Hedonic Housing Price Estimation Using Administrative Micro-data
-The effect of School Quality on House Prices-

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Abstract

This paper applies the hedonic housing price model using the administrative micro-data which include daily-based real prices from all transactions made during the sample period. Especially, this paper focuses on how much effects school districts may have on house prices. The dataset is originated from the Ministry of Land, Infrastructure and Transport(MOLIT) which has recorded real transaction prices of all houses regardless of their types since the government introduced the legal system which enforces all house transaction to be reported and aims at enhancing the transparency in the real estate market in January, 2006. One contribution of this paper can be that all the transaction prices of the population are utilized considering that the previous literatures rely on bid/ask prices or subsample. The dataset includes key characteristics which may attribute to prices of houses such as the time of transactions, locations, built year, floors, squares and brands of the transacted house.

Combining a hedonic housing price model with a spatial regression discontinuity design, this paper tries to disentangle school quality effects from house prices by controlling unobserved neighborhood characteristics. I compare the transacted price-pairs of houses that are adjacent to the school district boundary from each other and are highly similar across all other characteristics, but which lie in school districts of different education quality. This method takes an advantage of robust controls for the confounding effects in quantifying school quality effects. The estimation result shows that school quality has a significant impact on house prices.

Keywords: hedonic housing price model; administrative data; school quality effects

The views expressed in this paper are those of the author and are not necessarily reflective of views at the Bank of Korea. Any errors or omissions are the responsibility of the author.

1. Introduction

Education can play a pivotal role in building up human capital. In this regard, it is important that analyzing the effects of quality of education on housing prices can help understand the efficient distribution of human capital. As parents have stronger preferences for their children's education, they are willing to pay higher price for a house with better educational environments because better environments can have positive effects on the build-up of their children's human capital.

Kim(2014) argued that if only children whose parents have economic capabilities to be willing to pay higher price can have access to better educational environments, in perspective of overall economy, human resource are hindered to be distributed efficiently, then fail to optimize the economic growth and economic efficiency. He noted that instead of students with better gifted potential talent, if students with ordinary gifted potential talent have an opportunity to get better education, this means human resources fail to be distributed in an efficient way.

From the macroeconomic point of view, investigating the relationship between housing markets and education can also be meaningful. It is because price hikes at specific region with better educational environment can give rise to spill-over effects on overheating in property market of surrounding areas. Kim et al(2016) show that house prices in Gangnam 3Gu which are regarded as having better educational environments in Seoul have considerable spill-over effects on overall metropolitan area neighbored in Seoul at least in the short run.

According to Tiebout(1956), individuals consider quality of education, local public infrastructures like parks, roads, police protection, transportation accessibility in making locational decisions. They may be viewed as picking that community which best satisfies his preference pattern for public goods. In this regard, it can be explained how communities with higher residential prices can be developed when people with similar preferences for education flock together in specific residential area fulfilling their preferences.

Also, earlier empirical studies show that education and house prices are closely correlated. Black(1999) argued that 5% increase of test score(about one standard deviation) in elementary school gave rise to 2.5% hike in house prices in Massachusetts. Fack and Grenet(2008) showed that one standard deviation rise of public school performance leaded to 1.5~2.5% increase in house prices in Paris. There has been many studies in domestic academics that dealt with the relationship between education and real estate prices. However, they relied on bid/ask prices or only subsample transactions

rather than real transacted prices in all transactions due to lack of sufficient database, or most of them failed to separate out unobserved neighborhood effects in an effective way. Lee(2010) summarizes these earlier studies well.

This paper studies how the difference of house prices between residential districts is caused by school quality using total real transacted prices database constructed by the government to enhance the transparency of real estate market since 2006. This study is differentiated from the previous studies which relied on bid/ask prices or only subsample in all transactions rather than real transacted prices in all transactions. The estimation result shows that though the effects of school quality considerably are reduced compared to before controlling for unobserved neighborhood characteristics, school quality still have a significant impact on house prices. Controlling for boundary fixed effects, a 1%p increase in the ratio of students with average math scores or above gives rise to 0.7~0.9% hike in property prices.

