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Did the Abolition of School District Zoning Affect House Prices? Evidence from the Housing Market in Osaka City

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Abstract

This study examined the impact of the academic performance of accessible public schools on house prices within school districts utilizing rental housing data in Osaka City. A hedonic analysis based on a regression discontinuity design was conducted by restricting the analysis to houses within a certain distance from the boundaries of junior high school and high school districts. The result demonstrated that the education premium capitalized in the rent is considerably smaller than that found in a previous study that conducted a similar analysis for a rural city in Japan. Furthermore, we also measured changes in the education premium over time, including data before and after the abolition of the school district system. The result indicates that the premium did not decrease but rather increased after the abolition of school districts. This could be due to the announcement effect of the disclosure of the test scores of all public junior high schools around the same time as the abolition of the school district system. In addition, it may also be due to the dysfunctionality of the newly implemented school choice system, in which students are unable to choose a school under the capacity constraint of the school.

Keywords: housing market, education premium, school district system, regression discontinuity design

JEL Classification Numbers: C13, C51, C81, D12, D40, E21, E22, I22, I28, P25, R31

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1 Introduction

How and to what extent parents' school choice behavior for their children is affected by changes in the school choice environment (e.g., the reform of the school district system and the opening of new option schools) is one of the primary questions for researchers and policymakers. Recently, increasing attention has been paid to uncovering the relationship between the school choice environment and the capitalization of the regional housing market. This is because if the housing market is geographically segmented by school attendance areas, and if school quality differs across these areas, its capitalization would be linked to the income and willingness to pay for educational opportunities of parents who care about the school their children attend.

In general, the educational opportunity for children to attend a higher quality school should be a significant concern for their parents. In addition, the academic level of the school, such as average scores on standardized examinations, is in some cases, a visible and comparable attribute of school, and parents can use it as a proxy of quality measurement of school. Thus, the existence of school district system, in which the public authorities mechanically assign children to a particular public school based on their home address, would influence parents' residential location choices, in part as a reflection of a measurable school performance.

Based on such a prediction that a higher school quality brings a higher value to parents' willingness to pay for home location, many researchers have attempted to empirically estimate education premium passed on to the house price using hedonic regression approaches (Agarwal et al. (2016), Clapp et al. (2008), Fiva and Kirkebøen (2011), Gibbons et al. (2013), Fleishman et al. (2017)).[1]

Using a cross-section or a panel data of the housing market, these studies regressed house prices (housing rent and/or house sale price) on school quality variables such as academic achievement test scores, college attendance rates, and/or teacher-student ratios that correspond to the attendance area of the school in which the house is located, with some additional control variables that measure housing quality. The estimated coefficients of the school quality variables are interpreted as residents' average marginal willingness to pay for the school quality.

While the hedonic regression models are applicable to any cross-sectional and panel data of the housing market, two econometric identification problems arise: One is the endogeneity problem of the quality variables, and the other is the omitted variable problem in the

[1] There exist comprehensive survey articles on previous hedonic studies of the house price associated with school quality. They include Black and Machin (2011), Machin (2011), and Nguyen-Hoang and Yinger (2011).

regression models.

The first problem occurs when the capitalization of the housing market leads to an improvement in the quality of public schools, reverse causality will be present. This is the case when the local government's budget for public-school education depends on the school district's tax revenue: The more tax revenue from the residential property increases due to the capitalization of housing markets, the more education spending in the district increases, leading to an improvement in the quality of public schools. So far, the estimation using instrumental variables that are correlated with school quality, but not directly correlated with house price is applied by Black and Machin (2011).

The second problem is the uncontrollability of omitted variables that could affect house prices. The neighborhood factors surrounding a house such as access to train stations, shopping facilities and natural parks, as well as the quality of the landscape, might be worth paying for. But such information is not necessarily available to researchers. Similarly, demographic variables of neighbors are not always observable to researchers. It is well known that the omitted variables in the hedonic model can bias the estimated results by correlating with school quality. These problems are both identification problems of the causality effect of school quality variables in the estimation.

Recently, there has been a significant progress in the identification strategy of the causality effect of school quality in the hedonic models. In particular, studies using hedonic analysis have increasingly relied on regression discontinuity designs that focus on samples near school district boundaries. This approach, proposed by Black (1999) in analyzing the impact of elementary school districts on house prices in Boston, focuses on properties near school district boundaries that happen to be located in different districts, even though they have similar characteristics in terms of housing quality, environmental factors, and neighborhood amenities. By comparing these properties, the approach measures the impact on house prices of being located in school districts with different levels of educational quality.

If two adjacent houses located across a school district boundary are of exactly the same quality, and one is located in school district "A" and the other in school district "B", any difference in their house prices can be partially attributed to the quality of the schools to which they have access. Therefore, by performing a hedonic analysis on samples restricted to areas around the school district boundaries, the effect of differences in school districts on house prices can be revealed. Empirical studies using regression discontinuity designs include Beracha and Hardin III (2018), Carrillo et al. (2013), Dhar and Ross (2012), Kuroda (2018), La (2015), Machin and Salvanes (2016), Mothorpe (2018), and Ries and Somerville (2010).

However, it has been pointed out that there are other problems with analyses using regression discontinuity designs. One potential problem is that if the demographics of residents in a given area, such as race, education level, income level, and age composition, change discontinuously across school district boundaries, these differences in regional demographics could affect house prices (Bayer et al., 2007). For example, if there is a clear division between school district "A" with predominantly white residents and school district "B" with predominantly black residents on either side of a boundary, the difference in house prices between the districts may reflect not only the difference in accessible schools but also residents' preferences for the racial demographics of the area. In this case, estimating the impact of school districts on house prices using a regression discontinuity design would still lead to biased estimates.

As a result, recent regression discontinuity designs have taken two approaches. One is to refine the regression model by including as explanatory variables regional demographics that were previously treated as unobservable variables. However, this method is not always feasible due to significant data availability constraints. The other approach is to perform a quasi difference-in-differences analysis using multiple time points of real estate transaction data. In situations where there are changes in the school district boundaries at different time points, and it is assumed that there are no changes in the regional demographics of interest, it is possible to remove the effects of these demographics by taking the differences in house prices between the time points.

Empirical studies using data from multiple time points in a regression discontinuity design include Andreyeva and Patrick (2017), Neilson and Zimmerman (2014), Schwartz et al. (2014), and Chung (2015). These studies estimated the effect of school quality on house prices by accounting for differences in house prices before and after changes in the school choice environment occur.

In line with these studies, we conduct a house price analysis using regression discontinuity design at multiple time points for the housing market in Osaka City, Japan, which abolished the traditional public school district system between 2014 and 2015. Specifically, we use data on family-oriented rental housing located near the boundaries of public junior high school and high school districts to estimate the extent of the education premium embedded in rental prices. We also examine the extent to which such premiums have changed since the abolition of the school district system.

The paper is organized as follows: In section 2, we review the details of the abolition of the school district system in Osaka City and review previous studies. In section 3, we explain the data and empirical methods used in this study. We present the estimation results in section 4 and discuss the existing school quality premium in the following section 5. Finally, in section 6, we summarize the analysis results obtained in this study and discuss future research issues.

2 Research background

In this chapter, we first describe the process of abolishing the school district system in Osaka City. We then review previous studies that evaluated the impact of school quality on house prices using a regression discontinuity design, focusing on events in which accessible schools changed over time by establishing special permit schools or by changing the school district system. All of these studies estimated the education premium in cities outside Japan. We also describe a study that estimated the education premium in a rural Japanese city, albeit using a regression discontinuity design with cross-section data.

2.1 Abolition of school district system in Osaka City

In Japan, primary and secondary education has traditionally been provided through a school district system. In this system, local governments designate the areas in which students can attend public schools. For compulsory education including elementary and junior high school, the system divides the regional administrative districts into multiple school districts, and students are assigned to one school based on their home address. For high school, school districts are established across several administrative districts, and students are able to choose a high school to take an examination based on their academic ability from among several schools within the same school district.

