DSSR

Discussion Paper No. 68

The Effect of School Quality on Housing Rent: Evidence from Matsue city in Japan

Yuta Kuroda

April, 2017

Data Science and Service Research
Discussion Paper

Center for Data Science and Service Research
Graduate School of Economic and Management
Tohoku University
27-1 Kawauchi, Aobaku
Sendai 980-8576, JAPAN

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

Yuta Kuroda [2]

Abstract

This study investigates the effect of public school quality on the housing rent within its school district by using Japanese data. I estimate the causal effect of school quality as measured by average test score on housing rent by using regression discontinuity design to control for unobserved characteristics of neighborhoods. Specifically, I focus on apartment buildings located on school attendance district boundaries. I find that school quality has significantly positive effect on housing rent of apartment for families, where school quality does not have significant effect on housing rent of houses for single person. This results show that parents are willing to pay more to send their child to better school.

Keywords: *Housing rent, School quality, School District, Regression discontinuity design*

JEL classifications: R31, R21, I20

---

[1] I would like to thank my advisor Kentaro Nakajima. I am also grateful to Koichi Ushijima, Jenn-Jou Chen, and participants at the 2016 Japanese Economic Association Spring Meeting, the 30th Annual Meeting of the Applied Regional Science Conference (Kobe University) and workshop at National Chengchi University for helpful comments. All remaining errors are my own.

[2] Graduate School of Economics and Management, Tohoku University, Sendai 980-8576, Japan. Email: kuroda@student.econ.tohoku.ac.jp

1. Introduction

How much do parents pay for the education of their children? Because education is investment not only for children but also for parents, many parents spend much for their children to make them enroll to good school and take high education. It is very important to analyze the concrete parents' behavior concerning investments in education of their children from the perspectives of equality in the public educational system. However it is difficult to observe the parent's willingness to pay because primary education is free and compulsory in Japan.

We cannot directly observe the parent's willingness to pay of the public school, however can indirectly observe it from land price or housing rent under the school district system. When parents having a child purchase a house or rents apartment, they consider the characteristic of the local public school. In other words, the value of education that parents consider might be capitalized as land price or housing rent. Actuality, the real estate agency advertises high quality of the school in the district, the quality of the school may be made capital to land price or housing rent.

However, estimation of school quality from housing rent have difficulty from endogeneity. Because the test score of the child is influenced by parents characteristics such as educational background or income level, good test score does not mean a high quality education provided at the school. Contrary to this, better schools tend to be located in better neighborhoods. Furthermore, it is impossible to observe the parents characteristics to influence their children's test score in many cases, and it may cause bias for an estimate result.

To avoid these problems, Black (1999) uses the regression discontinuity design focusing 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 to those houses that are very close to the attendance district boundaries, she can control for unobserved characteristics.

Following to Black (1999)'s methodology, I focus on the apartments located on the public school boundary using the data from Matsue city[3] which is a local capital city in Japan. I estimate the causal effect of school quality on housing rent by using test score to proxy for school quality. Results show that the quality of the school has significantly positive effect on housing rent of apartment intended for families. This means that the parents who have a child have a willingness to pay of living the better school district contrary to single person.

[3] Matsue city is the capital city of Shimane Prefecture, in Southwest Japan.

Furthermore, I find that the effect of test score on the apartment is strong in proportion to number of rooms and occupied area. It means that the more the apartment intended for a family, the more apartment is affected by school quality. I also estimate the effect of the junior high school test score by the same equation. In contrast to the result of elementary school, junior high school test score has insignificant effect on housing rent.

The structure of the paper is as follows: Section 2 reviews the previous literature analyzing the effect of school quality on housing rent. Section 3 describes my empirical strategies. Section 4 discusses data. Section 5 discusses some results. In Section 6 I conclude.

