

Direct and External Effect of Key School Districts on Housing Price: A Case from City of Shenzhen

Abstract: The paper applies the hedonic model to the existing housing market of Luohu administrative district of Shenzhen, China. We verify the positive effect of key school districts on housing price. Housing price in a key middle school district is 20% higher than its counterparts in Luohu. We further examine the external effect of key school districts on housing price, that is, how a key school district influences the effect of other housing price determinants. We find that housing consumers inside key school districts are more tolerant of reduced quality of housing structure and neighborhood conditions. Combining direct and external effect, housing price in key middle school districts is 30% higher in the Luohu district.

Key Words: Housing Price, School District, External Effect, Shenzhen

1. Introduction

Parents, for their kids, chasing housing located inside key school districts is a common phenomenon around the world, including the United States, Europe and other developed regions or countries which are supposed to have more adequate educational resources. Better educational resources provided by key school districts are capitalized in their housing price, which is verified by scholars using data from various places. For example, Bogart and Cromwell (1997) and Seo and Simons (2009) using data from Ohio, Kane et al. (2005) using North Carolina data, Hu and Yinger (2007) using New York data, Chiodo et al. (2010) using St. Louis data, Dhara and Ross (2012) using data from Connecticut, Davidoff and Leigh (2007) using data from Australian Capital Territory, Fack and Grenet (2007) using Paris data, Wang and You (2006) and Wen (2011) using Shanghai data, Yang et al. (2010), Huang (2010) and Li et al. (2011) using data from Beijing, among others.

A real estate market could be defined in terms of its geographical scope covered. A very large one could be the national market. Sometimes the national market is partitioned into several large regions, such as the West (East, Northeast, or South) region. A smaller one could be a provincial or a state market. Even smaller is a city market, and a very small housing market could be an administrative district within a city. For example, above mentioned Chinese literatures are all focused on important administrative districts, such as Beijing Haidian district, Shanghai Changning district, etc. This paper uses the last definition. We fit housing microdata to a hedonic model to investigate the effect of key school districts on housing price of existing homes in an administrative district of Shenzhen China, namely, the Luohu district. Housing markets are locally meaningful. By focusing on a smaller jurisdiction's housing market, we can, to a larger extent, identify the separate influence of key school districts on housing price from omitted fundamental variables which might be different across housing markets.

In addition to verifying the the *direct* effect from key school districts on housing price, this paper also aims to figure out the interaction between a key school district and other housing price determinants, that is how key school district resource affects other determinants' effect (both magnitudes and signs) on housing price, which we call in this paper the *external* effect of key school districts on housing price. The latter has never been touched in previous research to the best of our knowledge.

The next section introduces our model, data and variables used in the hedonic regression. Section 3 summarizes statistics of variables. Section 4 presents empirical results of the hedonic model. The last section concludes.

2. Model, data and variables

The hedonic model estimates contribution from durables' each type of attribute to their price. This model has been widely used in real estate economics, whereby housing structural features (size, facing south, number of rooms, number of bathrooms, home age, etc.), neighborhood characteristics (green rate, floor area ratio, life convenience, neighborhood condition, etc.), as well as other amenities (school district, water view, parks, etc.) or disamenities (landfills, nearby airports, air pollution, etc.), are all potential housing price contributors. The housing price in a hedonic model is regressed on such explanatory variables. In terms of the hedonic equation format, a large number of empirical studies use semi-logarithmic format whereby the dependent variable (housing price), as well as some independent variables, takes the logarithmic form. A semi-logarithmic form can also help explain variation of the dependent variable in a way of percentage change. This paper uses the semi-logarithmic format as below:

$$\ln P_i = X_i B + \varepsilon_i$$

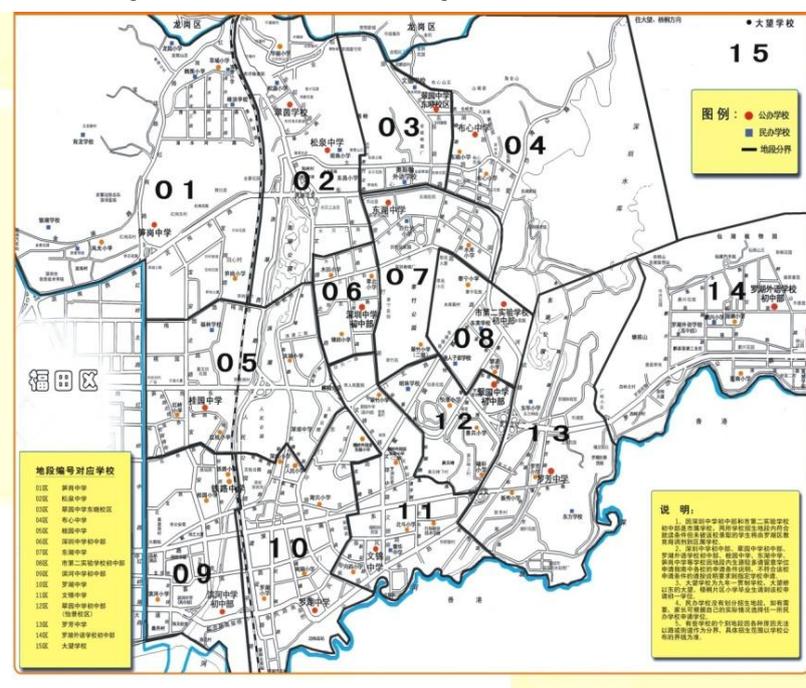
where P is housing price, X are housing attribute variables generally used in hedonic literatures, including (1) structural features: building areas (*size*), number of rooms (*room*), number of bathrooms (*bathrm*), internal decoration level (*deco*), house age (*age*); (2) neighborhood condition variables: floor area ratio (*far*), green rate (*gr*), property management fee (*manafee*, a proxy for management quality), distance to supermarkets (*lnmarket*), number of restaurants (*food*), number of entertainment facilities (*entertain*), distance to subway stations (*lnsubway*), number of nearby bus lines (*bus*), distance to the immigration port (*lnport*) which takes into consideration Luohu district's special geographical proximity with Hong Kong; (3) key school district dummy (*schdist*), which is our major interest in this study. B is the hedonic coefficients to be estimated, and ε is the error term.

There is no school zoning policy for high schools in China because high schools admit students based on students' entrance examination results, rather than on students' residence addresses. Elementary and middle schools, however, are subject to the zoning policy. A school-age student is assigned his or her elementary or middle school according to which school district their families presently live in. Contrast to somehow contradicting rankings of

elementary schools from different ranking agencies, middle school ranking in Shenzhen is much more consistent because middle school ranking is mostly based on the proportion of students admitted by the four first-tier high schools (Shenzhen Senior School, Shenzhen High School, Shenzhen Experimental School, and Shenzhen Foreign Language School). Using this criterion, three key middle schools in Luohu district is established: Shenzhen Middle School, Luohu Foreign Language School, and Cui Yuan Middle School. Figure 1 shows the map of middle school districts in Luohu district where Area No. 06 is Shenzhen Middle School district, Area No. 12 is Cui Yuan Middle School district, and Area No. 14 is Luohu Foreign Language School district.

In the hedonic model, we construct the key middle school district dummy in such a way that if an existing home unit is located in any one of these three key middle school districts, then this home has the dummy valued 1, otherwise it is valued 0.

Figure 1: Middle School Zoning in Luohu District, Shenzhen



Data sources in this paper are as follows: the housing transaction microdata are from “Sou-Fun.com”; neighborhood condition data are from “go2map.com”; information on elementary and middle school zoning is from Shenzhen Education Bureau and Luohu District Education Committee.

There are about 500 residential buildings (condos) in Luohu district. Applying the principle of geographically uniform distribution, and getting rid of missing and or odd data (variable value being too big or too small), we keep 95 buildings in our sample which has a total of 19,978 housing units, nearly half of the existing housing stock in Luohu district. We randomly select 5 or 6 units from each selected building, a total of 455 observations, and then collect

their structural, neighborhood and other information needed for our hedonic regression. Each home's listing price (in logarithmic format) is used as the dependent variable.

3. Summary statistics of variables

Table 1 provides summary statistics of all variables.

3.1 Housing price

The mean housing price (P) from our sample is about 1.6 million RMB, with the minimum being 300,000 RMB and the most expensive being over 10 million RMB. Frequency analysis shows that units whose prices are between 1 and 2 million RMB account for nearly three-fifths of our observations¹.

3.2 Housing structure

The average building area is 80 square meters. Units of 60-90 square meters account for one half in our sample. On average, each unit has 4 rooms (excluding bathrooms and kitchens) and 1 bathroom. About 60% of homes in our sample have a medium level of decoration. Among our selected homes, the youngest unit is only 1.5 years old, while the oldest is 18 years old. The average home age is about 9-year. Homes aged between 5 and 10 years account for 55% of our sample, while homes of over 15 years old account for only 3.3%.