The paper is organized as follows. Section 2 provides the estimation strategy. Section 3 and 4 describe our data and summary statistics, and present the estimated results. Finally, Section 5 summarizes and concludes.

2. Estimation Strategy

Before analyzing the education and house prices, we provide the background on school districts in Seoul and school performance across school attendance zone.

A. Background

Seoul are composed of total 25 administrative district Gus and 424 Dongs as a subdivision. School districts include 2~3 administrative district Gus. School districts are 11 in total and supervised by Seoul Metropolitan Office of Education(SMOE). Among 11 school districts, both Gangnamgu and Seochogu are regarded as a good school district for a long time. Besides, with Songpagu, the three school districts are called Gangnam3Gu and it is considered to be a good school districts.

According to Kim(2014), ratio of 1st rank in Math of SAT at the region of Gangnamgu and Sechogu in 2011 are reported as 2 times higher than average of all Seoul. Also he presented that the number of graduates entered Seoul National University(SNU), one of top universities in South Korea, is 173 from Gannamgu and 150 from Seochogu while the average number is 94.9 in 2011. According to Kim(2014), graduates from the high schools located in Gangnamgu have probabilities of admission for SNU of 2.1 persons per 100, that is higher by 10~20 times comparing to 0.1 persons of Gangbukgu, 0.2 persons of Gumcheongu, 0.2 persons of Gurogu.

Graph1 : Administrative district map in Seoul

B. The endogeneity of school quality

Consider the hedonic housing price model as follows.

$$y_{igt} = x'_{it}\beta_x + z'_g\beta_z + \beta_s School\,Quality + v_{igt}$$

y_{igt} is the house price of house i located in district g in the time of t. x_{it} is characteristics vector such as size of house, number of rooms, bathrooms, floors, etc. z_g is regional characteristics vector including crime rates, transportation accessibilities, property tax, etc. β_s is our interested parameter which is school quality effect on house prices. However, there may be an endogeneity issue in the model. If regional characteristics which can impact on house prices and correlated with school quality are not included in the model, it causes omitted variable bias.

It has already noted that disparity in school quality between Gangnam3Gu and the other areas is pretty sizable. However, analyzing how much effects school quality can have on house prices is more delicate due to the endogeneity. One of challenges in quantifying school quality premium is to disentangle unobserved neighborhood characteristics from house prices

How can we control for unobserved neighborhood characteristics? The seminal paper about the relationship between school quality and house prices, Black(1999) controlled for boundary fixed effects using only houses with school districts located on attendance district boundaries. She utilized the fact that while test scores make a discrete jump at attendance boundaries, changes in neighborhoods are smoother. Chiodo et al(2010) analyzed the housing prices of St.Louis and Missouri in the USA, besides using houses in the vicinity of school attendance zones, supplementally he included racial composition of regional groups as a variable to control neighborhood characteristics. Chiodo et al(2010) showed that school quality has an important influence in the house prices even after controlling neighborhood characteristics. Fack and Grenet(2008) adopted a matching framework to solve the endogeneity problem of neighborhood characteristics.

However, in the case of Seoul the school districts are almost identical to the city districts unlike the cases of the above mentioned studies. In effect, the above method of controlling unobserved neighborhood characteristics is not applicable.

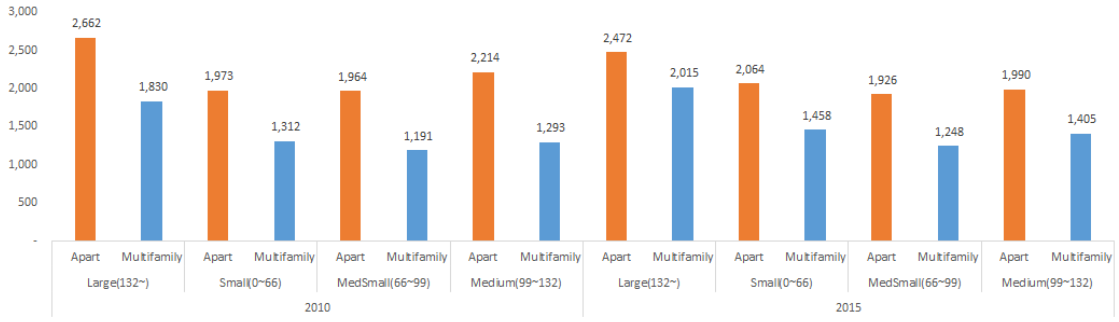
However, it is possible to partly control unobserved neighborhood characteristics when analyzing