2. Literature review

There are a lot of studies considering the effects of school quality on housing rent around the world. Figlio and Lucas (2004) and Clapp, Nanda and Loss (2008) estimate the effects of school quality on house price by a fixed effect model using the panel data to control the unobserved neighborhood characteristics. Bogart and Cromwell (2000) analyze using the data which there are some school districts in the same local government to separate the quality of the public school and local characteristics. With the case which there is one public school in one local government, we cannot distinguish whether the difference of land prices is produced by a characteristic of the local governments such as the tax system or community facilities or by the quality of the school, because the border of the school district is the same as the border of the local government. However, when there are some school districts in the same local government, we can think the difference of the house price to be caused by a difference of the quality of the public school under the other factors controlled, because the characteristics of the local government is unchangeable through a school district. In this way, they show that the difference of a substantial house price exists between school districts and conclude that the difference is caused by a difference of the quality of the public school.

In Japan, Yoshida, Chou and Ushijima (2008) analyzed the effect of the quality of the school on land prices and the change of it by the introduction of the school choice system using the achievement test score and the ratio of enrollment in private junior high school for the proxy of the quality of the school. As a result, they conclude that the quality of the elementary school had an influence on the land prices in the school

district, but the effect become smaller by the introduction of school choice system.

Ushijima and Yoshida (2009), estimate the effect of the school quality on land price using the panel data of land prices in special wards of Tokyo Prefecture from 2001 through 2007 assuming that the ratio of enrollment in private and national junior high school for the proxy of the quality of the school. They control for unobserved neighborhood characteristics by individual fixed effect approach. They find that the quality of the school influenced land prices only in the districts which have the high quality school, and the influence is not so big. However, there is still room for argument about the validity of using the ratio of enrollment for the proxy of the quality of the school because the ratio of enrollment in private and national junior high school strongly correlated with educational achievement of elementary school, but the parents consider about various factors such as budget or distance when they think about entrance of their children. In addition, authors themselves point out the possibility that the relationship between the quality of the school and the land prices were weakened by the influence of a school choice system introduced into the many special wards during an analysis period.

On the other hand Black (1999) designed the highest reliability approach under the situation that panel data is not available. She uses regression discontinuity design and estimates the effect of test score on the house price with controlling to the unobserved neighborhood characteristics by focusing on the houses which differ only by the elementary school the child attends. As a result, she finds that parents are willing to pay to enter their children to better school test.

Following to Black's (1999) regression discontinuity design approach, I estimate the effect of the quality of the school on housing rent. This paper's contributions are as follows. First, I can use the detailed information of the apartment because I use the housing price instead of land price used by previous studies in Japan. In the land price data, we cannot identify whether the land is actually used for family residence or not. On the other hand, I can estimate and interpret the effect of test score on the housing rent more clearly because apartment data has indices as to whether the property is for family or for a single person. Because I can identify whether the apartment is intended for families or single, I can estimate the impact on people who care about the quality of elementary school appropriately. Furthermore I can analyze the difference between the apartment that can be affected by the school quality and the apartment that cannot be affected by school quality.

Second, I estimate the effect of public school clearly by focusing on Japanese local city, Matsue. Because the school choice system is introduced in Tokyo that is targeted in

previous literature, the effect of public school may be underestimated. On the other hand, school choice system is not introduced and a clear school district exists in Matsue city. In addition, there is few of private elementary and junior high schools in Matsue. In areas where there are a lot of private schools, like Tokyo, the relationship between the quality of the public school and housing rent in the school district may weaken because the private school does not restricted by school district. Furthermore, because the child having rich parents is easy to go to the private school, the result will be biased. These problems are solved by using my data that does contain little private school. Due to the above reasons, I can cleanly estimate the effect of public school quality on housing rent under the school district system.

3. Empirical strategies

As mentioned above, I estimate the effect of the quality of the school on housing rent using hedonic regression. I regress the test score on housing rent with some control variables. The basic relationship 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 the apartment i in attendance district a in school district j. The vector X includes characteristics of apartment such as number of rooms and age of building, Z is a vector of neighborhood and school district characteristics. $test_a$ is the average test score of the public school.