In the 1990s, there was a growing demand to allow students to choose the schools they attend based on their own preferences or the wishes of their parents emerged. The importance of each public school highlighting its unique characteristics and competing with each other was also discussed in education committees and other institutions nationwide. Following these developments, the school district system was abolished in several urban areas, and the introduction of a "school choice system" that allows students to choose a school regardless of their home address was promoted.

The decision to introduce the school choice system in Osaka City was made in March 2013. Through deliberations in the Osaka City Board of Education, 12 out of the 24 administrative wards in the city abolished the school district system from the 2014 school year. The other 11 wards abolished the system from the 2015, allowing students to freely choose a public school within the same administrative ward for enrollment. In terms of high schools, the previous division of Osaka Prefecture into four school districts was completely abolished in the 2014 school year, allowing students to apply to any high school within the entire Osaka Prefecture.

To provide more details on the process of introducing the school choice system, in the 2014 year, the system was implemented in 12 administrative wards: Asahi, Chuo, Sumiyoshi, Nishiyodogawa, Konohana, Yodogawa, Fukushima, Minato, Tsurumi, Kita, Miyakojima, and Nishi. However, among these administrative wards, the first six wards introduced the school choice system for both elementary and junior high schools, while the remaining six wards introduced it for junior high schools in 2014 and for elementary schools in 2015, staggering the implementation. Furthermore, in 2015, the school choice system was implemented in 11 wards: Taisho, Tennoji, Higashiyodogawa, Suminoe, Hirano, Higashinari, Ikuno, Joto, Abeno, Higashisumiyoshi, and Nishinari. In these wards, elementary and junior high school districts were abolished at the same time.

On the other hand, there existed two areas that postpone introducing the school choice system. One is Naniwa ward, which introduce the school choice system in 2018, and the other is the western area of Ikuno Ward (covering 11 elementary schools and 4 junior high schools), which introduce the system in 2022. The reason for these areas to postpone the introduction of school choice system was the need to proceed with the consolidation and abolition of elementary schools first.

Fig 2.1 Location of public junior high schools and school districts in Osaka City prior to 2014

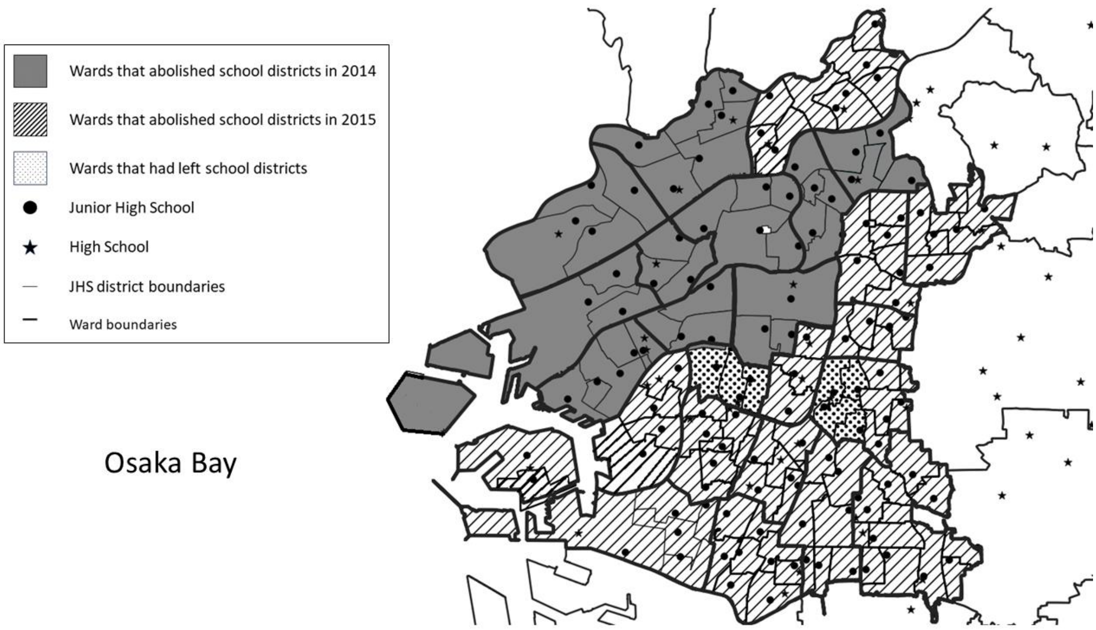
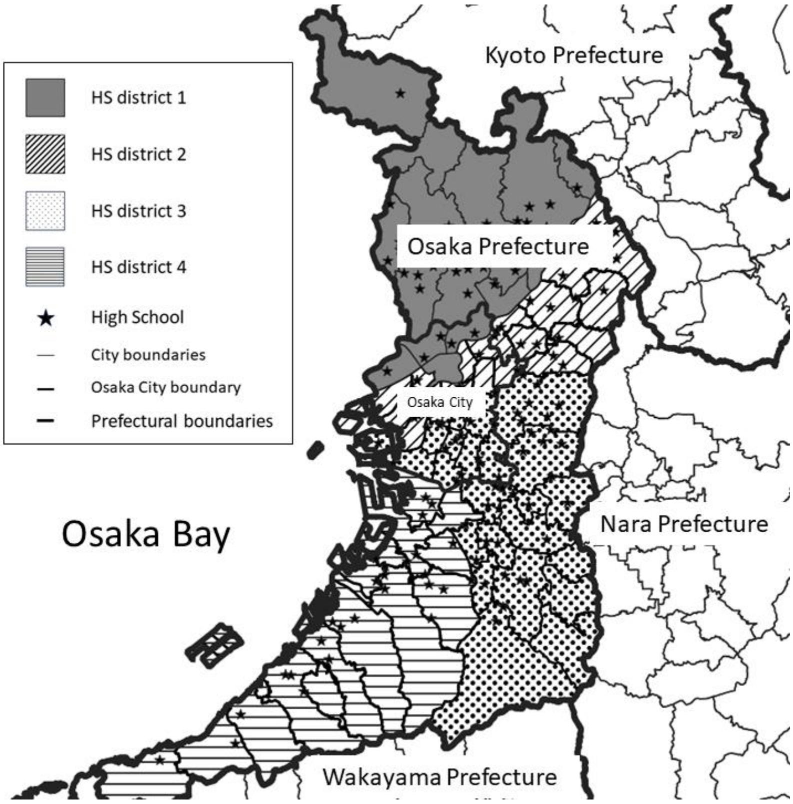


Figure 2.1 shows the location of public junior high schools and school district boundaries in Osaka City that existed before 2014. There are 24 administrative wards in Osaka City, which are enclosed by thick solid lines, and they were divided into several junior high school districts by thin solid lines. The black circles indicate the locations of junior high schools. The total number of junior high school districts in the city was 127.[2] For public high schools, Figure

[2] There are two national university-affiliated junior high schools in Osaka City. They are

2.2 shows the school district boundaries prior to 2014, dividing the entire Osaka Prefecture into four areas, three of which cover Osaka City. Osaka City shared these three school districts with other municipalities adjacent to Osaka City.[3]

Fig 2.2 Location of public high schools and school districts in Osaka City prior to 2014



2.2 Literature review

As explained in section 1, there are several empirical studies that have conducted hedonic analysis using regression discontinuity design with multiple time points to examine the impact of changes in the school attendance zone on house prices. These studies include Chung (2015), Schwartz et al. (2014), Andreyeva and Patrick (2017), and Neilson and Zimmerman (2014). In this section, we provide an overview of these previous studies.

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public schools that do not have a specific school district and we exclude these schools from our analysis. Similarly, public junior high schools that offer only evening courses and correspondence courses (one school each) are also excluded from the analysis.

[3] We exclude from our analysis high schools affiliated with national universities that do not have a specific school district. As a result, we consider 200 public high schools (prefectural and municipal) that were available to students living in Osaka City.

