ADBI Working Paper Series

ARE CHINESE PAYING TOO MUCH OR TOO LITTLE FOR SCHOOL QUALITY? THE RENT YIELD GAP APPROACH FOR ESTIMATING THE CAPITALIZATION OF SCHOOL QUALITY IN SHANGHAI

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No. 724
April 2017

Asian Development Bank Institute

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Suggested citation:

Zhang, M. and J. Chen. 2017. Are Chinese Paying Too Much or Too Little for School Quality? The Rent Yield Gap Approach for Estimating the Capitalization of School Quality in Shanghai. ADBI Working Paper 724. Tokyo: Asian Development Bank Institute. Available: https://www.adb.org/publications/are-chinese-paying-too-much-or-too-little-school-quality

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The authors thank Ming Lu, Xun Zhang, Xufeng Zhu, and participants of the 2014 China Young Economists Conference, the 14th China Economics Annual Conference, the 2nd Young Economists Forum for Public Economics, the 1st China Annual Conference for Public Administration, and the ADBI Workshop on Urbanization and Infrastructure in Asia. Our research is funded by the National Natural Science Foundation of China (NSF71173045; NSF71573166), Key Projects of Philosophy and Social Sciences Research, Ministry of Education (13JZD009), the Shanghai Shuguang Scholars Project (13SG35), and the Basic Research Funds of Shanghai University of Finance and Economics (2015110119).

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Abstract

This paper explores how the unequal right of enrollment for public schools between households with different tenure statuses in urban People's Republic of China (PRC) affects rental yields. In the PRC, the rental yield is as low as 2% in major cities, mostly due to the lack of property tax and the lasting boom in real estate prices. Using a hedonic pricing model, we find that the rental yield in neighborhoods associated with high-quality schools is 0.1–0.4 percentage points lower than those associated with ordinary schools, but the estimated opportunity cost of accessing high-quality schools is around CNY90,000–CNY100,000, which is affordable for many families. However, "tenant discrimination" for the right of enrollment of public schools, accompanied with tight credit constraints, creates high entry costs that prevent children from middle-income families from attending high-quality schools, thus allowing families with high initial wealth to access better education at a lower cost. This paper provides a new perspective on the results of education equalization programs in terms of educational and residential segregation and intergenerational mobility. It also adds important new insights into the studies on household behavior in the PRC's housing market during the country's rapid urbanization process. The policy implications of our study are discussed in the concluding section.

Keywords: school quality, tenant discrimination, rental yield, credit constraint, People's Republic of China

JEL Classification: H44, I24, R38

Contents

1. INTRODUCTION

It is widely acknowledged by scholars and the public that neighborhood amenities have a large impact on housing prices and rents, among which the quality of primary and secondary schools in the neighborhood may be the most influential factor. Starting from the seminal paper of Oates (1969), the capitalization of school quality into housing prices and rents has been widely recorded in many countries, such as the United States (US) (Bogart and Cromwell 2000; Clark and Herrin 2000; Crone 1998), the United Kingdom (Gibbons and Machin 2003; Gibbons, Machin and Silva 2013; Rosenthal 2003), France (Fack and Grenet 2010), and the People's Republic of China (PRC) (Feng and Lu 2013; Zheng, Hu, and Wang 2015). Since the true value of school quality is not readily measurable, the premium of housing prices and rents is an interaction of both school quality and the willingness-to-pay of the local residents. Thus, the premium may be heterogeneous across regions, localities, time, and different types of neighborhood (Brasington 2001).

In highly urbanized countries such as the US, primary education is mainly financed by property tax. Families in communities with high housing prices actually pay more tax, so they should enjoy better education. Despite the market outcome, unequal school quality has been widely criticized for its polarization effect: children from wealthier families attend better schools and have more opportunities for enrollment in famous colleges, which reduces intergenerational mobility and also causes segregation between wealth and income levels (Chakrabarti and Roy 2015; Frankenberg 2013). Thus, some scholars and policy makers have called for "no-wealth" schooling policies in place of current policies (Carrington 1973).

