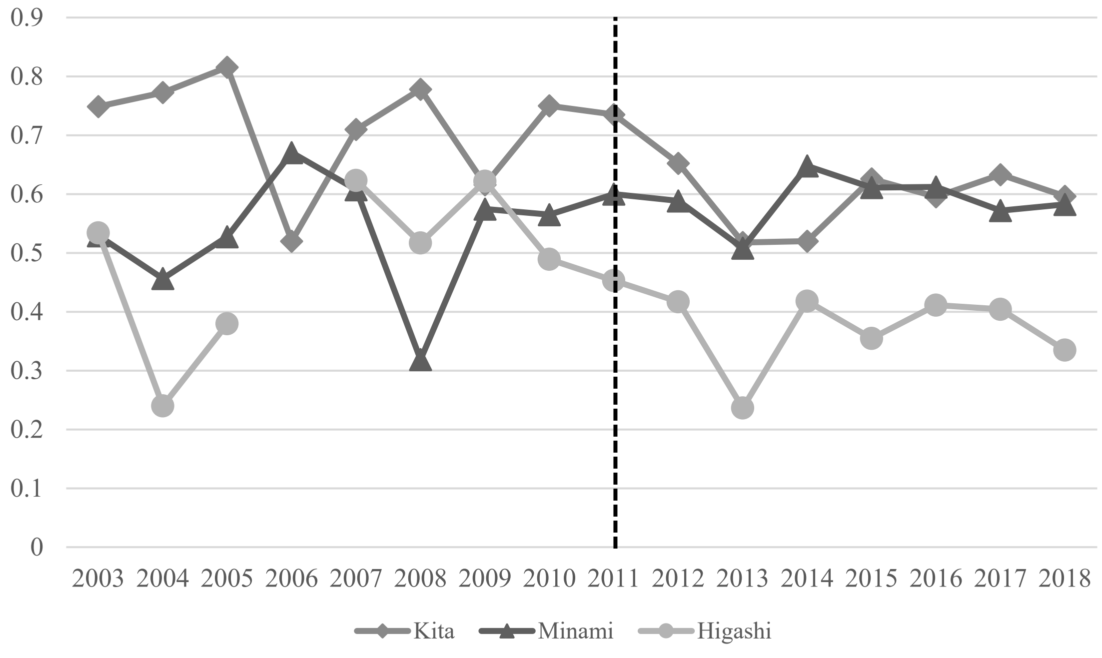


Figure 4.3 Ratio of Successful Applicants to National Universities

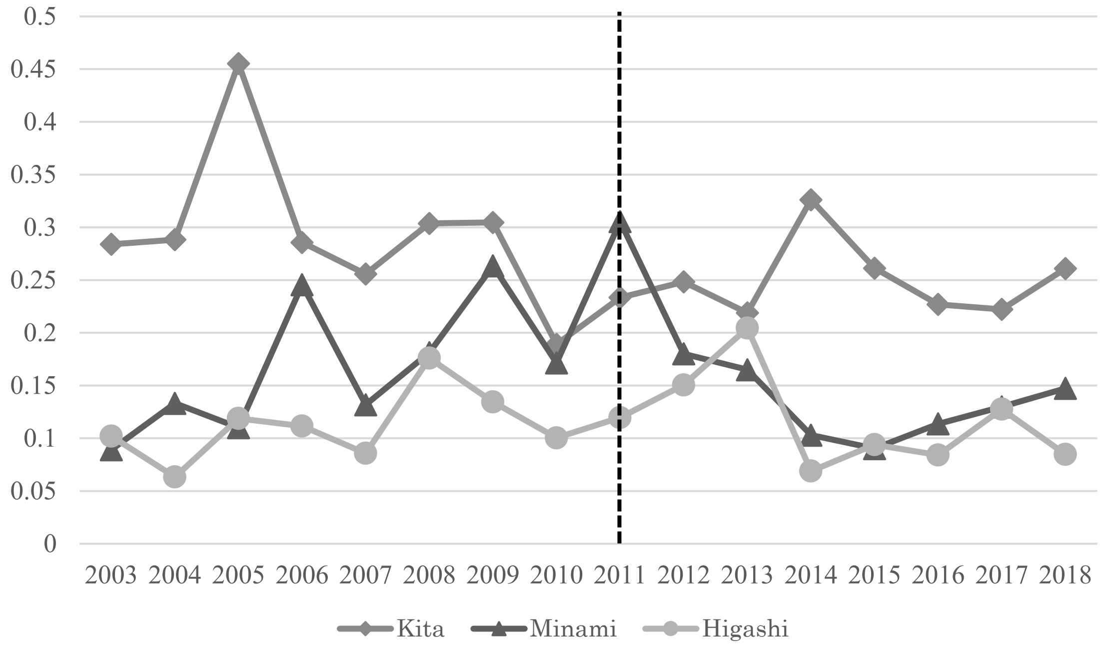


Figure 4.4 Ratio of Successful Applicants to Group B and C Universities

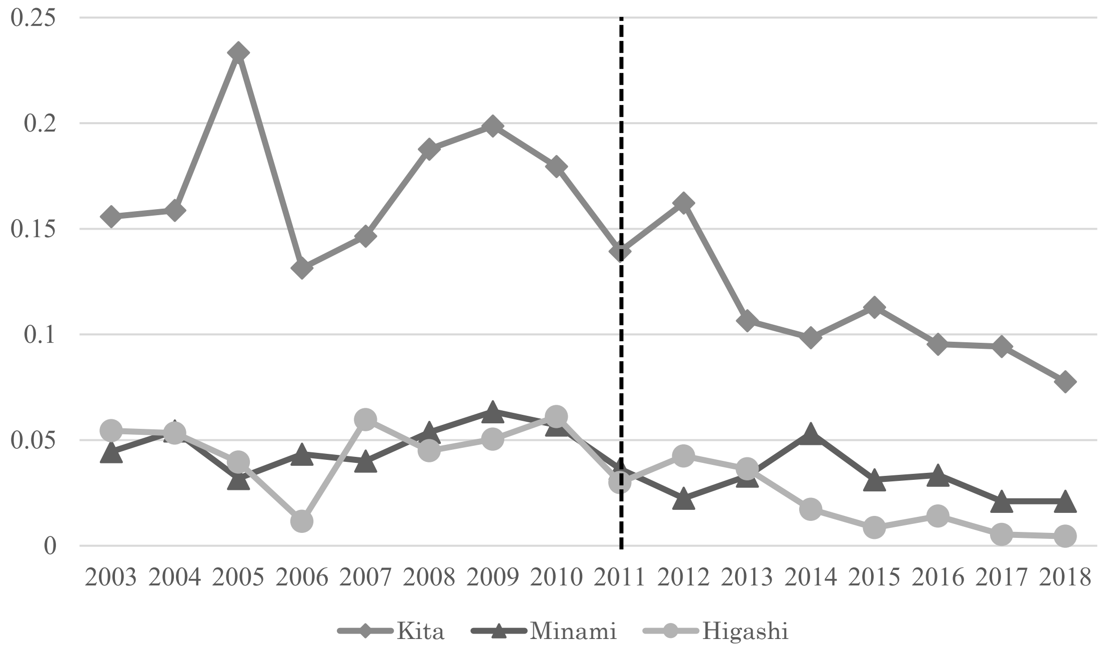


Figure 4.5 Ratio of Successful Applicants to Group A Universities

4.7. Conclusion

This study explores the impact of the school-district system on the relationship between school quality and land prices. The data were drawn from Matsue City, Japan, where the school-district system of public high schools was partly relaxed. The findings show that relaxing the school-district system significantly reduces land prices in high-level school districts. Using a regression discontinuity design to focus on school-district boundaries produces the same result. This suggests that, as the school-district system is relaxed, families no longer find it necessary to live in a specific school district, weakening the relationship between school quality and land prices.

A partial relaxation of the school-district system also increases the disparity of the ratio of successful applicants to prestigious universities; however, there is no large change in the case of applicants to national or other universities. This implies that relaxing the school-district system may have an impact only on particularly academic students if the change is partial. However, it is necessary to analyze areas without a school-district system to discover whether this effect is actually caused by the change of school-district systems.