However, it is difficult to observe all the socioeconomic characteristics such as access to public facilities or average income in the district, the result without including those variables may have bias. To address this problem, I estimate using Regression discontinuity design. I replace the vector of observed characteristics with the boundary dummies that indicate apartment building that share an attendance district boundary.

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

where K is a boundary dummy if the apartment building located in the boundary b takes one and it controls for any unobserved characteristics of shared by apartment buildings on either side of the boundary. It is considered that apartment buildings in the same boundary resemble it in a characteristic such as accessibility to public facility or

average income in district.

Therefore I analyze using the data which I limited to the sample which there is to constant distance from the boundary after having added the boundary dummy to an equation. I become able to compare the apartment building which resembled closely of the geographical information directly, and it is thought that the prices of apartment difference are caused by the right to be able to go to the different public school.

In my estimation, in addition to the analysis using full sample, I make the subset of an apartment located within less than 500m, 350m and 200m from the boundary of the school district and analyze it for each sub sample.

Because the control variables such as the education expenditure per student or tax rate are not different across schools in Matsue, unlike previous study, it is not necessary to consider those variables.

4. Data and summary statistics

4.1 About Matsue city

Matsue is the one of the regional city in Southwest Japan and faces the Sea of Japan. The population of the city is approximately 200,000 people in 2015.

There are several reasons that I focus on Matsue. Primarily, in Matsue, there is very little number of private elementary and junior high schools. In area where there are a lot of private schools, the relationship between the quality of the public school and housing rent in the school district may weaken because the private school does not come close to the school district to live in, and anyone can go to school freely. However, I can identify the effect of the quality of the public school on housing rent more clearly because there is little way to receive an elementary education other than public school in Matsue with a few private schools.

Furthermore, Matsue is the city which a school choice system is not introduced and a clear school district exists, and has the population scale that is enough for analysis. Of course, if the school is very far from the house, or if parents change their address during school year, they can send their child to school that is located outside their own school district. But that kind of situations is very rare.

Figure 1 presents the map and the school district of Matsue that I used for analysis. The bold black line represents the boundary line of the school district, and only one public school exists each in all school districts. There are 35 public schools in Matsue,

but the number of public schools which I used in this analysis is 23 of 35, because I cannot use the data of the school in the non-city area where there is almost none of the apartment in the district or the branch school where test score is not shown because there is only a few students. Furthermore, when I estimate using the boundary dummy of the school district, I omit the boundary divided by large object such as the big river or site of castle from my dataset because I concern that neighborhood characteristic on opposite sides of an attendance district boundary.