Gangnam and its vicinity. This is due to the similarity in the high accessibility of amenities and transit facilities in the areas adjacent to Gangnam. Additionally, the property tax which commonly refers to the differences in neighborhood quality is luckily the same within Seoul's city districts.

Still, the composition of residents may have a considerable heterogeneity. We can consider to find appropriate explanatory variables in order to control for this heterogeneity. This paper uses the ratio of apartments as a proxy for the heterogeneous composition of residents. Many people regard that the difference in the composition of residents can be mainly driven by strong preference for apartment rather than other types of dwellings such as multistory collective dwellings. Generally speaking, people prefer apartments to other types of dwellings in Korea, because apartments tends to be managed in more efficient way and more advantageous for crime protection, clearings services, parking, etc.

The graph below presents the comparisons of the average price per pyong(3.3㎡) transacted during 2010 and 2015 year between apartments and multistory collective dwellings by size.

Graph2 : comparisons of the average price per pyong(3.3㎡) by size

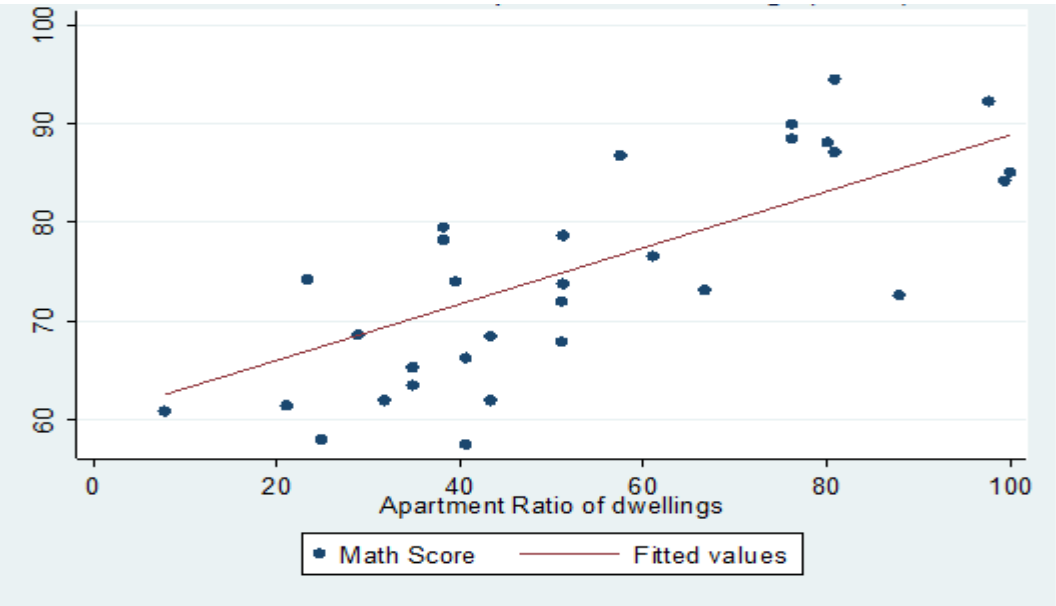


It is more likely that parents of students in schools surrounded by apartment complex may have higher income or education compared to those of students in schools gathered in other types of dwelling including multistory collective dwellings. It means that parents' education level or income of households can be differently grouped by types of dwellings such as apartments, multistory collective dwellings, singe houses, etc. Parents prefer apartments to other types of dwellings because districts with large apartment complex attracts more private institutions for test preparation for admissions to high ranked universities deriving from parents' strong aspirations. In this regard, it is desirable that the ratio of apartments is used as a proxy variable controlling for unobserved neighborhood demographics such as children's talent, parents' economic abilities. Parents gathered in apartment complex tend to be more