Appendix 4.A Summary Statistics of Samples at the School-District Boundary

	1000m				750m				500m			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Land price	75280	25217	11300	223000	77959	26486	11300	223000	79904	26548	11300	223000
5% period dummy	0.558	0.497	0	1	0.560	0.497	0	1	0.560	0.497	0	1
20% period dummy	0.082	0.274	0	1	0.081	0.274	0	1	0.083	0.276	0	1
After 5% dummy	0.640	0.480	0	1	0.642	0.480	0	1	0.642	0.480	0	1
Land characteristics												
Distance from nearest station (kilometer)	1.994	1.207	0.100	6.900	1.879	1.054	0.100	6.900	1.859	0.892	0.650	6.900
Acreage (square meter × 1/1000)	0.300	0.187	0.111	1.710	0.302	0.204	0.111	1.710	0.294	0.239	0.111	1.710
Irregular shape dummy	NA				NA				NA			
Road width (meter)	6.926	3.479	3.400	22.000	7.300	3.764	3.500	22.000	7.409	4.226	3.500	22.000
Building Coverage Ratio (%)	0.610	0.107	0	0.800	0.613	0.109	0	0.800	0.611	0.117	0	0.800
Floor-Area Ratio (‰)	0.204	0.079	0.060	0.500	0.215	0.084	0.080	0.500	0.220	0.082	0.080	0.500
Land use zones dummies												
Category 1 residential zone dummy	0.357	0.479	0	1	0.365	0.482	0	1	0.459	0.499	0	1
Category 2 residential zone dummy	0.145	0.352	0	1	0.156	0.363	0	1	0.168	0.375	0	1
Category 1 low-rise residential zone dummy	0.127	0.333	0	1	0.070	0.256	0	1	0.049	0.216	0	1
Category 1 mid/high-rise residential zone dummy	0.107	0.309	0	1	0.106	0.308	0	1	0.049	0.216	0	1
Category 2 mid/high-rise residential zone dummy	0.107	0.309	0	1	0.123	0.329	0	1	0.122	0.328	0	1
Commercial zone dummy	0.080	0.272	0	1	0.106	0.308	0	1	0.098	0.298	0	1
Neighborhood commercial zone dummy	0.048	0.215	0	1	0.035	0.184	0	1	0.049	0.216	0	1
Quasi-fire prevention zone dummy	0.128	0.335	0	1	0.141	0.348	0	1	0.147	0.354	0	1
Area characteristics												
Central urban dummy	0.407	0.492	0	1	0.437	0.497	0	1	0.462	0.499	0	1
School district dummy												
Kita dummy	0.367	0.482	0	1	0.332	0.471	0	1	0.315	0.465	0	1
Minami dummy	0.233	0.423	0	1	0.264	0.441	0	1	0.269	0.444	0	1
Higashi dummy	0.400	0.490	0	1	0.404	0.491	0	1	0.416	0.494	0	1
Number of observation points	45				33				24			
Number of samples	600				455				327			

Appendix 4.B Summary Statistics for Each School District

	Kita school district				Minami school district				Higashi school district			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Land price	66332	32172	11200	223000	46399	21344	11300	120000	50203	30989	8200	150000
5% period dummy	0.562	0.497	0	1	0.614	0.487	0	1	0.574	0.495	0	1
20% period dummy	0.094	0.292	0	1	0.102	0.303	0	1	0.096	0.295	0	1
After 5% dummy	0.656	0.476	0	1	0.716	0.451	0	1	0.670	0.471	0	1
Land characteristics												
Distance from nearest station (kilometer)	2.024	1.681	0.000	5.700	1.854	1.513	0.000	7.200	2.086	2.009	0.000	10.000
Acreage (square meter × 1/1000)	0.310	0.137	0.111	0.856	0.287	0.128	0.104	0.712	0.318	0.217	0.150	1.710
Irregular shape dummy	0.032	0.176	0	1	NA				0.016	0.124	0	1
Road width (meter)	7.085	2.911	3.400	17.000	5.927	2.215	3.500	15.100	6.678	3.368	3.000	22.000
Building Coverage Ratio (%)	0.536	0.233	0	0.800	0.550	0.200	0	0.800	0.437	0.278	0	0.800
Floor-Area Ratio (‰)	0.180	0.115	0	0.500	0.178	0.086	0	0.400	0.131	0.089	0	0.400
Land use zones dummies												
Category 1 residential zone dummy	0.128	0.335	0	1	0.418	0.494	0	1	0.301	0.459	0	1
Category 2 residential zone dummy	0.071	0.257	0	1	0.032	0.176	0	1	0.125	0.331	0	1
Category 1 low-rise residential zone dummy	0.165	0.372	0	1	0.104	0.306	0	1	0.089	0.285	0	1
Category 1 mid/high-rise residential zone dummy	0.147	0.354	0	1	0.060	0.238	0	1	0.036	0.186	0	1
Category 2 mid/high-rise residential zone dummy	0.110	0.313	0	1	0.094	0.292	0	1	0.036	0.186	0	1
Commercial zone dummy	0.110	0.313	0	1	0.056	0.230	0	1	NA			
Neighborhood commercial zone dummy	0.030	0.170	0	1	NA				0.036	0.186	0	1
Quasi-fire prevention zone dummy	0.140	0.347	0	1	NA				0.036	0.186	0	1
Area characteristics												
Central urban dummy	0.004	0.485	0	1	NA				0.179	0.383	0	1
Number of observation points	33				43				37			
Number of samples	436				501				448			