Chung (2015) investigates the relationship between school quality and house prices in Seoul, South Korea, during the 2010 high school district reform. Prior to the reform, the assignment method for Seoul's school district system was based on proximity, with students more likely to be assigned to schools closer to their residences within the same district. However, the 2010 reform introduced a randomized assignment method, allowing students to potentially attend schools outside their district if they wished. This change enabled students to choose schools regardless of their residence location. The study conducts a hedonic analysis with housing rent (and real estate prices) in the areas surrounding the school district boundaries as the dependent variable. As a measure of school quality, the study uses the enrollment rate for Seoul National University. The analysis results reveal that both rents and real estate prices in high-performing school districts decreased by approximately 10-27% compared to low-performing districts following the reform. Additionally, the study notes that the impact was more significant in areas closer to the school district boundaries.

Schwartz et al. (2014) analyzed the relationship between the quality of existing public elementary schools and house prices in areas where choice schools opened in New York City. When a choice school opens in a certain area, students who previously only had the option of attending public elementary schools within their school district are now given the option to attend a higher-performing school. Therefore, it is believed that changes in house prices are more likely to occur in areas geographically closer to choice schools. The study conducted a hedonic analysis using rental prices as the dependent variable and the reading and math abilities of students at existing schools, as well as the education and experience of teachers, as explanatory variables. They focused on rental properties in the surrounding areas where choice schools opened in New York City between 1989 and 2004. The results showed that when a choice school opened near an existing public elementary school, the impact of the quality of the public elementary school on rental prices fell to one third of the pre-opening level. The study also reported that this trend was stronger in areas where high-quality public elementary schools already existed.

Andreyeva and Patrick (2017) analyzed the impact of the opening of charter schools on rental prices in urban areas of Atlanta, Georgia. Charter schools have designated priority areas for enrollment, and students living within these areas have a higher probability of being admitted. Therefore, it is expected that there will be a discontinuity in house prices at the boundary between the area with the highest priority and the rest. Using a regression discontinuity design, this study conducted a hedonic analysis with the sale prices of real estate properties around the boundary of the priority areas of charter schools opened between 1990 and 2015 as the dependent variable. The results showed that the opening of charter schools increased house prices in the priority areas by 6-8% (average of $9,092 to $12,332). It was also found that this trend is more prominent in areas where the performance of existing public high schools is low and the difference with charter schools is large.

Neilson and Zimmerman (2014) examined the impact of a new elementary and middle school construction project (The School Construction Project) in New Haven, Connecticut, on house prices and academic performance. In this study, a hedonic analysis was conducted with the selling price of real estate properties within the target school district from January 1, 1995, to January 31, 2010, as the dependent variable. The results showed that house prices in the relevant areas increased by about 10%, and the number of enrollees in public schools also increased. The study also analyzed the academic performance of students within the school district using reading and mathematics test scores. In this regard, it was found that students' reading skills increased by 0.15 standard deviations more than before the completion of the planned building, up to six years after its completion, due to school construction and infrastructure improvements. However, no such trend was observed in the math test scores.

These studies combined a regression discontinuity design, which limited the analysis area to school district boundaries, with a difference-in-differences analysis utilizing the temporal changes in boundary areas. On the other hand, Kuroda (2018), which used rental property data in Matsue City, Shimane Prefecture, is a study using a regression discontinuity design with cross-sectional data from a single time point in Japan. This analysis examines the relationship between academic achievement of public schools and house prices by using rental property data near the boundaries of school districts in Matsue City. it was found that when the test scores of elementary schools increase by 10%, the rent of family-oriented rental properties in the district increases by approximately 1.7%. A similar trend was observed in middle schools, although the impact was smaller than that in elementary schools.

3 Estimation method and data

In this study, we use rental housing data from the city of Osaka that was posted on the housing and real estate information site LIFULL HOME'S between January 2013 and December 2016. As explained in section 1, a simple regression of rent on various environmental factors, including educational attainment, can lead to biased estimation results. Therefore, we conduct our analysis using a regression discontinuity design that limits target data to rental housing in the vicinity of the boundaries of public-school districts.

In Osaka City, the school district system was abolished from 2014 to 2015, and a school choice system was introduced. If there were differences in the rents of houses adjacent to the boundaries of school districts before the abolition of the school district system, and these differences disappeared with the abolition of the system, it can be interpreted that the impact of school quality on house prices disappeared as the public schools available for attendance were relaxed. In other words, by comparing the period before and after the abolition of the school district system, it is possible to identify the impact of the school quality of available schools on house prices. Therefore, the approach used in this study combines a regression discontinuity design using data from the vicinity of school district boundaries and a difference-in-differences analysis comparing the period before and after the abolition of the school district system.

3.1 Hedonic model

To apply the approach described above, we estimate a hedonic model that explains housing rents, considering the school quality of accessible public junior high and high schools, as well as the impact of the abolition of the school district system. The estimation equation is as follows:

$$\log(R_{ijt}) = \beta' X_{it} + \kappa \cdot 1(t \geq T_j) + \gamma \cdot test_{it} + \theta \cdot test_{it} \cdot 1(t \geq T_j) + \alpha_j + \mu_t + \epsilon_{ijt} \quad (3.1)$$

where the left-hand side represents the logarithm of the rent R_{ijt} of the rental housing i adjacent to the junior high school district boundary $j(=1, \dots, J)$ at time t. On the right-hand side, X_{it} represents the vector of observable characteristics of housing i. The variable $1(t \geq T_j)$ is a dummy that takes the value 1 at the time after the school district boundary j was abolished. Note that although the junior high school districts were abolished within each administrative ward in T_j =2014 or 2015, except for Naniwa ward and the western part of Hirano ward, the ward boundaries have remained as school district boundaries since then. Therefore $1(t \geq T_j)$ remains consistently 0 for the boundary j corresponding to the ward boundaries. The coefficient κ represents the average effect of the elimination of the school district boundary on rent. In the estimation, however, we will not be able to estimate κ because of the multicollinearity due to the inclusion of the time-fixed effect terms μ_t.

The variable $test_{it}$ is the quality of the junior high school district where housing i is located, and the coefficient γ is a parameter that measures the impact of the quality of the accessible junior high school on rent. The interaction term of $1(t \geq T_j)$ and $test_{it}$ measures a change in the impact of school quality on rent after the elimination of the school district boundary. In other words, if the coefficient θ is statistically significantly different from zero, it can be judged that there was a change in the capitalization of school quality after the abolition of the school district. Finally, α_j represents the fixed effect of boundary j and ϵ_{ijt} is the error term.

In this study, we use the school-specific average scores of Japanese language and mathematics in the nationwide academic achievement test conducted by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) for third-year junior high school students as a variable representing school quality.[4]

Although the above explanation is for a model that considers only the effect of junior high school districts, in the actual estimation, we also include the effect of high school districts. Since there are multiple public high schools within one school district, we use the average quality of high schools as the academic level corresponding to that high school district. As an indicator of school quality, we use the deviation score of each school's entrance exam published by the major cram school Osaka Shinken. The reason why we use this score is that the MEXT does not conduct or publish a nationwide academic survey for high schools.

3.2 Geographic data on rental housing and school district boundaries

We describe the data used to estimate equation (3.1). First, information on rental properties in Osaka City was obtained by web scraping the LIFULL HOME'S real estate archive. In constructing the analysis data, we extracted all rental housing in Osaka City that was posted on the web site from January 2013 to December 2016 from the archive. Since this analysis is interested in the relationship between the academic level of junior high schools and high schools and rents, we limit the target housing to those intended for households with children. Therefore, in terms of the layout of the houses, we consider houses of 2LDK or more, excluding 3K, as defined by LIFULL HOME'S for families.[5] The total number of rental houses that met these conditions was 81,896. The rental housing information includes the name of the building, address, age, posting period, rent, floor space, layout, floor number, building structure, and time required to the nearest station.