interested in their children's education, have higher income, job security, educational level, etc, as a result, their children also are more likely to be talented for educational achievements. In reality, statistical survey shows that school achievements and the ratio of apartment by residential areas are strongly correlated. The graph below indicates that as the ratio of apartments get higher, school achievement get better according to Demographics Survey 2015 conducted by National Statistics Agency.

In addition, this paper employs the method to restrict the sample of data to only houses adjacent to the boundary area as well as to control for unobserved neighborhood characteristics so as to isolate school quality effects.

Graph3 : Math score and apartment ratio of dwellings



3. Data and Summary Statistics

A. Administrative house price database

We use prices for only apartments among various types of dwellings including as apartments, multistory collective dwellings, singe houses, etc. With regard to the number of rooms, bathrooms, structures, managing system, apartments can be treated as a homogenous good. In general, most of apartment with the size of about 20 pyong have two bedrooms, 1 bathroom, living or cooking space, or if built in recent years, those size apartment have two bedrooms, 2 bathrooms, living or cooking space.

In case of apartments with the size of around 30 pyong, they are designed to have three bedrooms, 2 bathrooms, living or cooking space. It is regarded that characteristics such as the structure, number of rooms, bathrooms of houses tend to be designed homogeneously.

The dataset in the paper contains real transaction prices by types of all houses which are publicly re corded by the Ministry of Land, Infrastructure and Transport(MOLIT) since the government has introd uced the legal system to report mandatorily all transactions of houses so as to enhance transparency in t he real estate market in January, 2006. MOLIT has released price data every month, including core cha racteristics which contribute to determine the price of houses such as times of transactions, locations, b uilt year, floors, squares, brands etc. This database is founded in order to eliminate unfair contract prac tice and enhance the transparency in the housing markets.

In this paper, the ratio of students with or above average score in the math test is used as a proxy for school quality and the test was given nationwide. Under the authority of the ministry of education, School Information Site has opened test score by schools. The distribution of the ratio shows that there are markedly differences between schools' education quality. We utilize middle school students' test score. The date from high schools are not appropriate because high schools are systemically different among each other because some students go through admission process to get into better schools such as special purposed-high schools, etc and this results in non-random distribution of the ratio. Special purposed high schools give an admission to students regardless of residential areas, while middle schools accept students depending on their residence.

B. Summary Statistics

Table1 shows the summary of statistics on the sample data of all apartments transacted in "Gangnam3Gu" and "adjacent non-Gangnam5Gu during the period from 2006 to 2016. It indicates that while average prices of apartment per pyong(3.3㎡) in "Gangnam3Gu" are evaluated as 989(tens of million Korean won), maximum price is as 3,370(tens of million Korean won), those in "non-Gangnam5Gu are 647(tens of million Korean won), maximum price is as 3,227(tens of million Korean won). In addition, while average established year of apartment in "Gangnam3Gu" are built in 1995 as an age of 18.6, those in "non-Gangnam5Gu are built in 1997 as an age of 16.0. It notes that the size of apartments in "Gangnam3Gu" relatively are bigger that that in "non-Gangnam5Gu. Average of heights in "Gangnam3Gu" is 8.9 floors compared to 8.4 floors in "non-Gangnam5Gu. Appendix shows the summary of statistics on the sample data of all apartments transacted in all Seoul during the period from 2006 to 2016.