3.3 Neighborhood

This group of variables describes the neighborhood condition of our sampled homes. The mean floor area ratio is 5.7; about 40% homes are located in communities with floor area ratio between 3 and 6. The community's mean green rate is 0.4, and most communities have this index between 0.2 and 0.4. Property management fee in Luohu district is 3 RMB per square meter on average, with the minimum being 0.9 RMB and the most expensive being 5.8 RMB. The management fee is used as a proxy in this research for community management quality; generally speaking, good quality of community management requires high cost. The shortest distance from a community to the nearest large supermarket is less than 5-meter, which is not rare in Shenzhen where the first floor of a residential building is rented out to a brand-name supermarket and the second and higher floors are for living. The average distance to the nearest large supermarket is 1,360 meters. The average number of restaurants or food shops around a community in our sample is 121, and the average number of entertainment facilities is about 10. The nearest distance from a community to a metro station is 202 meters, and the average is about 3,300 meters. Over half communities in which our housing sample is located are more than 3,000 meters away from a metro station. In stark contrast to such inconvenient traveling on metro, communities have very accessible public transportation on buses. A community has about 15 bus lines within 5-minute walking distance, while the maximum reaches as large as 41. The nearest distance from a community to Luohu port is 900 meters, and there are 13.4% of our sampled homes are within a distance of 2,000 meters to the Shenzhen-Hong Kong border.

¹ Frequency analysis table is available by request.

3.4 Middle school district

This dummy variable (*schdist*) is our major interest. If a home is located in any one of those three key middle school districts marked in Figure 1, this home then has the dummy *schdist* valued 1, otherwise it is valued 0. About 36% of units are located in one key school district.

Table 1: Summary Statistics of Variables (455 observations)

Variable			Mean	Variance	Min	Max
Dependent variable: <i>Housing Price</i> *	in ten thousands RMB	<i>P</i>	164.4	118.4	30	1090
Independent variable: Housing structure						
<i>building area</i>	in square meters	<i>size</i>	80	33	23	214
<i>building area squared</i>		<i>size2</i>				
<i># of rooms</i>	exclude bathroom and kitchen	<i>room</i>	3.9	1.2	1	7
<i># of bathrooms</i>		<i>bathrm</i>	1.2	0.4	1	3
<i>house age</i>	in years	<i>age</i>	9.3	3.3	1.5	18
<i>house age squared</i>		<i>age2</i>				
<i>decoration</i>	4 levels, 1= the worst	<i>deco</i>	2.3	0.6	1	4
Independent variable: Neighborhood						
<i>floor area ratio</i>		<i>far</i>	5.7	3.2	0.9	19.5
<i>green rate</i>		<i>gr</i>	0.4	0.1	0.1	0.75
<i>property management</i>	RMB per square meter	<i>manafee</i>	3.0	0.7	0.9	5.8
<i>distance to market</i> *	distance to the nearest large supermarket (in meters)	<i>lnmarket</i>	1360	1405	4	5279
<i># of restaurants</i>		<i>food</i>	121	116	1	501
<i># entertain facilities</i>	Includes theatre, KTV, etc.	<i>entertain</i>	9.3	7.8	0	33
<i>distance to subway</i> *	distance to the nearest subway (in meters)	<i>lnsubway</i>	3289	2079	202	7620
<i># of bus lines</i>	nearby bus lines	<i>bus</i>	14.3	9.3	0	41
<i># of bus lines squared</i>		<i>bus2</i>				
<i>distance to port</i> *	distance to Luohu port (in meters)	<i>lnport</i>	4300	1900	900	8200
Independent variable: <i>Middle school district</i>	1= in a key school district	<i>schdist</i>	0.36	0.48	0	1

Note: * indicates the logarithmic form used in the hedonic.

4. Empirical results

Empirical results of hedonic regressions are presented in Table 2. Model (1) does not include the key middle school district dummy (*schdist*), Model (2) includes the dummy, and Model (3) further includes the interaction terms of the middle key school district dummy and other housing price determinants. Adjusted R^2 from three models are between 0.75 and 0.77, indicating our hedonic models have strong explanatory power on housing price.

Results from Model (2) show that the key middle school district has positive *direct* effect on housing price of homes located inside. For two otherwise the same homes, the one located in

a key middle school district of Luohu is priced 20% higher than the other one without key middle school resources. We Apply a Chow test to test a null hypothesis of whether two groups of coefficient estimates from Model (1) and Model (2) are being equal as a whole. F value from the Chow test is larger than the critical value of a 95% confidence level, so we reject the null hypothesis, which implies the key middle school district resources have intervention in other variables' influence on housing price (*external* effect defined in this paper). In order to quantitatively estimate this *external* effect of key school districts on housing price, we add in Model (3) a few cross products of *schdist* with housing structural and neighborhood variables to investigate how key educational resources affect other housing price determinants' influence on housing price. These interaction variables are denoted by putting an “x” sign in front of the original housing structural and neighborhood variables.