In this study, in order to conduct a hedonic analysis using a regression discontinuity design, it is necessary to identify the school district in which each house is located, and to determine whether they are located near school district boundaries. For this purpose, we used a Geographic Information System (GIS) to incorporate the boundary information of school districts on the map of Osaka City, and then calculated the distance from each house to the

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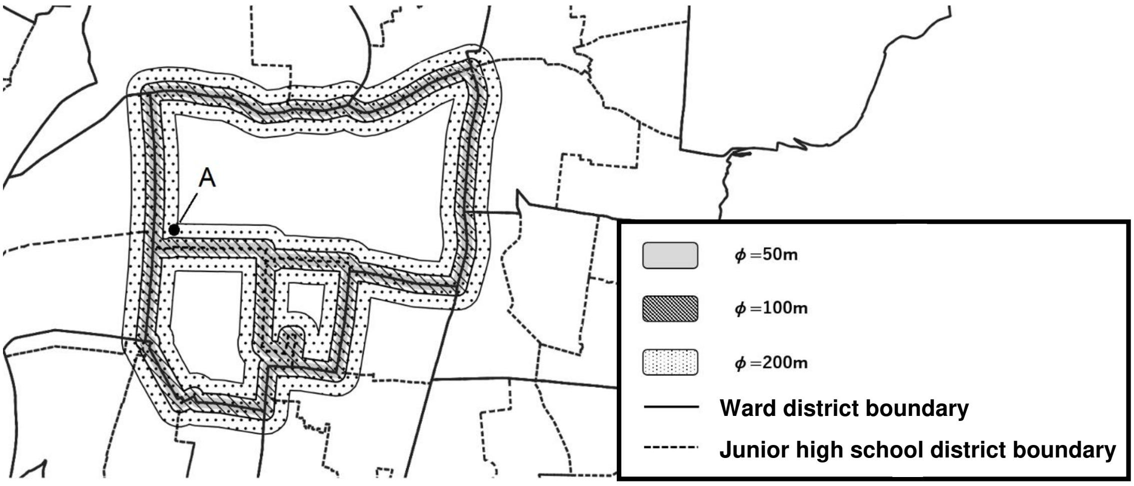
[4] The test is administered to sixth-grade students in public elementary schools and third-grade students in public junior high schools throughout Japan as part of the National Assessment of Academic Progress. For more information, please refer to the following website. https://www.nier.go.jp/English/departments/menu_8.html

[5] In the Japanese housing market, 2LDK refers to a property that has two separate rooms plus a living room, a dining room, and a kitchen. Living room, dining room and kitchen are often combined into one room.

schools that can be attended. The geographic information (shape file) for the boundaries of junior high school districts was obtained from the Planning Promotion Department of the Osaka City Planning Coordination Bureau. Since the boundaries of three high school districts covering Osaka City partially correspond to administrative ward boundaries, we created them separately from the shape file of Osaka City ward boundaries provided by the G Spatial Information Center.[6]

When extracting housings around the school district boundaries, we define a geographic range within a certain distance ϕ(=200, 100, 50m) from the school district boundaries as the boundary area. Figure 3.1 shows a specific example, the boundary area for junior high school districts in Chuo Ward. In this figure, the thick solid lines represent the boundaries of administrative ward districts. The dotted lines represent the boundaries of junior high school districts. For each boundary line, the lightly gray-painted range represents the boundary area of ϕ=50m, the hatched range represents ϕ=100m, and the dotted range represents ϕ=200m.

Fig. 3.1 Boundary area in the junior high school districts of Chuo Ward, Osaka City



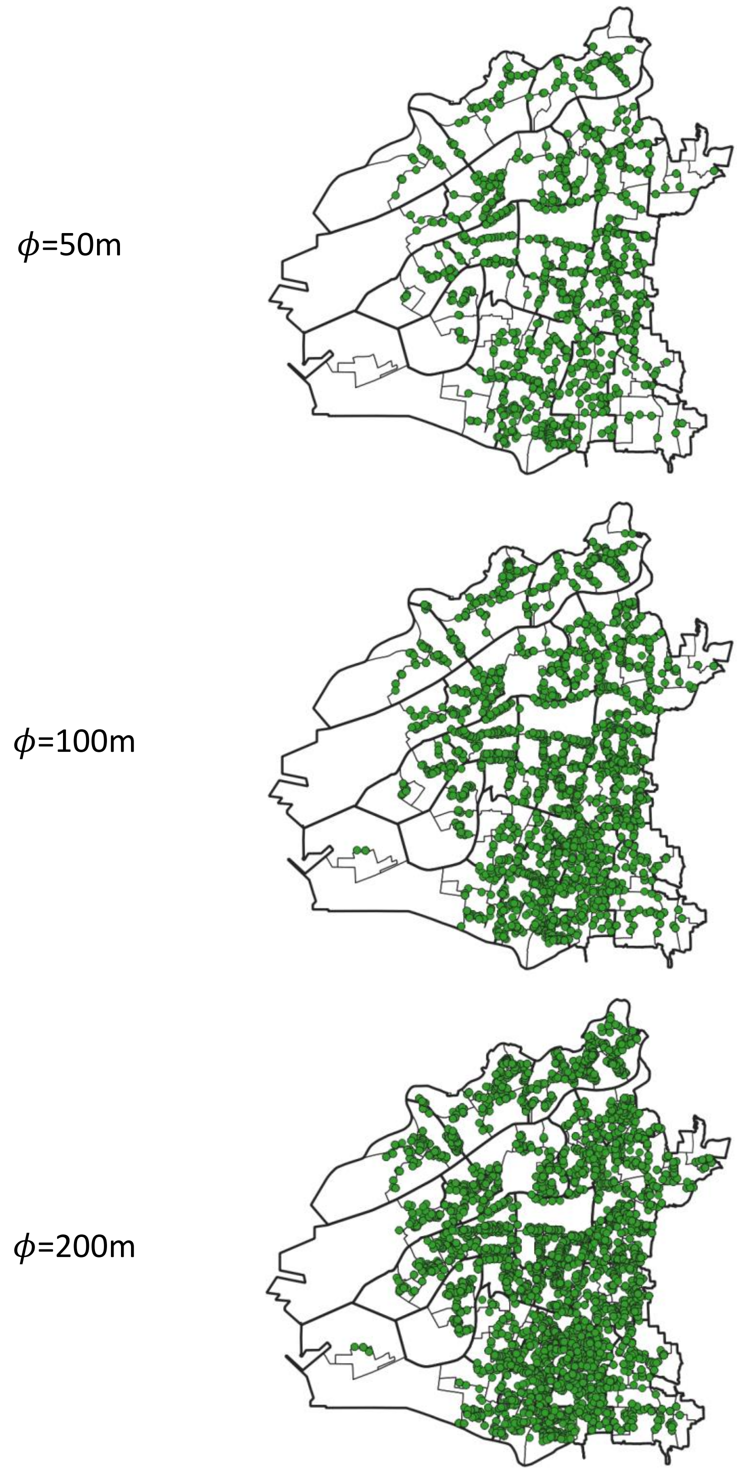
To apply the regression discontinuity design, we focus on the housing located within these boundary areas. One issue to consider when enlarging the boundary areas is the existence of houses adjacent to multiple boundary lines. For example, in the area around point A in Figure 3.1, there are housings adjacent to both the administrative ward boundary of Chuo Ward and the junior high school district boundary within the ward. In this area, there are multiple junior high schools that could be compared outside the boundary line, and thus the housing rent

6 https://front.geospatial.jp/

would be influenced from the academic performance of the multiple schools outside the district. To avoid mixed results due to the presence of multiple entities for comparison, we decided to remove from our analysis housings adjacent to two or more boundary lines. In other words, the target of our study is housings that are within a certain range ϕ from the junior high school district boundary or the ward boundary line and that are adjacent to only one boundary line. Similarly, we defined the boundary area for high school districts.

As a result, the number of housing that satisfied the above boundary area condition was 37,893 for ϕ=200m, 24,948 for ϕ=100m, and 12,219 for ϕ=50m out of the 81,896 rental housing obtained from LIFULL HOME'S. In Figure 3.2, the locations of our sample are plotted on a map of Osaka City for each of ϕ= 50m, 100m, 200m and all cases.

Fig 3.2 Locations of targeted rental housings



3.3 Data description

Here, we explain the details of the data used to estimate equation (3.1). First, the analysis period is 48 months from January 2013 ($t = 1$) to December 2016 (t =48), during which the rental houses registered on the housing information website of LIFULL HOME'S are the subject of the analysis. The year and month in which the target housing was listed is considered as the time when the rental contract was concluded. For houses listed over multiple months, the end of the listing period is considered the contract date.