Table1: Summary of Statistics
(Gangnam3Gu+Adjacent5Gu : 2006~2016)

	Gangnam3Gu				Adjacent5Gu			
	Mean	SD	Min	Max	Mean	SD	Min	Max
price per 3.3㎡ (10,000KRW)	989.3	338.1	125.2	3,370.3	647.8	230.8	109.1	3,227.4
Year established	1995	11.5	1973	2016	1997	9.0	1970	2016
Average size(3.3㎡)	93.7	38.8	12.5	325.4	81.2	30.0	12.3	317.4
age	18.6	11.7	0	44.0	16.0	9.5	1	47
size:								
small	0.232	0.422	0	1	0.390	0.488	0	1
medsmall	0.443	0.497	0	1	0.417	0.493	0	1
medium	0.179	0.383	0	1	0.135	0.342	0	1
large	0.146	0.353	0	1	0.058	0.233	0	1
average story	8.9	6.3	1	46	8.4	5.8	1	57
N	56,110				39,545			

Table2 shows the summary of statistics on the sample data of all apartments transacted in Dongs adjacent to “Gangnam3Gu” and “non-Gangnam5Gu during the period of 2015. It indicates that while average prices of apartment per pyong(3.3㎡) in “Gangnam3Gu” are evaluated as 1,048(tens of million Korean won), maximum price is as 2,549(tens of million Korean won), those in “non-Gangnam5Gu are 692(tens of million Korean won), maximum price is as 3,146(tens of million Korean won). In addition, while average established year of apartment in “Gangnam3Gu” are built in 1996 as an age of 20.4, those in “non-Gangnam5Gu are built in 1997 as an age of 18.8. It notes that the size of apartments in “Gangnam3Gu” relatively are bigger than that in “non-Gangnam5Gu. Average of heights in “Gangnam3Gu” is 9.1 floors compared to 8.7 floors in “non-Gangnam5mGu.

While the ratio of students with average score or above in math test in “Gangnam3Gu” is 83.1%, the ratio in “non-Gangnam5Gu is 70.0%. It means that students in “Gangnam3Gu” are better in academic achievements than students in “non-Gangnam5Gu. In addition, it notes that while the ratio of students living in apartments is 68.2%, that ratio in “non-Gangnam5Gu is 49.1% with the difference markedly.

Table2: Summary of Statistics
(boundary Dongs of Gangnam3Gu+Adjacent5Gu : 2015)

	Gangnam3Gu				Adjacent5Gu			
	Mean	SD	Min	Max	Mean	SD	Min	Max
price per 3.3㎡ (10,000KRW)	1,048.3	333.4	188.2	2,548.7	692.1	228.2	267.8	3,146.1
Year established	1996	11.5	1973	2015	1997	9.6	1970	2015
Average size(3.3㎡)	96.9	39.5	13.4	273.5	84.0	30.2	12.3	317.4
age	20.4	11.5	1.0	43.0	18.8	9.6	1	46
size:								
small	0.196	0.397	0	1	0.328	0.469	0	1
medsmall	0.458	0.498	0	1	0.458	0.498	0	1
medium	0.181	0.385	0	1	0.149	0.356	0	1
large	0.165	0.371	0	1	0.065	0.246	0	1
average story	9.1	6.6	1	46	8.7	6.3	1	57
math	83.1	8.1	62.0	94.5	70.0	6.9	58	84.2
apart ratio	68.2	25.7	23.3	100	49.1	26.7	7.7	99.4
N	8,838				6,604			

4. Estimation Results

A. Hedonic Housing Price Model

Apartments used in estimation have very similar structures in terms of the number of rooms, bathroom, etc by size(small, smallmedium, mediumlarge, large). Especially, individual apartments in large apartment complex have almost homogeneous structures. In addition, administrative dataset include main variables regarded as affecting house prices. It is desirable that hedonic housing price estimation can take advantage of these set of information in qualifying school quality effects on house prices.

$$y_{igt} = \beta_c + \beta_t + Q\beta_g + x'_{it}\beta_x + z'_g\beta_z + \beta_m math + v_{igt}, \quad v_{igt} = \delta_g + u_{igt}$$

$$Q = 1\ [g = Gangnamgu, Seochogu, Songpagu]$$

$$y_{igt}\ is\ \log(price\ per\ 3.3m^2)\ of\ house\ i\ \ in\ \ district\ g\ at\ time\ t$$

$y_{igt}$is the house price of $i$house located in district g in the time of $t$as said earlier. x_i tis characteristics vector such as established year, size of house, number of rooms, bathrooms, floors, location, etc. $z_g$is the ratio of residents living in apartments as a proxy indicating regional characteristics. $math$is the ratio of students with average achievement or above as a proxy variable for school quality. Two-way clustered robust standard error are calculated because error terms are correlated within districts in spite of no correlation between districts.