Table 2: Regression Results of Hedonic Models

Variables	Model (1)		Model (2)		Model (3)	
	Estimates	S.E	Estimates	S.E	Estimates	S.E
<i>constant</i>	4.0200***	0.2040	4.7310***	0.1953	4.4738***	0.2127
<i>size</i>	0.0290***	0.0013	0.0277***	0.0011	0.0282***	0.0012
<i>size2</i>	-7.07e-05***	5.65e-06	-6.39e-05**	4.72e-06	-6.48e-05**	5.49e-06
<i>room</i>	0.0237**	0.0116	0.0165*	0.0100	0.0168	0.0121
<i>bathrm</i>	-0.0219	0.0218	-0.0354*	0.0188	-0.0350**	0.0235
<i>age</i>	-0.0277**	0.0114	-0.0362***	0.0096	-0.0298**	0.0129
<i>age2</i>	-0.0007	0.0006	-0.0002	0.0005	-0.0005	0.0006
<i>deco</i>	0.0437***	0.0122	0.0496***	0.0098	0.0502***	0.0118
<i>far</i>	-0.0123***	0.0027	-0.0099***	0.0025	-0.0087***	0.0026
<i>gr</i>	0.2150***	0.0506	0.1772***	0.0475	0.4031***	0.0780
<i>manafee</i>	0.0652***	0.0159	0.0742***	0.0140	0.1156***	0.0185
<i>lnmarket</i>	0.0223***	0.0062	-0.0100*	0.0057	-0.0208***	0.0055
<i>food</i>	0.0006***	8.57e-05	0.0004***	0.0001	0.0004***	0.0001
<i>entertain</i>	-0.0022	0.0023	-0.0034*	0.0020	-0.0028	0.0019
<i>lnsubway</i>	-0.1900***	0.0340	-0.2526***	0.0314	-0.2460***	0.0330
<i>bus</i>	0.0067***	0.0019	0.0055***	0.0017	0.0063***	0.0019
<i>bus2</i>	-0.0003***	4.93e-05	-0.0002***	4.78e-05	-0.0002***	5.09e-05
<i>lnport</i>	0.2360***	0.0594	0.2581***	0.0521	0.2513***	0.0540
<i>schdist</i>			0.2042***	0.0171	0.7785***	0.1435
<i>xsize</i>					-0.0013***	0.0002
<i>xsize2</i>					2.27e-06	9.17e-06
<i>xroom</i>					-0.0095	0.0201
<i>xbathrm</i>					0.0493	0.0340
<i>xage</i>					0.0056	0.0173
<i>xage2</i>					-0.0006	0.0009
<i>xdeco</i>					-0.0366**	0.0189
<i>xfar</i>					0.0019	0.0062
<i>xgr</i>					-0.3609***	0.0934
<i>xmanafee</i>					-0.0900***	0.0233
Adj R-square	0.75		0.76		0.77	

*** p<0.01, ** p<0.05, * p<0.1

Results from Model (3) again show that the key middle school district has significantly positive effect on housing price in Luohu. Four interaction variables ($xsize$, xgr , $xdeco$, $xmanafee$) have significantly negative effect on housing price, indicating that effect of building area, green rate, internal decoration, and property management cost on housing price is weakened in key middle school districts. Housing demanders are willing to pay a higher price in order to live in key middle school districts and enjoy quality educational resources, even knowing the building size, green rate, decoration level and management quality are relatively less desirable compared to units located in non-key school districts. The externality of key middle school districts has somehow changed consumers' preferences, and parents could be more tolerant of reduced quality of housing structures and neighborhood conditions. Table 3 shows the difference between key middle school districts and non-key middle school districts in terms of the combined effect magnitudes of those four housing structural and neighborhood variables.