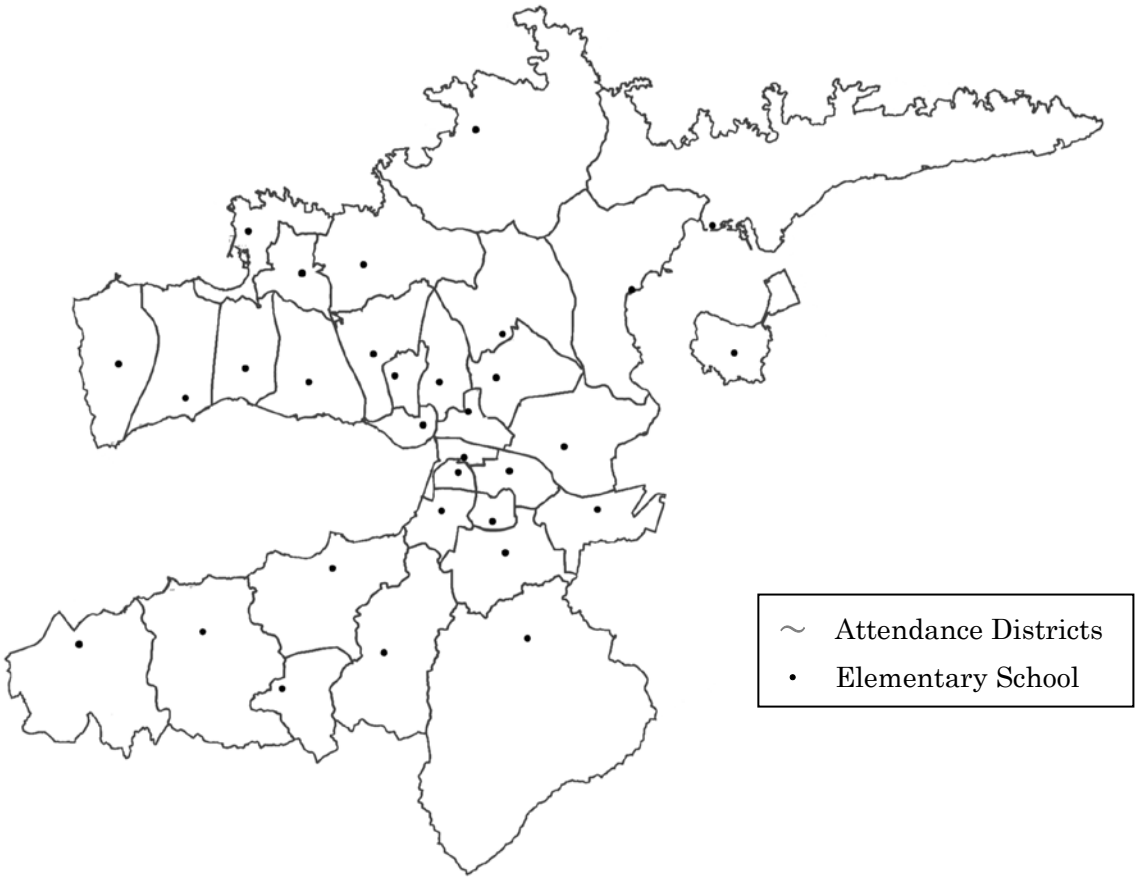

Figure1. Elementary School Districts of Matsue City

4.2 Data

Table 1 shows summary statistics. The full sample consists of 2,686 apartment data I use apartment information placed in three kinds of rental information sites: HOME MATE, CHINTAI and SUUMO. Each apartment includes data of housing rent, number of the rooms, layout (have living room or dining room), occupied area (㎡), number of floors, age of building, building structure and address information. For a family dummy equals to one if the apartment has two or more rooms. Here, the apartment intended for a family is defined as it has two or more than rooms. This definition is generally used by real estate agent in Japan. Using address information and Google Maps, I calculate the distance from house to nearest attendance boundary, nearest station, Matsue Station and Shimane University. Furthermore, these websites provide the more detailed information about the house, and I have used it to make some dummy variables. Living dummy and Dining dummy is the dummy variable which equal to one if the apartment has living or dining room. In addition, I set different dummy variables for each construction method such as reinforced concrete and steel frame.

I obtained the statistics data about Matsue and the information of the school district in the city from the website of Matsue. I used the students per teacher as a characteristic of the schools, and I used the age group of less than 15 years, those of 65 or older, sex ratio, the average household size in the district as a variable to control a local characteristic.

The test score as a proxy variable of the quality of the school are two kinds of test: 6th grade elementary school student take NAAA, 4th and 5th grade elementary school student take Shimane Academic Ability Survey (SAAS) . I use the sum of the math and language test scores, averaged over the three years as the test score of the school. NAAA is the scholastic ability investigation examination that MEXT carries out once a year from 2007 and applies to a sixth grader and a ninth grader. SAAS is the scholastic ability investigation that Shimane prefecture carried originally and 4th, 5th and 6th grader of the public school and the student of the public junior high school take it. In Matsue, however, it was carried out only for the 4th, 5th, 7th, and 8th grade school student (because the 6th grader and the 9th grader exchanged NAAA with this).