Appendix 4.C Full Sample Results

	(1)	(2)	(3)	(4)	(5)
Kita dummy	.0702**	.0553	.0554		
	(.0227)	(.0379)	(.0380)		
Minami dummy	-.0369	-.0200	-.0194		
	(.0290)	(.0501)	(.0502)		
After 5% (5% period) dummy		-.1302	-.1287	.0017	.0029
		(.0763)	(.0766)	(.0099)	(.0099)
Kita dummy × After 5% (5% period) dummy		.0251	.0178	-.0171	-.0179
		(.0443)	(.0453)	(.0107)	(.0106)
Minami dummy × After 5% (5% period) dummy		-.0237	-.0233	.0152	.0142
		(.0576)	(.0588)	(.0088)	(.0088)
20% period dummy			-.2496*		.0086
			(.1116)		(.0175)
Kita dummy × 20% period dummy			.0753		-.0119
			(.0775)		(.0172)
Minami dummy × 20% period dummy			-.0347		.0234
			(.0912)		(.0148)
Control variables					
Year fixed effects	YES	YES	YES	YES	YES
Central urban trends	YES	YES	YES	YES	YES
Land characteristics	YES	YES	YES		
Area fixed effects				YES	YES
N	1784	1781	1778	1654	1651
Adjusted R2	0.7363	0.7365	0.7365	0.9936	0.9936

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Appendix 4.D Results using School-District Boundaries

	1000 meter		750 meter		500 meter	
	(1)	(2)	(3)	(4)	(5)	(6)
Kita dummy	.0001	.0004	.0641**	.0640**	-.0524*	-.0518*
	(.0206)	(.0207)	(.0209)	(.0210)	(.0259)	(.0260)
Minami dummy	-.0615	-.0610	-.4276***	-.4268***	-.3356***	-.3346***
	(.0386)	(.0387)	(.0351)	(.0355)	(.0315)	(.0321)
After 5% (5% period) dummy	.0885*	.0887*	.0603*	.0603*	.0541	.0546
	(.0397)	(.0400)	(.0276)	(.0278)	(.0347)	(.0350)
Kita dummy × After 5% (5% period) dummy	-.0397	-.0401	-.0514*	-.0513*	-.0363	-.0365
	(.0241)	(.0245)	(.0200)	(.0201)	(.0220)	(.0222)
Minami dummy × After 5% (5% period) dummy	-.0314	-.0237	-.0106	-.0074	-.0680*	-.0662*
	(.0290)	(.0296)	(.0241)	(.0246)	(.0296)	(.0301)
20% period dummy		.1621**		.0993		.1160*
		(.0596)		(.0515)		(.0541)
Kita dummy × 20% period dummy		-.0413		-.0555		-.0328
		(.0429)		(.0421)		(.0487)
Minami dummy × 20% period dummy		-.0726		-.0294		-.0918
		(.0603)		(.0498)		(.0476)
Control variables						
Year fixed effects	YES	YES	YES	YES	YES	YES
Central urban trends	YES	YES	YES	YES	YES	YES
Boundary fixed effects	YES	YES	YES	YES	YES	YES
Land characteristics	YES	YES	YES	YES	YES	YES
N	548	545	403	400	275	272
Adjusted R2	0.8926	0.8926	0.9456	0.9454	0.9493	0.9492

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.

※Standard errors are adjusted for clustering at the area level.