The rent, which is the dependent variable in the regression model, is the monthly amount (in ten thousand JPY) excluding management fees and common service charges. The reason for not including these costs is that the LIFULL HOME'S archive does not provide information on these fees, so they are not available for use.

The observable attributes X_{it} of the rental housing include age of building (in months), floor space (in square meters), floor dummy (1F to 10F, 11F and above), building structure dummy (wood, steel, light steel, PC, RC, ALC, SRC, HPC, others), and the linear distance (in meters) to the nearest junior high school.[7] These are all obtained from the housing data of LIFULL HOME'S. As an indicator of convenient transportation and easy access to commercial facilities, we use the linear distances to the nearest train station and to Umeda Station, a major terminal. These were measured using QGIS based on the address of each house.

Also, X_{it} includes demographic information about the area around the house, such as population, male population ratio, 0-14 age population ratio, 65+ age population ratio, number of people per household, and number of crimes per year. For all of these except for the number of crimes, we obtained the 500m mesh data from the 2015 Statistical Geographic Information System published by the Statistics Bureau of the Ministry of Internal Affairs and Communications, and assigned the corresponding values to each house by deploying them on QGIS. For the number of crimes, we use the number of snatch theft incidents at the town street level published by Osaka City as a proxy variable.

The dummy variable d_{ij} indicating which boundary line each house is adjacent to, was generated by creating boundary areas of ϕ=50, 100, 200m for each boundary line on QGIS, and assigning 1 to houses within that area and 0 to other houses.

For the academic quality variable $test_{jt}$ for public junior high schools, we used the deviation value of the national academic test scores (average of Japanese language and mathematics)

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[7] For construction structure variables, abbreviations stand for prestressed concrete as PC, reinforced concrete as RC, autoclaved lightweight aerated concrete as ALC, steel reinforced concrete as SRC, hard precast concrete as HPC respectively.

from 2013 to 2016, extracted from the websites of each junior high school. For schools that were unable to obtain test scores for these years due to data deletion or other reasons, we substituted the average of available test scores from 2017 to 2021.[8] On the other hand, the academic quality variable for high schools was measured using the deviation value corresponding to the lower limit of the "safe zone for passing" reported in the "High School Entrance Examination Guidebook for Private and Public Examinations 2015 (Kansai Edition)" published by Osaka Shinken.

Table 3.1 presents basic statistics for the above variable data, for houses in the boundary areas of ϕ =50, 100, 200m, and for all houses.

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[8] The national academic achievement test was not conducted in 2020 due to the spread of the COVID-19 pandemic.

Table 3.1 Summary statistics of variables

	All houses				ϕ =200m				ϕ =100m				ϕ =50m			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Rent (ten thousand JPY)	9.16	3.28	2.70	74.40	9.20	3.23	3.40	67.20	9.44	3.55	3.40	67.20	9.50	3.85	3.40	67.20
Academic scores (deviation value)																
Junior high school	52.05	8.25	19.70	79.48	52.40	8.69	19.70	79.48	52.67	8.63	26.77	79.48	53.18	8.62	29.22	79.48
High school	48.28	0.66	47.32	50.01	48.27	0.66	47.32	50.01	48.25	0.65	47.32	50.01	48.24	0.64	47.32	50.01
Housing variables																
Floor space (m^2)	58.89	12.91	11.50	313.15	58.96	13.14	11.50	313.15	59.62	14.08	11.50	313.15	60.05	16.13	20.00	313.15
Age of building (month)	252.62	116.75	0.00	669.00	251.67	116.52	0.00	669.00	253.60	119.23	0.00	653.00	257.60	118.09	0.00	653.00
Floor dummy																
2F	0.17	0.38	0.00	1.00	0.17	0.38	0.00	1.00	0.16	0.37	0.00	1.00	0.15	0.36	0.00	1.00
3F	0.17	0.38	0.00	1.00	0.17	0.37	0.00	1.00	0.16	0.37	0.00	1.00	0.16	0.37	0.00	1.00
4F	0.15	0.35	0.00	1.00	0.14	0.35	0.00	1.00	0.14	0.35	0.00	1.00	0.14	0.35	0.00	1.00
5F	0.11	0.31	0.00	1.00	0.11	0.32	0.00	1.00	0.11	0.32	0.00	1.00	0.12	0.33	0.00	1.00
6F	0.09	0.28	0.00	1.00	0.09	0.28	0.00	1.00	0.09	0.28	0.00	1.00	0.09	0.29	0.00	1.00
7F	0.07	0.25	0.00	1.00	0.07	0.25	0.00	1.00	0.07	0.26	0.00	1.00	0.08	0.27	0.00	1.00
8F	0.05	0.21	0.00	1.00	0.05	0.21	0.00	1.00	0.05	0.22	0.00	1.00	0.05	0.22	0.00	1.00
9F	0.03	0.18	0.00	1.00	0.03	0.18	0.00	1.00	0.04	0.19	0.00	1.00	0.04	0.19	0.00	1.00
10F	0.03	0.16	0.00	1.00	0.03	0.17	0.00	1.00	0.03	0.18	0.00	1.00	0.03	0.17	0.00	1.00
11F and above	0.06	0.23	0.00	1.00	0.06	0.24	0.00	1.00	0.07	0.26	0.00	1.00	0.08	0.26	0.00	1.00

Table 3.1 Summary statistics of variables (cont.)

	All houses				ϕ =200m				ϕ =100m				ϕ =50m			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Building structure variables																
Wooden	0.01	0.08	0.00	1.00	0.01	0.07	0.00	1.00	0.01	0.08	0.00	1.00	0.01	0.08	0.00	1.00
Steel	0.14	0.35	0.00	1.00	0.14	0.35	0.00	1.00	0.14	0.35	0.00	1.00	0.15	0.35	0.00	1.00
Light steel	0.02	0.14	0.00	1.00	0.02	0.13	0.00	1.00	0.01	0.11	0.00	1.00	0.01	0.11	0.00	1.00
PC	0.00	0.04	0.00	1.00	0.00	0.04	0.00	1.00	0.00	0.04	0.00	1.00	0.00	0.05	0.00	1.00
RC	0.57	0.49	0.00	1.00	0.56	0.50	0.00	1.00	0.55	0.50	0.00	1.00	0.57	0.50	0.00	1.00
ALC	0.00	0.07	0.00	1.00	0.01	0.08	0.00	1.00	0.01	0.08	0.00	1.00	0.00	0.06	0.00	1.00
SRC	0.20	0.40	0.00	1.00	0.20	0.40	0.00	1.00	0.23	0.42	0.00	1.00	0.21	0.41	0.00	1.00
HPC	0.00	0.01	0.00	1.00	0.00	0.01	0.00	1.00	0.00	0.02	0.00	1.00	0.00	0.02	0.00	1.00
Distance to nearest station (m)	441.3	266.3	16.2	2417.2	439.2	269.1	16.2	1725.2	422.7	260.0	16.2	1662.9	431.5	257.4	16.2	1662.6
Distance to Umeda station (m)	5721.4	2653.5	402.8	12808.0	5668.0	2636.7	682.2	12746.4	5676.5	2679.9	825.0	12555.1	5594.0	2939.1	825.0	12555.1
Distance to nearest JHS (m)	491.8	228.7	10.8	1502.7	503.2	231.1	10.8	1310.7	497.7	229.3	26.0	1310.7	497.5	226.8	32.7	1310.7
Demographic variables																
Population	4749	1595	79	9677	4818	1549	142	9677	4847	1483	142	9677	4937	1498	142	9144
Male population ratio	0.48	0.02	0.35	0.73	0.48	0.02	0.35	0.73	0.48	0.02	0.35	0.73	0.48	0.02	0.35	0.73
0-14 years old population ratio	0.11	0.03	0.02	0.27	0.11	0.03	0.02	0.27	0.11	0.03	0.02	0.27	0.11	0.03	0.02	0.27
Over 65 years old population ratio	0.23	0.06	0.06	0.67	0.23	0.06	0.06	0.67	0.23	0.06	0.06	0.67	0.23	0.06	0.06	0.67
Number of people per household	2.01	0.33	1.27	5.16	2.01	0.33	1.27	5.16	2.01	0.33	1.27	5.16	2.01	0.33	1.27	5.16
Annual number of crimes	0.22	0.52	0.00	3.00	0.21	0.53	0.00	3.00	0.24	0.58	0.00	3.00	0.19	0.47	0.00	3.00
Number of observations	81896				37893				24948				12219			

4 Estimation results

In this section, we will explain the estimation results of equation (3.1). Table 4.1 shows the estimated coefficients and their standard errors when the boundary area is set to (1) all, (2) ϕ=200m, (3) ϕ=100m, and (4) ϕ=50m. Although the estimated coefficients of most variables change to some extent depending on the value of ϕ, there are no substantial differences in the sign conditions and significance, except for the case of ϕ=50m in which variables related to academic scores are insignificant. Therefore, the following explanation is based on the results of ϕ=200m.