Table1. 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			

5. Results and discussion

5.1 Baseline Results

Table 2 shows the baseline result. Column (1) shows the results which using full sample and not including boundary fixed effect. It shows that the elementary school test score has positive significant effect on housing rent just like Black's (1999) result. Furthermore, other major variables can also represent similar tendency. However, these results still have the problem of unobserved neighborhood characteristics.

Then, I restrict sample by the distance from boundary to control for unobserved neighborhood heterogeneity. Column (2) shows the results restricting sample to apartment building located within 500 meters from boundary using the boundary dummy instead of census variables. Column (3) and (4) also shows the results restricting sample to apartment building located within 350 and 200 meters from boundary. Unlike previous studies, these results show that the test score does not have positive significant effect on housing rent. To indicate that the result does not come from the decreeing of sample size, I estimate the same equation of column (1) for the sample located within 200 meters from the boundary as shown in column (5). Column (5) shows that the similar trend to column (1) except for the significant level of the test score coefficient.

The result of Table 2 indicates that the public elementary school test score does not effect on housing rent of apartment within its attendance district. One of the reasons why these result is obtained is the difference of the dependent variables from previous studies. In previous studies, the dependent variable is land price or house price. However in this study I use the hosing rent of apartments or condominiums and about half of those is only one room apartment which designed for a single person. Naturally, someone who cares about the quality of school when renting a room is a family which has or will have children. Therefore, the quality of the school may only effect on the housing rent of the apartment which intended for a family.

To analyze this issue in detail, I set "for a family dummy" and added the interaction term of the test score and the dummy into the equation. The results are represented in Table 3.

Table2. Baseline Estimation

	(1)	(2)	(3)	(4)	(5)
	All houses	500m	350m	200m	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.
※Culstered standard erroer at the attendance district level are in parentheses

In short, table 3 shows the results that the test score has strongly positive significant effect on the apartment intended for a family and negative significant effect on the apartment intended for a single person. The samples used in each column of table 3 are similar to those in table 2, and the results of columns (2) - (4), which are the key results, will be explained below. The coefficient of the test score shows a negative and significant, indicating that the higher the score of the test, the lower the housing rent. For a family dummy also showed negative and significant and it means that family-oriented apartment showed lower rent for apartment which intended for single person. However, the interaction term of the test score and the dummy has positive and significant effect, and for families, the housing rent increases as the test score rises. Furthermore all the three coefficients of test score, for a family dummy and the interaction term will be large in inverse proportion to distance from boundary. It could mean that only family cares about the quality of school, on the other hand single person does not care about it.

When I considered the monetary value, the coefficient of the regression where the apartment buildings are only 200 meters from the boundary (column (4)) suggests that a 10 percent increase in test score leads to approximately 1.7 percent increase in housing rent. In other words, parents are willing to pay 921 Japanese yen in monthly hosing rent more for a 6.7 point increase in test score (the mean of housing rent is approximately 55,000 yen and the mean of test score is approximately 67).

It is difficult to compare with previous study because both proxy of school quality and independent variable are different, I compare below as reference. Yoshida, Chou and Ushijima (2008) revealed that the land price will increase by 2.6% (about 23,000 yen) if the private school admission rate increases by 10% points. In addition, if the mathematics test score increases by 10 points, it shows that the land price will rise by 0.09%, but the coefficient of the test score is not significant. In my result, if the test score rises by 10 points, the housing rent will rise by about 2.5% (about 1400 yen). This difference in the effect of test score may be caused by the educational environment such as presence or absence of a private school.

Table3. Family vs. Single

	(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.
※Culstered standard erroer at the attendance district level are in parentheses

5.2 Robustness

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 of Table 3, I define that the apartment which has more than two rooms as the apartment intended for a family based on the definition by websites. However, in actually, the more rooms and the larger occupied area the more the house is suitable for the family. Therefore, I estimate whether the effect received from the test score becomes stronger as the degree for families is larger.