There has been a consensus that *hukou*, the PRC's household registration system, has become a major barrier to the PRC's urbanization process. Currently, 45% of the 24 million permanent residents in Shanghai do not possess local *hukou*. It is good to see that migrants who do not possess local *hukou* are now eligible for employment for most positions thanks to the rise of the private sector. However, many children of migrant families are still ineligible for public schooling, and most of them are either attending privately operated migrant schools or are left behind in their hometowns. In both cases, these children suffer from worse academic performance (Chen and Feng 2013). In 2008, the Shanghai government launched a campaign to admit children of migrant families into public schools during the next 3 years. Although this policy greatly improved the educational attainment of migrant children, it was strongly opposed by some native citizens, and the competition to enter public schools with better reputation is becoming fiercer. This competition is reflected in the housing market, as the right to public elementary school enrollment is unequal for homeowners and tenants. In major metropolitans, such as Shanghai, when the number of children of schooling age exceeds the capacity of the local public schools, children from families that own houses or apartments take priority for enrollment, while children from tenant families rank after them. This so-called "tenant discrimination" creates a market that sees extremely high selling and reselling prices but normal rent (Zheng, Hu, and Wang 2015). This is discrimination against low income families and new migrants. With the lack of property tax, families with high initial wealth can purchase a house or apartment, while middle-income families cannot afford them due to credit constraints.

In this paper, we assess how tenant discrimination together with credit constraints further add to the unequal right of enrollment in public schools using listed offer prices of both selling prices and rents. To do so, we first calculate the rental yield using hedonic pricing models at the neighborhood level. We then treat the difference in the rental yields between neighborhoods with schools of good and ordinary reputations as the opportunity cost of possessing an apartment in neighborhoods with good schools. Through these steps, we find that the opportunity cost is about CNY15,000–CNY17,000 per year. Even if families need to purchase an apartment up to 6 years in advance to ensure priority, and can only sell it after their children finish elementary school, the opportunity cost from a lower rent return amounts to CNY100,000, around twice the average annual income in the city. It is likely that many families wish to and are able to pay this amount for better education, but with tenant discrimination, they have to pay the price of the apartment, which is usually CNY4 million–CNY6 million, an amount that most of them cannot afford due to the credit constraints that exist widely in the nation. In this sense, we argue that tenant discrimination creates high entry costs that prevent children from middle-income families from enjoying better schools, while families with a high initial wealth can access better education at a lower opportunity cost. This feature harms the equalization of school as a universal public good, which in turn reduces intergenerational mobility.

This paper provides a new perspective on the results of education equalization programs in terms of educational and residential segregation and intergenerational mobility. Unlike public schools that are financed primarily by the local government, which can cause greater disparity between races and income levels, public schools in the PRC are co-financed by both the central and local governments. While a major part is still financed by the local government at the city or county level, the central government plays an affirmative role. Although there is still disparity across regions and between urban and rural areas, the within-city/county disparity has been greatly reduced (Wu 2013).[1] However, it seems that the government's efforts for equalization have not resulted in the desired equalization of quality reputation among public schools, as wealthier families are still being sorted for schools of good historical reputation. The sorting behavior and the sky-rocketing housing prices in these school districts are self-enforcing, which may be causing both educational and residential segregation by income level. In this paper, we argue that when only the children of homeowners are eligible for enrollment, wealthy families actually pay less for good education, which further increases the inequality of primary education in the city.

Our research sheds new light on the literature on credit constraints and educational attainment. Although governments in most countries have recognized human capital as an important factor for economic growth and have devoted a substantial share of government spending on various types of education, there still exist families that cannot afford the cost of primary, secondary, or higher education. Besides their low income, they cannot get sufficient loans from the credit market to pay for tuition, especially in the developing world. In a cross-country study, Mimoun (2008) finds that school enrollment is negatively correlated with income inequality and positively correlated with financial market development. Whereas the correlation exists for all stages of education in the developing world (Jacoby 1994), for developed countries it only appears for high school and college education, mostly due to compulsory education laws (Keane 2002; Keane and Wolpin 2001; Lochner and Monge-Naranjo

[1] According to the authors' interview with a key member of the Education Committee of the Shanghai Municipal Government in 2015, the per-student expenditure has been fully equalized in Shanghai.