First, regarding the relationship between academic performance and housing rent, junior high school test scores are significantly positive at the 0.1% level. This means that houses located in school districts with high test scores have higher rents. Translating the effect on rent into monetary terms, it shows that when the deviation value of the test score of junior high school increases by 1, the monthly rent of increases by 48 JPY (only 0.05% of the average rent).[11]

Furthermore, even in the interaction term with the school district abolition dummy, the test scores were significantly positive at the 0.1% level. This indicates that the education premium has increased since the abolition of the school district system, resulting in an estimated result opposite to that of previous studies. Specifically, the impact on the rent when the deviation value increases by 1 after the abolition of the school district increases from 48 to 66 JPY (0.07% of the average rent). This result will be discussed in detail in Section 5.

On the other hand, it was found that the academic scores of high schools, unlike junior high schools, have a negative effect on the rent: a unit increase of the deviation value reduces the rent by 340 JPY (0.11%). However, the significance of the coefficient disappears when the boundary area is narrowed from ϕ=200m to 100m, 50m. The negative coefficient of the high school score implies that housing rents tended to be higher in school districts with lower high school scores. Note, however, that this analysis assigns an "average" of the high school scores in the school district to each housing unit, so the impact on housing rents is based on the average within the school district, unlike in the case of the junior high school. In fact, the variation in high school scores is much smaller than in junior high schools (see Table 3).

Furthermore, there is no significance for the interaction term between the school district abolition dummy and the high school academic scores. This implies that there was no change in the education premium after the abolition of the school district system for high schools.

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[11] In the log-linear model in (3.1), a unit increase in the deviation value of the test score $test_{it}$ increases the rent $\widehat{R_i}$ by $\hat{\gamma}\widehat{R_i}$. We calculated the average value of $\hat{\gamma}\widehat{R_i}$ over all houses for $\phi = 200$m.

This finding should not be surprising, since prior to the abolition of the school district, students were free to apply to one of several high schools in the district, so the abolition of the high school district had little effect on rents.

Next, for the housing attribute variables, floor space and building age are significantly positive at the 0.1% level. As the floor space expands by $1m^2$, the rent increases by about 991 JPY (1.08%) on average. For each additional year of age (12 months), the average rent decreases by 978 JPY (1.06%). As for the floor dummies, there is a tendency for the rent to increase as the number of floors increases relative to the first (ground) floor. Regarding building structure dummies, compared to other structures, wood construction is negatively significant, and PC, RC, SRC are positively significant. This means that special structures with high durability such as PC, RC, and SRC tend to increase the rent, while cheaper wooden structures tend to decrease the rent. For example, switching from wood construction to RC increases the rent by 7.3%. For the distance variables, the farther the distance to the nearest train station and Umeda station, the lower the rent tends to be, suggesting that the convenience of transportation is reflected in the rent. On the other hand, the distance to the nearest junior high school is ambiguous: it is positively significant when ϕ =200m, but not significant when ϕ =100m, and negatively significant when ϕ =50m.

With regard to the regional demographic variables, all variables except the proportion of the population under the age of 14 are statistically significant at the 5% level. While the total population has a positive effect on rents, areas with a higher proportion of males and people aged 65 and over tend to have lower rents. This may be due to the fact that women are more likely than men to value the safety of the environment, the floor level of the room, and facilities such as automatic locking systems, which may be reflected in the rent. The proportion of people aged 65 and over may be linked to a decrease in income levels due to the increase of pensioners. There is also a negative significant trend in the number of people per household. However, the proportion of the population under the age of 14 is only negatively significant at the 0.1% level when using all data, and significance was not observed in other cases.

As for the number of crimes, it is positively significant at the 0.1% level, suggesting that the rent increases as the number of crimes increases. This result requires further interpretation. First, the number of crimes is small in absolute terms and may be due to chance. The number of incidents of purse snatching in this analysis is, at most, three, and in most cases, zero. Consequently, it is possible that the impact of a purse snatching incident that happened to occur in that location is heavily reflected in the estimation results.

Another possible reason is that this variable may include factors other than the safety of the surrounding area. It can be observed that minor crimes such as purse snatching tend to occur in areas where there is a significant discrepancy between the daytime and night-time populations, such as downtown areas. In this case, it can be anticipated that this variable strongly reflects the influence of commercial areas, which is not apparent from regional demographics based on the night-time population.

Table 4.1 Estimation results

	(1)	(2)	(3)	(4)
	All houses	ϕ =200m	ϕ =100m	ϕ =50m
Academic scores (deviation value)				
Junior high school	3.45E-03 ***	5.28E-04 ***	8.80E-04 ***	-2.69E-04
	(7.42E-05)	(1.39E-04)	(1.80E-04)	(2.94E-04)
Interaction between JHS district abolition dummy	2.50E-04 ***	1.99E-04 ***	2.49E-04 ***	1.80E-04 *
	(3.17E-05)	(4.81E-05)	(5.92E-05)	(8.46E-05)
High school	-9.82E-03 ***	-3.72E-03 *	-1.93E-03	-4.60E-04
	(1.10E-03)	(1.57E-03)	(2.06E-03)	(3.01E-03)
Interaction between HS district abolition dummy	3.14E-03 ***	1.15E-03	5.40E-04	-1.88E-03
	(1.54E-03)	(2.02E-03)	(2.61E-03)	(3.72E-03)
Housing variables				
Floor space (m^2)	0.012 ***	0.011 ***	0.011 ***	0.010 ***
	(1.18E-04)	(1.86E-04)	(2.32E-04)	(2.98E-04)
Age of building (month)	-8.93E-04 ***	-8.93E-04 ***	-9.15E-04 ***	-9.13E-04 ***
	(5.11E-06)	(7.43E-06)	(8.82E-06)	(1.29E-05)
Floor dummy				
2F	0.003	0.006 *	0.004	0.004
	(0.002)	(0.003)	(0.004)	(0.006)
3F	0.011 ***	0.011 ***	0.007 *	0.013 *
	(0.002)	(0.003)	(0.004)	(0.006)
4F	0.004	0.007 *	0.009 *	0.016 *
	(0.002)	(0.003)	(0.004)	(0.006)
5F	0.016 ***	0.018 ***	0.013 ***	0.020 **
	(0.002)	(0.003)	(0.004)	(0.006)
6F	0.031 ***	0.032 ***	0.024 ***	0.031 ***
	(0.002)	(0.003)	(0.004)	(0.006)
7F	0.045 ***	0.048 ***	0.040 ***	0.046 ***
	(0.003)	(0.004)	(0.004)	(0.007)
8F	0.054 ***	0.055 ***	0.049 ***	0.062 ***
	(0.003)	(0.004)	(0.005)	(0.007)
9F	0.077 ***	0.071 ***	0.066 ***	0.069 ***
	(0.003)	(0.004)	(0.005)	(0.007)
10F	0.095 ***	0.098 ***	0.090 ***	0.091 ***
	(0.004)	(0.005)	(0.006)	(0.009)
11F and above	0.175 ***	0.156 ***	0.142 ***	0.137 ***
	(0.003)	(0.004)	(0.005)	(0.008)

Note: Values in parenthesis indicate the heteroskedasticity robust standard errors of parameters.
Significance levels: * 5%, ** 1%, *** 0.01%.