Then, table 4 shows that the result which using the interaction term of the test score and the apartment characteristics which may have effect on the tendency to be intended for a family. Column (1) and (2) show the result that using the interaction term of the test score and the number of rooms. Column (1) shows the results which using full sample and not including boundary fixed effect. Column (2) shows the results restricting sample to apartment building located within 200 meters from boundary using the boundary dummy. The interaction term of the test score and the number of rooms has positive and significant effect, and it means that the effect of test score on the apartment will be strong in proportion to number of rooms. Column (3) and (4) show the result that using the interaction term of the test score and the occupied area. The samples used in each column (3) and column (4) are similar to column (1) and column (2). The interaction term of the test score and the occupied area has positive and significant

effect, and it represents that the larger occupied area is the stronger the effect of test score is. These results also indicate that the apartment intended for a family tend to be more effected by the test score than that intended for a single person.

Table4. Robustness of for familiy

	Number of Rooms		Occupied area	
	(1)	(2)	(3)	(4)
	All houses	200m	All houses	200m
Elementary school test score	−.0140***	−.0206***	−.0183***	−.0198**
	(.0023)	(.0042)	(.0033)	(.0062)
Test score × Number of Rooms	.0097***	.0091***		
	(.0011)	(.0019)		
Test score × Occupied area			.0005***	.0004**
			(.0001)	(.0001)
Test score × Distance from school				
Number of Rooms	−.5772***	−.5059***	.0753***	.1086***
	(.0798)	(.1282)	(.0129)	(.0128)
Occupied area	.0071***	.0061***	−.0247***	−.0192*
	(.0021)	(.0008)	(.0044)	(.0085)
Distance from Elementary school (km)	−.0124	−.0265	−.0113	−.0277
	(.0101)	(.0064)	(.0101)	(.0262)
Other house characteristics	YES	YES	YES	YES
Boundary fixed effects	NO	YES	NO	YES
Census variables	YES	NO	YES	NO
N	2641	667	2641	667
Number of boundaries	N/A	29	N/A	29
Adjusted R2	0.8504	0.8782	0.8508	0.8765

※*, ** and *** indicate statistical significance at 5%, 1%, 0.1%, respectively.
※Culstered standard erroer at the attendance district level are in parentheses

5.2.2 Other Concerns

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

First, the parents who are interested in school quality strongly may be more likely to be interested in apartment quality. Because the apartment quality strongly correlates with the housing rent, if there is a positive correlation between the quality of the school

and the quality of the apartment, our findings may just represent the housing quality effects instead school quality effects. To address this concern, I regress the apartment quality such as number of rooms and occupied area on the test score as shown in Table 5, column (1) and column (2). Column (1) shows that the quality of the school does not affect the number of rooms, and column (2) also shows that school quality does not affect the occupied area. These results show that there is no positive correlation between the quality of the school and the quality of the apartment.

Another concern is that the test score used in this study may be accidental. Because the test score used in this paper is of a single year, using different test score in other years may produce different results. Therefore I estimate the same equation of previous estimation using the other year test score as shown in column (3) and column (4). Column (3) shows the results which using full sample, column (4) shows the results restricting sample to apartment building located within 200 meters from boundary using the boundary dummy and for a family dummy. The result of either column is somewhat different in magnitude but positive and negative direction is the same as the main result. Thus I can emphasize the validity of using these test score as a proxy of the school quality.

Table5. Senitivity Tests

	House quality		Other test score	
	(1)	(2)	(3)	(4)
	Rooms	Occupied	Rent	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.