2011). Our research adds to this strand of literature by investigating the consequence of credit constraints on the cost of high-quality primary education. Although primary education is nominally free in Shanghai, households compete for enrollment in famous primary schools by purchasing apartments in those school districts. Using a simple partial equilibrium model, we argue that with the presence of credit constraints, families with low initial wealth are unable to make the purchases, which results in lower costs at the equilibrium for those who can afford them. In this way, we find that credit constraints reduce intergenerational mobility not only at the lower tail of the income distribution but throughout the whole income spectrum.

This paper also adds some new important insights to the studies on household behavior in the PRC's housing market during the great urbanization period. For example, it helps to understand the extraordinary price hike in several metropolitans, which fundamental factors cannot explain (Wang and Zhang 2014; Wu, Gyourko and Deng 2012). The results of this paper also suggest that the lack of property tax has played a significant role in the speculation of the real estate market, which further distorts the distribution of primary education. Empirical evidence from two small-scale pilot property tax collection schemes in Shanghai and Chongqing suggests that the existence of property tax, even of limited scale and scope, can lower the growth rate of housing prices as it adds to the opportunity cost of real estate ownership (Bai, Li, and Ouyang 2014; Du and Zhang 2015). The results in this paper suggest that given other policies remain unchanged (i.e., tenant discrimination and credit constraints), if a property tax were to be implemented, the price of apartments would drop. This would allow families with relatively lower initial wealth to successfully access high-quality education for their children.

The rest of the paper is organized as follows. Section 2 provides a simple model to highlight the rationale of the argument. Section 3 introduces the data and the main empirical strategy. Section 4 shows the empirical results on rental yield. Section 5 gives a brief analysis based on the results in Section 4. Section 6 concludes and offers some policy implications.

2. THE MODEL

Suppose there is a continuum of families, each with one child. The total measure of families is 1 and families are indexed by $i \in [0,1]$. In a two-period model, each family consumes numeraire goods, C_1 and C_2, and the child school undergoes school education in Period 2. There are two types of schools, "ordinary" schools and "good" schools. The supply of schools is perfectly inelastic and is normalized to 1, among which a measure n of them are "good" schools. The remaining $1-n$ schools are "good" schools.

We assume that the family utility from the consumption of the numeraire is $u(C)$ in each period, and the utility from schooling is $v(S)$, where S takes the value of S_o for ordinary school attendance and S_g for good school attendance. Without loss of generality, we assume that $v(S_o) = 0$ and $v(S_g) = v$. The conventional conditions that $u'(C) > 0$ and $u"(C) < 0$ are maintained. With the assumptions of a zero interest rate and no time discount, the total utility is

$$U = \begin{cases} U(C_1) + U(C_2) & \text{for ordinary schools} \\ U(C_1) + U(C_2) + v & \text{for good schools} \end{cases}$$

Income is generated at the beginning of each period, denoted as I_1 and I_2. For simplicity, we assume that I_1 and I_2 are independently and uniformly distributed between 0 and 1. The ex-ante distribution of $I_1 + I_2$ is the Irwin-Hall distribution of degree two. Families have full information on their income in both periods at the beginning of Period 1.[2]

For simplicity, we ignore the difference in housing quality and omit the amount of housing consumption in the utility function. In this sense, we treat all apartments as identical, except for the schooling amenities, and take them as representative apartments. This implies that the housing market for ordinary school districts is highly competitive. When the interest rate is zero, the marginal cost of rental supply is only the depreciation cost.

2.1 No Credit Discrimination

In this benchmark case, families bid for good school enrollment by either possessing or renting an apartment in the corresponding neighborhood.

2.1.1 The Rental Market

If a family chooses to rent an apartment in a neighborhood with a good school, it faces the problem:

$$\max_{C_1, C_2} U(C_1) + U(C_2) + v$$

subject to $C_1 + C_2 + r_g \leq I_1 + I_2$

where r_g is the rent for a representative apartment in a neighborhood with a good school.

By simple optimization, we can get the optimal consumption, $C_1 = C_2 = \frac{I_1 + I_2 - r_g}{2}$, and utility, $U^G = 2U\left(\frac{I_1 + I_2 - r_g}{2}\right) + v$

Similarly, if a family chooses an ordinary school, it faces the problem:

$$\max_{C_1, C_2} U(C_1) + U(C_2)$$

subject to $C_1 + C_2 + r_o \leq I_1 + I_2$

By simple optimization, we can get the optimal consumption, $C_1 = C_2 = \frac{I_1 + I_2 - r_o}{2}$, and utility, $U^O = 2U\left(\frac{I_1 + I_2 - r_o}{2}\right)$.