B. Estimation Results

Seoul metropolitan city has total 25 administrative district Gus. Among these Gus we estimated the restricted sample of “Gangnam3Gu” including Gangnam, Seocho, Songpa and adjacent “non-Gangna5Gu” including Seondong, Guangjin, Gangdong, Yongsan, Dongjack. Then, we estimate more restricted sample of neighboring Dongs included in “Gangnam3Gu” and “non-Gangnam5Gu”. Time period of data spans from 2006 to 2016 for 11 years.

(1) Full sample

<Table3> is the estimated results on the sample of data only including transactions of houses located in “Gangnam3Gu” and “non-Gangna5Gu” during the period of 2006~2016. (1)~(4) in <Table3> present results estimated without boundary fixed effects. The estimated results show that a 1%p increase in the ratio of students with average math scores or above gives rise to 2.0~2.3% hike in property prices. However, (5)~(8) in <Table3> indicate estimated results controlling for boundary fixed effects. In this case, a 1%p increase in the ratio of students with average math scores or above contributes to 1.2~1.6% hike in house prices. Controlling for boundary fixed effects, it is noted that the effect of school quality is decreased by 2/3 compared to those with no boundary fixed effects. Other explanatory variables show similar results as expected. Prices of apartments with the size of medium large or large are evaluated lower than those with the size of small and smallmedium. It is because it reflects less demand for larger size houses due to the burden of prices. Higher the floor of apartments get, more expensively houses are priced reflecting stronger preferences for upper floors of apartments.

Table 3. Regression results (N: 220,356)

(sample of all apartments transacted in "Gangnam3Gu" and "non-Gangna5Gu during the period from 2006 to 2016)

	Log(Price/Size)				Log(Price/Size)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
math	0.023***	0.022***	0.020***	0.020***	0.016***	0.015***	0.012***	0.013***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)	(0.003)	(0.003)
age		0.006	-0.012	-0.013		0.006	-0.014	-0.015
		(0.003)	(0.010)	(0.010)		(0.003)	(0.008)	(0.008)
age^2			0.050**	0.052**			0.056**	0.059**
			(0.020)	(0.020)			(0.0185)	(0.017)
medium				-0.066**				-0.075***
				(0.022)				(0.020)
large				-0.049				-0.070***
				(0.026)				(0.017)
story			0.007**	0.007***			0.007***	0.008***
			(0.002)	(0.002)			(0.002)	(0.002)
Boundary Fixed Effects	No	No	No	No	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note : Two-way clustered standard errors are listed in parentheses.
Significant levels : *** p<0.01, ** p<0.05, * p<0.1

(2) Boundary sample

<Table4> is the estimated results on the sample of data only including transactions of houses located in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu" during the period of 2006~2016. It show similar results as those in <Table3>. (5)~(8) in <Table4> indicate estimated results controlling for boundary fixed effects as before. It shows that a 1%p increase in the ratio of students with average math

scores or above contributes to 1.7~2.0% hike in house prices.