※Culstered standard erroer at the attendance district level are in parentheses

5.2.3 Junior high school

The above result shows that there is a significant positive correlation between the elementary school test score and the housing rent. However, In Matsue City, the elementary school district is completely included in the junior high school district (see Figure 2), so parents may consider the quality of junior high school rather than elementary school. Therefore, in this section, I analyze not only the elementary school test score but also the test score of junior high school.

Table 6 shows the results of estimating the equation using the junior high school test score and the junior high school district boundary. Column (1) - (3) show the result that using only junior high school test score. Column (1) shows the results which using full sample, column (2) shows the results restricting sample to apartment building located within 200 meters from boundary using the boundary dummy and column (3) shows the results restricting sample to apartment building located within 200 meters from boundary using the boundary dummy and for a family dummy. These results show that the junior high school test score has positive and significant effect on housing rent of apartment for families and show the same tendency as the result of the estimation by using the elementary school test score. Of course, in this analysis, it is not possible to distinguish between the effect of elementary school and the effect of junior high school.

Next, I estimated the equation that contained both the elementary school test score and the junior high school test score as shown in column (4) - (6). The samples used in each column (4) - (6) are similar to column (1) - (3). Looking at the results of column (6), the effect of elementary school test score remains positive and significant, but it turns out that the effect of the junior high school test score is insignificant. These results indicate that only elementary school test score has positive significant effect on housing rent, however, junior high school test score has insignificant effect on housing rent of apartment intended for a family.

Possible reasons for these results are as follows. First, the variation of junior high school test score is small in comparison with elementary school test score because the number of junior high school is smaller and the number of students per school is larger by contrast with elementary school. Second, elementary school and junior high school are may considered as a continuously integrated process and the parents make decisions of residential area only when their children enter elementary school. In Matsue city, attendance district of junior high school is a combination of elementary school attendance district, therefore, schoolmates from elementary school is schoolmates of junior high school. Thus parents and children may be refused to change

their attendance school when entering junior high school. Third, parents who have junior high school children may tend to have their own house in comparison to who have elementary school children because they are older and their income and social status is higher. Unfortunately I cannot test it because there is no information about detached house in my data.

Table6. Using Junior High School Data

	Only junior high school			Elementary & junior high school		
	(1)	(2)	(3)	(4)	(5)	(6)
	All houses	200m	200m	All houses	200m	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.
※Culstered standard erroer at the attendance district level are in parentheses