At equilibrium, $U^O = U^G$ must hold at the margin, i.e., the family with the lowest total income that chooses good schooling should feel equally satisfied for both types of school. The cumulative distribution function of $I_1 + I_2$ is

$$F(x) = \begin{cases} \frac{1}{2}x^2 & \text{for } x \leq 1 \\ 1 - \frac{1}{2}(2 - x)^2 & \text{for } x > 1 \end{cases}$$

[2] Letting families be uncertain about their income in Period 2 slightly changes the "purchase-in-advance" equilibria, but the main result remains unchanged.

Thus, in equilibrium, the price of a good school should be pinned down by $U^O = U^G$ for the marginal family with total income $I_1 + I_2 = F^{-1}(1-n) = 2 - 2n^{\frac{1}{2}}$, which results in

$$r_g - r_o = \left(2 - 2n^{\frac{1}{2}}\right) - 2\left[U^{-1}\left(U\left(\frac{2-2n^{\frac{1}{2}}}{2}\right) - v\right)\right]$$

That is, families with total income $I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}$ choose good schooling, and the others choose ordinary schooling.

2.1.2 The Resale Market

Families can also choose to own an apartment in a neighborhood to attend a school. In order to get good education for their children, families face the problem:

$$\max_{C_1, C_2} U(C_1) + U(C_2) + v$$

subject to $C_1 + C_2 + Q_g \leq I_1 + I_2 + (1-d)Q_g$

where Q_g is the price of a representative apartment in a neighborhood of a good school district, and d is the depreciation rate. Since there is no credit constraint, families can borrow sufficiently to finance the purchase of the apartment.

For families that do not seek high-quality school education, the problem is

$$\max_{C_1, C_2} U(C_1) + U(C_2)$$

subject to $C_1 + C_2 + Q_o \leq I_1 + I_2 + (1-d)Q_o$

where Q_o is the price of a representative apartment in a neighborhood of an ordinary school district.

By applying the no-arbitrage condition, it is straightforward that

$$Q_g - Q_o = \frac{\left(2 - 2n^{\frac{1}{2}}\right) - 2\left[U^{-1}\left(U\left(\frac{2-2n^{\frac{1}{2}}}{2}\right) - v\right)\right]}{d}$$

As in the previous case, families with a total income above $I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}$ choose good schooling, and the others choose ordinary schooling.

Based on the analysis, we can conclude the following.

Lemma 1: When there is no credit constraint, the rent-to-price rates of apartments in both good and ordinary school districts are equal, i.e., $\frac{r_g}{Q_g} = \frac{r_o}{Q_o} = d$.

Proposition 1: When there is no credit constraint, the market outcome is the same in cases with and without tenant discrimination.

2.2 Tenant Discrimination with Credit Constraint

Suppose that families are subjected to credit constraint in Period 1 when they purchase the assets that qualify their children for good education. Specifically, they can only borrow up to a $(1-s) \in [0,1]$ share of the asset price Q_c and must pay the remaining share of s from their Period-1 income, I_1. In Period 2, families can retrieve $(1-d) \cdot Q_c$ from the asset and get good education, where *d* denotes the depreciation rate. On the other hand, consumption is not subject to the credit constraint.

Thus, for good education, the family faces the following problem:

$$\max_{C_1, C_2} U(C_1) + U(C_2) + v$$

subject to $sQ_c \leq I_1$ and $C_1 + C_2 + Q_c \leq I_1 + I_2 + (1-d)Q_c$

where $s > d$.[3] The constraint $sQ_c \leq I_1$ implies that in Period 1, a family can use an amount up to its Period-1 income to purchase the asset, with Period-1 consumption fully financed from the credit market.

Proposition 2: If $sQ_g > 2 - 2n^{\frac{1}{2}}$, the price of a representative apartment in a good school district is lower when there is a credit constraint, i.e., $Q_c < Q_g$.

Proof: We can prove this proposition by showing that if the price of the asset is Q_g, there would be excess supply.