Table 4. Regression results without neighborhood characteristics (N: 95,655)

(sample of apartments transacted in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu during the period from 2006 to 2016)

	Log(Price/Size)				Log(Price/Size)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
math	0.024***	0.024***	0.021***	0.021***	0.020***	0.019***	0.017***	0.017***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
age		0.002	-0.018*	-0.018		0.002	-0.019***	-0.019***
		(0.002)	(0.009)	(0.010)		(0.002)	(0.009)	(0.009)
age^2			0.055**	0.055**			0.057**	0.058**
			(0.022)	(0.023)			(0.022)	(0.023)
medium				-0.026				-0.033
				(0.032)				(0.031)
large				-0.007				-0.020
				(0.047)				(0.046)
story			0.013***	0.013***			0.013***	0.013***
			(0.001)	(0.001)			(0.001)	(0.001)
Boundary FixedEffects	No	No	No	No	Yes	Yes	Yes	Yes
TimeEffects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note : Two-way clustered standard errors are listed in parentheses.
Significant levels : *** p<0.01, ** p<0.05, * p<0.1

<Table5> is the estimated results on the sample of data only including transactions of houses located in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu" during the period of 2006~2016, while , in addition, this controls for unobserved neighborhood effects by including the ratio of apartments into the model. (1)~(4) in <Table5> present results estimated without boundary fixed effects. (5)~(8) in <Table5> indicate estimated results controlling for boundary fixed effects as before. It shows that a 1%p increase in the ratio of students with average math scores or above contributes to 0.5~0.6% hike in house

prices. Controlling for boundary fixed effects, it is noted that the size of school quality effects is reduced by 1/3 compared to those with no boundary fixed effects. Still, math scores as a proxy for school quality have a statistically significant impact on house prices.

Table 5. Regression results with neighborhood characteristics(N: 95,655)

(sample of apartments transacted in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu during the period from 2006 to 2016, including the ratio of apartments by Dongs)

	Log(Price/Size)				Log(Price/Size)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
math	0.016**	0.016**	0.016**	0.016**	0.005	0.006*	0.005*	0.005*
	(0.005)	(0.005)	(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)
apart	0.004*	0.003	0.003	0.003	0.006***	0.005***	0.005***	0.005***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
age		0.004	0.004	0.004		0.004	0.004	0.004
		(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
medium				-0.012				-0.018
				(0.024)				(0.023)
large			0.026	0.024			0.016	0.012
			(0.036)	(0.039)			(0.034)	(0.037)
story		0.012***	0.012***	0.012***		0.011***	0.011***	0.011***
		(0.001)	(0.001)	(0.001)		(0.002)	(0.002)	(0.002)
Boundary FixedEffects	No	No	No	No	Yes	Yes	Yes	Yes
TimeEffects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note : Two-way clustered standard errors are listed in parentheses.
Significant levels : *** p<0.01, ** p<0.05, * p<0.1

<Table6> is the estimated results on the sample of data only including transactions of houses located in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu" only during the period of 2015. It is because the ratio of apartments are surveyed every 5 year, and the latest data is 2015. Above estimated results are based on assumptions that the ratio has not been changed for 10 years. However, because those assumption may be unfeasible, here we restricted the sample data for 2015. In addition, this controls for

unobserved neighborhood effects including the ratio of apartments into the model. (1)~(4) in <Table6> present results estimated without boundary fixed effects. (5)~(8) in <Table6> indicate estimated results controlling for boundary fixed effects as before. It shows that a 1%p increase in the ratio of students with average math scores or above contributes to 0.7~0.9% hike in house prices. Controlling for boundary fixed effects, it is noted that the size of school quality effects is reduced by 1/2 compared to those with no boundary fixed effects. Still, math scores as a proxy for school quality have a statistically significant impact on house prices.

Table 6. Regression results with neighborhood characteristics(N: 15,442)

(sample of apartments transacted in Dongs adjacent to "Gangnam3Gu" and "non-Gangna5Gu during only the period of 2015 year)

	Log(Price/Size)				Log(Price/Size)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
math	0.018***	0.019***	0.019***	0.020***	0.007**	0.009***	0.009***	0.009***
	(0.004)	(0.004)	(0.004)	(0.005)	(0.002)	(0.002)	(0.003)	(0.003)
apart	0.003	0.003	0.003	0.003	0.005***	0.005***	0.004***	0.004***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
age		0.000	0.000	0.000		0.000	0.000	0.001
		(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
medium				-0.047**				-0.052*
				(0.020)				(0.018)
large			-0.018	-0.028			-0.029	-0.040
			(0.041)	(0.043)			(0.038)	(0.040)
story		0.011***	0.011***	0.011***		0.010***	0.010***	0.010***
		(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Boundary FixedEffects	No	No	No	No	Yes	Yes	Yes	Yes
TimeEffects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note : Two-way clustered standard errors are listed in parentheses.
Significant levels : *** p<0.01, ** p<0.05, * p<0.1