Table 4.1 Estimation results (cont.)

	(1)	(2)	(3)	(4)
	All houses	ϕ =200m	ϕ =100m	ϕ =50m
Building structure variables				
Wood	-0.039 ***	-0.036 ***	-0.040 ***	-0.047 ***
	(0.005)	(0.009)	(0.010)	(0.013)
Steel	-0.005 *	-0.005	-0.009	-0.015
	(0.002)	(0.005)	(0.006)	(0.009)
Light steel	-0.014 ***	0.002	0.015	0.024 *
	(0.003)	(0.006)	(0.008)	(0.011)
PC	0.007	0.033 **	0.059 ***	0.071 ***
	(0.008)	(0.011)	(0.016)	(0.018)
RC	0.032 ***	0.038 ***	0.037 ***	0.050 ***
	(0.002)	(0.005)	(0.006)	(0.008)
ALC	0.035 ***	0.003	0.001	0.076 ***
	(0.006)	(0.010)	(0.011)	(0.016)
SRC	0.032 ***	0.023 ***	0.030 ***	0.060 ***
	(0.002)	(0.005)	(0.006)	(0.009)
HPC	0.113 ***	-0.026	-0.007	-0.030
	(0.023)	(0.032)	(0.032)	(0.035)
Distance to nearest station (m)	-4.17E-05 ***	-4.50E-05 ***	-4.96E-05 ***	-1.22E-05
	(1.87E-06)	(4.34E-06)	(5.57E-06)	(9.27E-06)
Distance to Umeda station (m)	-2.13E-05 ***	-2.46E-05 ***	-4.21E-05 ***	-5.75E-05 ***
	(2.48E-07)	(2.11E-06)	(2.62E-06)	(4.25E-06)
Distance to nearest JHS (m)	-6.55E-07 ***	1.04E-05 *	9.43E-06	-3.81E-05 ***
	(2.17E-06)	(4.49E-06)	(5.72E-06)	(1.01E-05)
Demographic variables				
Population	5.06E-06 ***	5.98E-06 ***	3.59E-07	-1.02E-05 ***
	(3.58E-07)	(7.27E-07)	(9.48E-07)	(1.24E-06)
Male population ratio	-1.076 ***	-0.803 ***	-1.060 ***	-1.446 ***
	(0.028)	(0.065)	(0.112)	(1.903)
0-14 years old population ratio	-0.273 ***	-0.046	0.025	-0.127
	(0.038)	(0.069)	(0.096)	(0.177)
Over 65 years old population ratio	-0.420 ***	-0.233 ***	-0.153 ***	-0.161 *
	(0.013)	(0.029)	(0.042)	(0.076)
Number of people per household	-0.078 ***	-0.019 *	-0.026 *	-2.124
	(0.004)	(0.008)	(0.012)	(0.020)
Annual number of crimes	0.016 ***	0.005 ***	0.007 ***	-0.005
	(0.001)	(0.001)	(0.002)	(0.003)
Intercept	2.878 ***	2.400 ***	2.573 ***	2.864 ***
	(0.057)	(0.090)	(0.122)	(1.832)
Boundary dummies	NO	YES	YES	YES
Monthly Time effects	YES	YES	YES	YES
Number of observations	81896	37893	24948	12219
Adjusted R-squared	0.784	0.824	0.848	0.857
F-statistics	3753 ***	669.9 ***	516.8 ***	305 ***

Note: Values in parenthesis indicate the heteroskedasticity robust standard errors of parameters.
Significance levels: * 5%, ** 1%, *** 0.01%.

5 Discussion

In this section, we will discuss the relationship between the academic performance of public schools and housing rent, based on the estimation results obtained in the previous section.

5.1 Why is the education premium so small?

First, the estimation results indicate that the test scores of accessible public junior high schools have a positive effect on rent. Specifically, a unit increase in the deviation value of the test scores of a junior high school increases the housing rent by 48 JPY. This figure is considerably smaller than the results of the previous study by Kuroda (2018), which focused on the education premium capitalized in the rural housing market in Japan. The author reported that, in Matsue City, Shimane Prefecture, a 10% increase in the test scores at an accessible elementary school (equivalent to 6.7 points in score) is associated with 1.7% increase in the housing rent. If we apply this figure to the average rent in the city, the corresponding change in rent is 964 JPY (=56,724 JPY × 0.017). This is equivalent to 144 JPY per point in test score. On the other hand, in our study, a deviation value of 1 for a junior high school test score corresponds to 0.9 points in the score, and the impact on the rent per point is 53 JPY (=48/0.9). Consequently, despite the differences between elementary and junior high schools, our result is close to one-third of the results obtained in Kuroda (2018).

Three potential explanations for this result can be proposed. First, there may be a significant disparity in the preferences of residents in Matsue City and Osaka City regarding the academic performance of public junior high schools. Osaka City, excluding the 23 special wards of Tokyo, is the second largest municipality in Japan with a population of 2.7 million (2015), while Matsue City, a regional city, has a population of 200,000. The population difference between the two cities is more than 13 times. In general, metropolitan areas are believed to have house prices that are more influenced by the specifications and conditions of a house than regional cities. For example, although the average floor space of houses in Osaka City is considerably smaller than in Matsue City, the monetary value per square meter of floor space would be proportionately greater.[12] Moreover, the environmental factors surrounding houses in Osaka City, such as the convenience of transportation, the availability of commercial facilities, the demographics of nearby residents, public safety, noise, and the natural environment, vary significantly by area. These factors may be considered more important than the academic level of public schools.

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[12] In 2018, the total floor area per house was 103.1 square meters in Matsue City, while it was only 62.9 square meters in Osaka City (Ministry of Internal Affairs and Communications, Housing and Land Statistics Survey).

Secondly, more importantly, there is a significant disparity between the two cities in the availability of high-scoring "private" junior high schools, which have no constraints on student residential address. The number of private junior high schools in Matsue City is limited to only three (average deviation score of 50), whereas Osaka City has 28 private schools (average deviation score of 55). This discrepancy suggests that the influence of the academic performance of public junior schools on housing rent may be less pronounced in Osaka City.

Thirdly, prior to the 2016 school year, the internal examination score (Naishin-ten) for entry into high school at junior high schools in Osaka City were based on a relative evaluation within the school, rather than an absolute evaluation.[13] This resulted in the problem of adverse selection, whereby students with high academic ability were willing to choose junior high schools with lower academic performance in order to obtain higher scores. If such behavior were prevalent, the impact of academic performance of public junior high schools on house prices would be reduced.

In contrast to the finding for junior high schools, the effect of high school academic performance on rent was found to be negative for $\phi = 200$m or not statistically significant for $\phi = 100, 50$m. It should be note that this result does not immediately imply that rents are lower in areas with higher academic scores for commutable public high schools. Unlike junior high school districts, high school districts are set up across a wide range of administrative divisions and municipalities. Within these districts, there are a number of public high schools with a variety of academic scores. Students are able to choose a single school to take an entrance examination based on their academic abilities. Therefore, this result indicates that public high school districts with high academic scores tend to cover relatively low-rent areas.

5.2 Why did the education premium increase after the abolition of the school district system?

In section 4, we also find that the education premium capitalized in rent did not decrease but rather increased after the abolition of school districts. Specifically, after the abolition of the school district system, the premium increased from 48 to 66 JPY. This is the opposite result to that of Chung (2015), who analyzed the impact of the reform of the school district system in Seoul. There are three possible reasons for this result, including (1) The effect of

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[13] In Japan, junior high school students are evaluated via a system known as "Naishin-ten," which assesses their academic performance and behavior in school. Typically, homeroom teachers in junior high school evaluate their students, and this evaluation affects the students when they go on to high school. In response to the adverse selection issue, the Osaka City Board of Education implemented a system change based on absolute evaluation from 2016 onwards.