Chapter 5

Conclusion

This dissertation empirically analyzes parental willingness-to-pay for public education using property market data. By focusing on a city with few private schools and a school district system, the value of public education, capitalized in property prices, is accurately estimated. In addition, I also analyze the comprehensive impact of the introduction or change in educational policies using property market data, the population census, and academic achievement indicators. Relative to previous studies, this dissertation makes several contributions. The main findings and contributions of the study in each chapter are summarized below.

In Chapter 2, I estimate the causal effect of school quality, measured by average test scores, on housing rents using a regression discontinuity design to control for unobserved characteristics of neighborhoods. I find that school quality has a significant and positive effect on housing rents of apartments for families, but does not have a significant effect on housing rents of dwellings for single people. There are two major contributions of this study compared with previous studies in Japan. First, I analyze the heterogeneity of the effect by apartment characteristics. Second, I estimate the effect of public education more clearly. I use detailed information on apartments by using housing prices instead of land prices, with the latter being employed in previous studies on Japan. Therefore, I analyze the difference between an apartment that may be affected by school quality and an apartment that is not so affected. In addition, because the cities targeted in the previous literature in Japan were subject to the school choice system, where students can attend public schools outside of the district in which they live, the relationship between public-school quality and land prices was weak. However, in my analysis, the school choice system was not implemented in the target city and clear school districts exist. Additionally, there are few private elementary and junior high schools. Therefore, I accurately estimate the effect of public-school quality.

Chapter 3 expands the analysis of Chapter 2 and focuses on the disclosure of school quality information. I exploit the fact that the school-level test scores were first disclosed in October 2014 in Matsue City in Japan and estimate how the effect of test scores on housing rent and population in the school district differs before and after the disclosure. I find that the school-level test score has a significant and positive effect on housing rents of apartments intended for a family after the school-level test scores were disclosed. I also find that the disclosure significantly increased the number of children in the elementary school age range within the designated district of schools with high test scores. In addition, I find that the relative standard deviation of test scores after disclosure is larger than before disclosure. Compared to previous studies that analyze academic performance, school choice, and the property market, this study's novelty is that I consider the effect of disclosure on all three simultaneously. Therefore, I suggest the mechanism exists as follows: the disclosure of school quality information affects the residential location decisions of parents. Therefore, it is reflected in the real estate market. As a result, the academic disparity between schools will increase.

In Chapter 4, I explore the effect of the school district system on the relationship between school quality and land price given the school district system's enrollment limits of public high schools were partly relaxed. I find that relaxing the school district system significantly decreases the land prices within school districts with high-quality high schools because the value of living within the high-quality school district decreased due to the relaxation of the school district system. In addition, a partial relaxation of the school district system will increase the disparity in the ratio of successful applicants to prestigious universities, but that of national universities and all universities does not change. This implies that a partial relaxation may only affect particularly high-achieving students. In this study, I analyze the different effects on specific students by using both the partial changes in the school district system and the number of successful candidates for universities. Additionally, I address various potential concerns by focusing on the city where there are school districts for multiple public schools in a narrow geographic area and there are no high-quality private schools.

Summarizing these studies, the property market is sensitive to changes in the educational system and subsequent changes in parent behavior. This suggests that actual expenses for public education will differ due to increased property prices, even as the nominal costs of public education are equal. This increases the cost of higher quality education. Therefore it may lead to widening disparities or hierarchization of academic achievement. In fact, the results in Chapter 3 suggest that the disparity in academic performance is increased by the property market and residential choice.

In addition, the results suggest that heterogeneity exists in the educational investment behavior of parents and children. By promoting the introduction of market principles or the disclosure of information on public education, parents with higher educational backgrounds, incomes, and enthusiasm will choose to live in high-quality school districts. As a result, the disparity in educational achievement may increase.

However, since one municipality is subject to analysis in these studies, it is important to note that the widening of the observed disparity is a simple pre- and post-comparison. Also, even if it can be confirmed that disparity increases with information disclosure or promoting the introduction of market principles, I do not address how academic achievement has changed compared to other municipalities. Therefore, to obtain more detailed findings on the effect of information disclosure or relaxation of school district enrollment limits, it is necessary to compare these findings with municipalities where information is not disclosed or the school district system has not been changed. This is an issue to be analyzed in the future.

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