<Table7> is the estimated results on the sample of data only including transactions of houses located in Dongs adjacent to only two Gus including Gangnam and Seocho instead of "Gangnam3Gu" and "non-Gangna5Gu" only during the period of 2015. (1)~(4) in <Table7> present results estimated without boundary fixed effects. (5)~(8) in <Table7> indicate estimated results controlling for boundary fixed effects as before. It shows that a 1%p increase in the ratio of students with average math scores or above contributes to 0.6~0.7% hike in house prices. Controlling for boundary fixed effects, it is noted that the size of school quality effects is reduced by 1/3 compared to those with no boundary fixed effects. Still, math scores as a proxy for school quality have a statistically significant impact on house prices.

Table 7. Regression results with neighborhood characteristics(N: 9,445)

(sample of apartments transacted in Dongs adjacent to "Gangnam and SeochoGu" and "non-Gangna5Gu during the period of 2015 year)

	Log(Price/Size)				Log(Price/Size)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
math	0.022***	0.024***	0.024***	0.024***	0.006	0.007**	0.007**	0.007**
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)
apart	0.001	0.001	0.002	0.001	0.004*	0.004*	0.004*	0.004*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)
age		-0.002	-0.002	-0.002	-0.001	-0.001	-0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
medium				-0.066**				-0.071**
				(0.026)				(0.025)
large			-0.033	-0.048			-0.047	-0.064
			(0.055)	(0.057)			(0.051)	(0.053)
story		0.012***	0.012***	0.012***		0.013***	0.013***	0.013***
		(0.002)	(0.002)	(0.002)		(0.002)	(0.002)	(0.002)
Boundary FixedEffects	No	No	No	No	Yes	Yes	Yes	Yes
TimeEffects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note : Two-way clustered standard errors are listed in parentheses.
Significant levels : *** p<0.01, ** p<0.05, * p<0.1

5. Conclusion

This study applies the hedonic housing price model using the administrative micro-data which are collected from daily-based real prices in all transactions during the sample period. Especially, this paper investigates how much effects school quality may have on the housing prices.

Combining a hedonic housing price model with a spatial regression discontinuity design, this paper tries to disentangle school quality effects from house prices by controlling unobserved neighborhood characteristics. I compare the transacted price-pairs of houses that are adjacent to the school district boundary from each other and are highly similar across all other characteristics, but which lie in school districts of different education quality. This method takes an advantage of robust controls for the confounding effects in quantifying school quality effects. The estimation result shows that school quality has a significant impact on house prices.

Controlling for boundary fixed effects, it is noted that the size of school quality effects is reduced by 1/3 compared to those with no boundary fixed effects. Still, math scores which is a proxy for school quality have a statistically significant impact on house prices. It shows that a 1%p increase in the ratio of students with or above average math scores contributes to 0.7~0.9% hike in house prices.

Lastly, this paper presents the usefulness of administrative data for determinants of housing prices, policy evaluation, etc.

<Appendix>

Table1 : Summary of Statistics(All Seoul)

	Gangnam	Gangnam -boundary	Non-Gangnam	Non-Gangnam -boundary
price per 3.3㎡ (10,000KRW)	941	989	484	648
year established	1995	1995	1998	1997
Average size(3.3㎡)	84	94	74	81
age	18	19	14	16
apartment ratio with 30 years or above	0.146	0.200	0.028	0.089
size:				
small	0.359	0.232	0.454	0.390
medsmall	0.383	0.443	0.424	0.417
medium	0.144	0.179	0.094	0.135
large	0.113	0.146	0.028	0.058
number of stories	9	9	9	8
N(transactions)	124,210	56,110	654,935	41,038

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