Table 3: Effect of Housing Structure and Neighborhood Condition in Key vs. Non-key School Districts

Variables	Self coefficient	Interaction coefficient	Combined Effect =Self + Interaction coefficients	
			In key school districts	In non-key school districts
<i>size</i>	0.0282	-0.0013	0.0269	0.0282
<i>deco</i>	0.0502	-0.0366	0.0136	0.0502
<i>gr</i>	0.4031	-0.3609	0.0422	0.4031
<i>manafee</i>	0.1156	-0.0900	0.0256	0.1156

Based on information provided in Table 3, we take two otherwise the same homes (except for one from a key middle school district while the other not) as an example, and consider both *direct* effect ($schdist$) and *external* effects (from $xsize$, xgr , $xdeco$, $xmanafee$) of key school district resources on housing price. The home located inside a key middle school district is priced about 30% ($=0.7785-0.0013-0.0366-0.3609-0.0900$) higher than the other one located inside a non-key middle school district.

Effect from other housing price explanatory variables is consistent with our expectation. Analysis of selected interesting variables is as follows. (1) Building area ($size$): it has positive effect on housing price. We include a quadratic term of building area ($size2$) in our hedonic and find coefficient estimates of $size$ and $size2$ are both significant. The growing rate of housing price will decrease as building area increases, an implied parabola of housing price growth. By calculation, the vertex of this parabola is at around 220 square meters. There is, however, no home in our sample with a size of more than 214 square meters, meaning our sample distributes only in the rising phase of the parabola. The existence of this quadratic term affects only the slope of housing price equation. (2) House age (age): it has expected negative effect on housing price. Some homes with old ages might have historical value; thus their price could instead increase after they reach certain ages. We add a quadratic term of house age ($age2$) in our hedonic. Regression results show that the coefficient of $age2$ is not significant; housing price has only a linear negative correlation with housing age. Housing

price decreases monotonously as homes age. An explanation is that the oldest home in our sample is only 18-year old, not old enough to produce historical value. (3) Number of bus lines nearby (*bus*): it has positive effect on housing price. In general, a certain number of bus lines provide more travel convenience; however, traffic congestion will bring potential noise and air pollution to these communities. We thus add a quadratic term of the number of bus lines (*bus2*) in our hedonic to examine this nonlinear effect. Regression results show that *bus* and *bus2* both significantly affect housing price. The number of bus lines positively affects housing price. However, the positive effect weakens gradually as the number of bus lines increases. A negative influence will take over after the bus line reaches its optimal number of 14 in our Shenzhen Luohu case.

5. Conclusion

Using an existing housing sample from Shenzhen Luohu district, this work estimates the direct and external effect of key middle school districts on housing price of homes located inside. We verify the positive effect (*direct* effect) of key school districts on housing price. Furthermore, we confirm that key school district resources affect other housing price determinants' influence on housing price (*external* effect). In key middle school districts, housing demanders are more tolerant of reduced quality of housing structure and neighborhood condition. In other words, demanders are willing to pay a higher price for homes located in key middle school districts so as to secure the right of enjoying quality educational resources for their kids, even their homes' building area, community green rate, internal decoration, and community property management might be relatively less desirable. Combining the direct effect (20%) and external effect (10%) of key middle school district resources on housing price, housing price in key middle school districts is about 30% higher than that located in other non key middle school districts of Shenzhen Luohu area.

We claim that school district housing, as a scarce resource, is a better real estate investment vehicle. On one hand, scarce resources are high priced because of more chasing demanders. Housing price in key school districts is higher than their counterparts. Assuming the appreciation rate of housing in key school districts and non-key school districts are consistent (in fact, the former may be even larger than the latter), then housing price will increase more in key school districts during a certain period because of its larger base price. On the other hand, since both supply and demand of school district housing are inelastic, the trading volume of school district housing keeps relatively stable even in the downturn period of real estate market, thus its housing price is unlikely too volatile. By contrast, housing price in communities without key school district resources fluctuates more intensely, because both supply and demand of ordinary housing are relatively elastic. In other words, housing in communities without key school district resources has more price risk. Considering the investment return and risk, school district housing is a better real estate investment option. As regulation in Chinese real estate market is being tightened, investment advantage of school district housing will become more and more prominent.

However, the so called school district housing reflects the unequal distribution of urban educational resources, geographically speaking. Not all school-age kids in their phase of compulsory education are entitled the right of enjoying high quality educational resources provided by key school districts. From the social perspective, the government should try her best to eliminate this inequality, so as to maintain social stability. At present, the Chinese local governments are making effort to balance educational resourced, especially the hardware facilities, among different areas. However, even the gap of hardware facilities among different schools is narrowing; key school accessibility still has significant positive effect on housing price of home located around. The reason might come from the fact that there still exists significant software gap among different schools, such as the teacher quality, the school management, and etc. Therefore, the government should attach even more effort in this software aspect to truly achieve equalization of educational chance for school-age kids before they enter high schools.

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