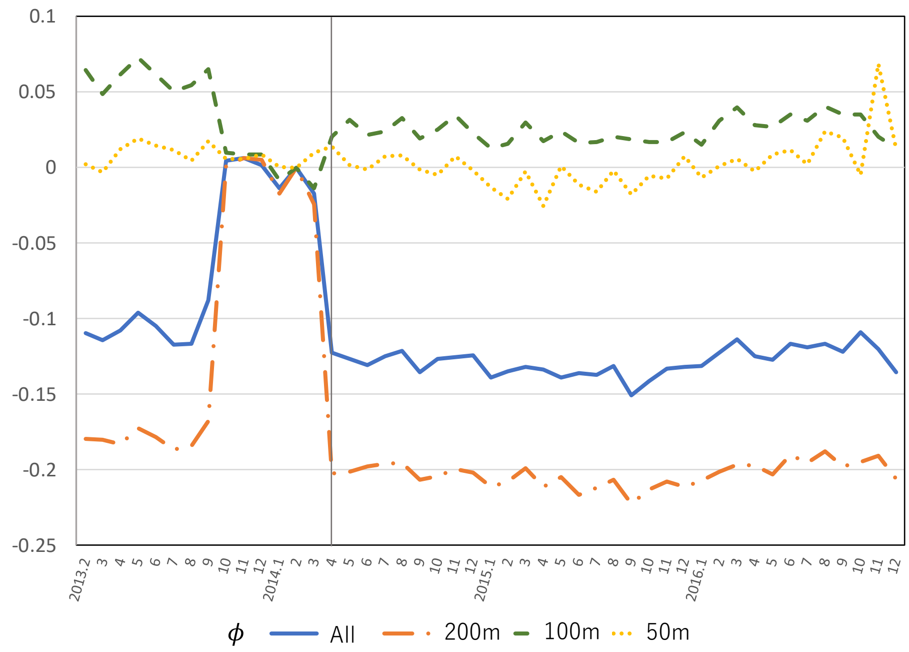
change in the consumption tax rate and (2) the influence of information disclosure on academic performance, and (3) the dysfunctionality of the school choice system.

First, in Japan, the consumption tax rate was raised from the conventional 5% to 8% in April 2014. While residential rents are not subject to consumption tax, the tax increase impacts the overall demand for consumer goods, which in turn may have affected house prices through the substitution of goods. Additionally, newly constructed houses subsequent to the tax increase may reflect the surging construction costs in the rent charged.

Consequently, it is necessary to examine the impact of the consumption tax increase on rental prices by plotting the estimated values of the time effect μ_t from Equation (3.1). This time effect encapsulates macroeconomic shocks that are not directly considered in the estimation model, such as changes in the consumption tax rate.

Figure 5.1 illustrates the substantial fluctuations in the time effect observed from October 2013 to March 2014 for the boundary areas of ϕ= all, 200m, and 100m. The absolute value of the time effect exhibits a notable decline in October 2013 but then approaches its previous level again in April 2014. This indicates that there was a macroeconomic adjustment in housing rent six months prior to the tax increase. If the impact of abolishing the school district system were included in this macroeconomic shock, the same trend should appear not only at the first phase of abolition in April 2014, but also at the second phase in April 2015. Nevertheless, such a trend is not observed in the time effect, which indicates that the impact can be considered separate from the macro-level shocks.

Figure 5.1 Transition of the estimated values of the time effect μ_t



Next, we will consider the announcement effect of disclosing information about school academic performance. In October 2013, prior to the abolition of the school district system, the Osaka City Board of Education required all public elementary and junior high schools in the city to publish the results of the national academic proficiency test on their school websites. Prior to the policy requirement, only a limited number of junior high schools had voluntarily reported their test results. However, the requirement resulted in virtually all junior high schools being obliged to disclose their test scores.[14]

While residents had previously judged the academic performance of junior high schools based on vague information such as rumors and online word-of-mouth, after the information disclosure, they were able to know the direct test scores. Consequently, the dissemination of information about the academic performance of public schools coincided with the abolition of the school district system. This may have heightened residents' awareness of education and their preference for school districts with higher deviation scores. Such an announcement effect of information disclosure may have appeared as a positive result in the estimates of the interaction term between the abolition dummy and the test scores in equation (3.1).

Indeed, recent empirical studies have shown that the disclosure of information about school quality can affect housing rents. For example, Kuroda (2021) estimated the effect on housing rents of the disclosure of the average national achievement test scores of public junior high schools in Matsue City, which were released in October 2014. The analysis revealed that for every one-point increase in the disclosed test score, house prices increased by 0.5 to 1.5 percent.

Another possibility we should consider is that the newly implemented school choice system is not working well. Although the abolition of the school district system, in principle, allows students to freely choose a junior high school outside the former school district, in reality, they may not be able to freely choose due to school capacity constraints. According to the Osaka City government, the average percentage of junior high school students who used the school choice system in the 23 wards increased from 2.7% to 4.9% from 2015 to 2019. However, there are salient differences in utilization rates between wards. For example, Nishinari-ku, the ward with the highest utilization rate, has 11.4 %, while Tennoji-ku, the ward with the lowest utilization rate, has only 1.2 %. This is due to the fact that in wards with a growing population under 14 years of age, there is no room in each school to accommodate

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[14] According to the Osaka City Board of Education, mere 19 out of 424 public schools, including both elementary and junior high schools, had disclosed their test scores in 2012. On the other hand, all elementary and junior high schools in the city had published the results of the 2013 academic achievement test by February 2014.

students from outside the school district. Thus, even if the school district system is abolished, if students are not free to choose their schools, the restriction by home address will not disappear and the education premium on housing rent will remain.

In contrast to the junior high schools, the abolition of high school districts did not have a significant effect on the education premium. One possible reason is that even before the abolition of the school district system, there was a sufficient variation in the academic performance of high schools within a school district and students could choose a school based on their own academic abilities. In addition, the fact that academic level of each high school was widely known through the admissions guides may have reduced the impact of the change.

6 Concluding Remarks

This study examined the impact of the academic performance of accessible public schools on house prices within school districts, using rental housing data in Osaka City. To ensure the reliability of the results, the analysis was limited to houses located within a specified distance from the boundary of public school districts. This approach allowed for the implementation of a hedonic analysis using a regression discontinuity design.

The results indicate that a 1% increase in the deviation value of a district's junior high school's national achievement test score is associated with an average rent increase of 48 JPY (equivalent to 0.05% of the average rent) in that area. This education premium is significantly smaller than that found in the rural area in Japan. This result implies that large metropolitan areas such as Osaka City, housing specifications, and environmental factors are more strongly reflected in the rent, potentially reducing the relative impact of the academic level of accessible public schools. Other potentially important factors are the presence of numerous private junior high schools that are not subject to district restrictions, as well as the relative evaluation system adopted on internal examination scores.

We also measured changes in the education premium over time, using data before and after the abolition of the district system. Our findings indicate that the premium increased by 18 JPY after the abolition of the school district system. This could be due to the announcement effect of the disclosure of the test scores of all public junior high schools around the same time as the abolition of the school district system in Osaka City. In addition, it may also be due to the dysfunctionality of the newly implemented school choice system, in which students are unable to choose a school under the capacity constraint of the school.

On the other hand, no significant effect of the academic level of high schools on house prices was observed. This may be due to the fact that high school districts are spread over a large area and cover several municipalities, and students can choose from many schools with different academic levels, resulting in smaller regional differences compared to junior high school districts.

It should be noted that two issues remain for further analysis. The first is the validity of the school quality indicators. In this study, we used the national academic test scores (and, for high schools, entrance exam deviation scores) as a proxy for the academic performance of public junior high schools. However, there may be other important factors besides academic ability. For example, the quality of teachers, the adequacy of school facilities, performance in extracurricular activities, and the absence of bullying may all have a significant impact on choice by students and their parents. These variables are typically unobservable and difficult to estimate. However, if they are correlated with the test scores, they could introduce bias into the estimated coefficients on the academic level of schools.

Second, as discussed in section 5, the announcement effect of information also needs to be examined separately. The analysis, which takes into account the time lag between the time when residents become aware of the academic level of public schools through information disclosure and the time when this is reflected in housing rents, is also a subject for future research.

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