From Section 2.1.2, we know that when the price of the asset is Q_g, families with a total income of above $I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}$ choose good schooling, and the others choose ordinary schooling. With credit constraints, families with total income above $I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}$ may encounter a credit constraint if $I_1 < sQ_g$. Since I_1 and I_2 are independently and uniformly distributed between 0 and 1, we have $\text{Prob}\left(I_1 < sQ_g \middle| I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}\right) > 0$ if $sQ_g > 2 - 2n^{\frac{1}{2}}$. That is, there exist some families whose total income exceeds $2 - 2n^{\frac{1}{2}}$, but their Period-1 income is too low for them to purchase the asset. Therefore, if the price is still Q_g, there is excess supply, and the price should decrease in equilibrium.

Corollary 1: With the presence of credit constraints, families with high Period-1 income enjoy good education at a lower cost if $sQ_n > 2 - 2n^{\frac{1}{2}}$.

Two groups of families are better off with the credit constraint. The first group includes families with $I_1 + I_2 \geq 2 - 2n^{\frac{1}{2}}$ and $I_1 \geq sQ_c$. They are better off with the credit constraint since they only need to pay Q_c instead of Q_n for the purchase, saving them $d(Q_n - Q_c)$. The second group includes some of the families with $I_1 + I_2 < 2 - 2n^{\frac{1}{2}}$ but $I_1 \geq sQ_c$. They are better off because they enjoy good schooling, which would be unaffordable in the absence of the credit constraint.

These facts imply that in the case of advance purchase with credit constraint, the provision of good schooling is biased towards families with high Period-1 income. This illustrative model fits the current public school enrollment process and housing market in many large cities in the PRC, where families need to purchase and own an apartment within the school district if they want their children to attend a famous public

[3] In the case of Shanghai, s is usually 0.3–0.4, whereas *d* is no more than 0.05.

school. This mechanism leads to the fact that families with high initial wealth enjoy the privilege at a lower cost, which harms education equality and poses a threat to intergenerational mobility.

In the presence of tenant discrimination, we can easily show that the rent in both types of neighborhood is r_o. Therefore, we can conclude the following proposition.

Proposition 3: When both tenant discrimination and credit constraints are present, the rental yield is lower for a representative apartment in a neighborhood with a good primary school, i.e., $\frac{r_o}{Q_c} < d$.

In the next section, we empirically estimate the cost of attending a famous public school, using data on housing prices and rents in Shanghai, the largest city in the PRC.

3. DATA AND EMPIRICAL STRATEGY

3.1 The Data

In this research, we utilize datasets collected from leading online brokers, such as SoFun and Centanet. There are two separate datasets: one for resale apartments and the other for rental apartments. The former includes the quoted sales prices for each apartment, while the latter includes the quoted monthly rent. For privacy reasons, the precise addresses are not available online, but the name of the neighborhood, the apartment area (in square meters), the number of bedrooms, the floor number, and the total number of floors in the building are listed for each apartment in both datasets. By matching the neighborhood information with the Geographic Information System (GIS) data, we can successfully locate the center of each neighborhood in our data and calculate the distance to the city center (the People's Square) and the nearest subway station, the two major geographic factors that affect housing value.

We then match the neighborhoods with the school districts in the city. Specifically, we collect the corresponding neighborhoods for each public primary school in each district. In most districts, neighborhoods are nested in school districts. This enables us to match each neighborhood with a specific school district. There are two districts, Huangpu and Xuhui, in which some boundaries of school districts cross neighborhoods. In the absence of detailed addresses within neighborhoods, we are unable to match each listed apartment with a school district, so we have to drop these two districts in our analysis.

As a measure of the equalization campaign, the municipal government cancelled the official rank of public primary and secondary schools in 2005. Despite this, almost all primary schools that were originally of high rank, i.e., key schools at the city level and at the district level, have kept their reputation among citizens. Meanwhile, as another measure of equalization, government spending on each student is also identical in all schools, and there should not be any standardized tests during the primary school grades. With the absence of these indices, we use the former rank of each school as a proxy for its quality and its reputation among local residents.