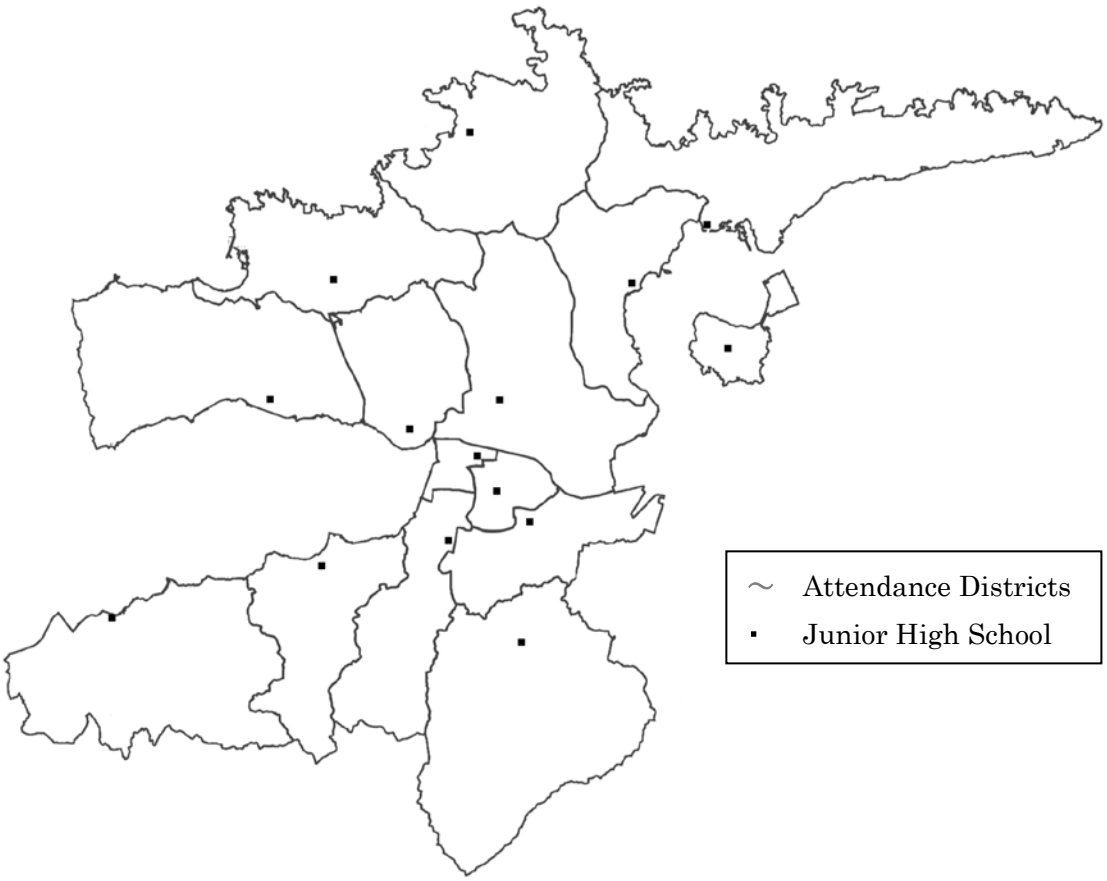

Figure2. Junior High School Districts of Matsue City

6. Conclusion

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

In contrast, test score has negative or insignificant effect on housing rent of apartment for single person. This result indicate that the relative demand of single room decreased in the district which has better school because university student and the single person thought to be the main consumers of the single room do not consider the school quality.

The test score has a strong positive effect compared with the previous study in Japan,

and this result may be due to the absence of private elementary school. In areas with many private elementary schools, school selection behavior of parents differ greatly, so it is necessary to pay attention to the possibility that the result of this paper is unique to Matsue city.

References

Black, S. E (1999) “Do Better Schools Matter? Parental Valuation of Elementary Education”, Quarterly Journal of Economics, 114(2), 577-599.

Bogart, T. W. and Cromwell, A. B (2000) “How Much Is a Neighborhood School Worth?”, Journal of Urban Economics, Vol.47, 280-305.

CHINTAI (2015.10) http://www.chintai.net/

David N. F. and Maurice E. L (2004) “What's in a Grade? School Report Cards and the Housing Market”, American Economic Review, 94(3): 591-604.

Homemate (2015.10) http://www.homemate.co.jp/

John, M. C., Anupam, N. and Stephen, L. R (2008) “Which School Attributes Matter? The Influence of School District Performance and Demographic Composition on Property Values”, Journal of Urban Economics, 63, 451-466.

Ministry of Education, Culture, Sports, Science & Technology in Japan (2014) “Heisei 26 Nendo Zenkoku Gakuryoku・Gakusyu Jyokyo Chosa Kekka Kouhyou Ni Kansuru Chosa Kekka Ni Tsuite”

Statistics Information of Matsue city (2015.10) http://ntoukei.city.matsue.shimane.jp/

SUUMO (2015.10) http://suumo.jp/

Ushijima, K. and Atsushi, Y (2009) “Shougakkou Ni Okeru Kyouiku No Shitsu Ha Chika Ni Eikyou Suruka? – Tokyoto Tokubetsuku No chika Data Wo Mochiita Kenshou”, Journal of Applied Regional Science, 14, 37-47.

Yoshida, A., Zhang, L. and Ushijima, K. (2008) “Gakkou No Shitu To Chika – Adachiku No Chika Data Wo Mochiita Kenshou”, Jutaku Toshi Keizai, 68, 10-18.