After merging the two datasets, we compose a matched sample of 6,526,102 sales records in 700 neighborhoods in 12 of the 14 districts in Shanghai between July 2013 and November 2014. Table 1 lists the number of neighborhoods and listed apartments with ordinary, district-level, and city-level key schools, and the summary statistics of these three types of apartments. We find that while there are a large number of ordinary and district-level key schools, the number of city-level key schools is much

smaller, and all of them are located in the urban area, whereas the distribution of district-level key schools and ordinary schools is relatively even.

Table 1: Data Descriptions

School Quality		Zones			
		Entire City	Puxi Districts	Pudong New District	Suburbs
Ordinary schools	Number of neighborhoods	350	196	63	91
	Number of listed apartments	2,584,852	1,138,533	478,183	968,136
District-level schools	Number of neighborhoods	308	162	55	91
	Number of listed apartments	3,494,946	1,404,222	802,167	1,288,557
City-level schools	Number of neighborhoods	42	34	8	0
	Number of listed apartments	448,304	342,604	105,700	0

Note: Puxi includes the districts of Jing'an, Changning, Putuo, Zhabei, Hongkou, and Yangpu. The suburbs include Minhang, Baoshan, Jiading, Songjiang, and Qingpu.

Source: Calculated from data collected from online brokers by the authors.

Table 2 provides summary statistics for apartments in the three types of school district. All three types of apartment share similar area means, but the prices for both resale and rent are higher for key schools. On average, the rent ratio for apartments with ordinary, district-level, and, city-level key schools are 2.21%, 2.05%, and 2.07%, respectively, showing a negative relation with school quality.

Table 2: Summary Statistics

	Ordinary Schools	District-level Schools	City-level Schools
Number of apartments for resale	2,584,852	3,694,946	448,304
Mean area (in square meters)	103	108	101
Mean total price (CNY10,000)	355	406	467
Mean unit price (CNY)	32,542	35,756	45,234
Mean monthly rent (CNY)	6,416	6,946	8,025
Estimated rent-price ratio (%)	2.21	2.05	2.07

3.2 Estimating Rental Yield

The rental yield is an index measuring the return on assets in the housing market, which are comparable with other tangible and intangible assets in the market, such as bonds and stock shares. However, rental yield cannot be directly calculated from the data because few apartments are listed simultaneously for resale and rent.

In order to estimate the rental yield, we utilize a neighborhood-wise hedonic pricing model for the rents. Specifically, we first use a hedonic pricing model for the dataset on rents:

$$\log r_{ij} = Z_{ij}\gamma_j + \theta_t + \epsilon_{ij} \quad (1)$$

where $\log r_{ij}$ is the logarithm of the monthly rent of apartment *i* in neighborhood *j*. Z_{ij} is the characteristics of the apartment, such as the area, number of bedrooms, apartment floor, and total number of floors in the building. θ_t is the month fixed effects. Note

that γ_j is a neighborhood-specific coefficient vector, which can be different for each neighborhood, so we estimate the model neighborhood by neighborhood to get each of the coefficients. This specification is the least restricted one, and allows all coefficients to vary across neighborhoods.

We then use the apartment characteristics in the same neighborhood, but from the dataset of resale offers, Z'_{ij}, to predict the logarithm of monthly rent by

$$\log \hat{r}_{ij} = Z'_{ij}\hat{\gamma}_j \quad (2)$$

where Z'_{ij} is the characteristics of apartment *i* in neighborhood *j* from the resale data, and $\hat{\gamma}_j$ is the estimated neighborhood-specific coefficient vector from Eq. (1). After getting $\hat{r}_{ij}$, we can easily get the rental yield by

$$s_{ij} = \frac{\hat{r}_{ij}}{p_{ij}} \times 12 \quad (3)$$

Table 3 reports the means and standard deviations of the rent-to-sale ratio grouped by school quality and area, which are calculated from Equations (1)–(3). The results show a clear gap in the rent-to-sale ratio between ordinary and key school districts. The gap is especially large for small apartments of less than 50 square meters. Since apartment characteristics and neighborhood amenities are not yet controlled for in this simple comparison, there is a large disparity within each group, and the differences are not significant. In order to estimate the willingness-to-pay for good schooling, we control for apartment characteristics and neighborhood amenities in the next step.

Table 3: Rental Yield Means by School Quality and Area

	All Apartments	Less than 50 m^2	50–90 m^2	90–120 m^2	More than 120 m^2
Ordinary schools	2.21 (0.579)	2.79 (0.870)	2.07 (0.439)	2.04 (0.416)	2.14 (0.454)
District-level key schools	2.05 (0.553)	2.40 (0.886)	2.07 (0.598)	1.89 (0.347)	2.07 (0.461)
City-level key schools	2.07 (0.430)	2.19 (0.532)	2.04 (0.339)	1.99 (0.293)	2.08 (0.399)

m^2 = square meters.

Note: Standard deviations are in parentheses.

Source: Authors.

3.3 Estimating Willingness-to-Pay for School Quality

After obtaining the rental yield estimates, we then regress s_{ij} on school quality to estimate the willingness-to-pay by

$$s_{ij} = \delta_1 q_{1i} + \delta_2 q_{2i} + X_j\beta_1 + Z_{ij}\beta_2 + d_k + \gamma_t + \varepsilon_{ij} \quad (4)$$

where q_{1i} and q_{2i} are dummy variables indicating whether the apartment enjoys a district- and city-key primary school, respectively; X_j indicates the amenities of the neighborhood, including the distance to the city center and the nearest subway station; Z_{ij} is a set of apartment characteristics, such as the area, number of bedrooms, floor,

and age. In Eq. (4), we include d_k, the boundary fixed effect, to control for a potential location difference that may cause bias in the estimation. Specifically, for a neighborhood with a key school, we find the nearest neighborhood with an ordinary school within 1 kilometer. In cases of a neighborhood with no ordinary school within 1 kilometer, we dropped the neighborhood. By using the boundary fixed effect with rental yield as the dependent variable, we eliminate the locality difference as well as the difference in living conditions that simultaneously affect rents and prices across the boundary. A month fixed effect, γ_t, is also included in the model. The standard error ε_{ij} is clustered at the neighborhood level, allowing for correlation within each neighborhood.

4. EMPIRICAL RESULTS

4.1 Baseline Results

Before we proceed to our empirical results, we try to estimate the premium in housing prices for neighborhoods with key primary schools. We find that compared with apartments in neighborhoods with ordinary schools, those with district-level key schools have 6.5% higher sales prices, and those with city-level key schools have 15.6% higher sales prices. Compared with the findings by Feng and Lu (2013) and Zheng, Hu, and Wang (2015), these results show a rising willingness-to-pay among residents for good education. However, as discussed previously, price premium is not a good measure of willingness-to-pay because resale opportunities always exist when children finish schooling.

We then employ the two-step approach described in the previous section, with the result from Eq. (4) listed in Column 1 of Table 4. With control variables for apartment and neighborhood characteristics, the results show that compared with apartments in neighborhoods with ordinary schools, those with district-level key schools are 0.098 percentage points lower in rental yield, and those with city-level key schools are 0.103 percentage points lower in rental yield, both statistically significant at the 1% level. The discount in rental yield is about 4.7% and 4.9%, respectively, of the average rental yield in the city, which is about 2.1%. The rental yield becomes significantly lower as the area in square meters increases, which is consistent with the existing literature on the housing market, and the distance to the subway also plays a key role.

Since every apartment in the same school district enjoys the same privilege for school entry, families can purchase a small apartment in order to acquire the privilege at a low price. We observe this phenomenon in the pre-owned housing market, where unit prices become higher as the apartment area decreases in key-school districts. To reflect this phenomenon, we divide the sample into four subsamples by area: less than 50 square meters, between 50 and 90 square meters, between 90 and 120 square meters, and more than 120 square meters. We then repeat the regression of Eq. (4). The results are listed in Columns 2–5 in Table 4. For apartments in both the district-level and city-level key school districts, we find a decreasing rental yield discount of both economic and statistical significance. Small and medium-small apartments (less than 50 square meters and between 50 and 90 square meters, respectively) see the largest discount in rental yield. The discounts for small and medium-small apartments are as large as 0.344 percentage points and 0.363 percentage points, respectively, for city-level key school districts. Medium-large apartments (between 90 and 120 square meters) see a smaller but still statistically significant discount, whereas for large apartments (120 square meters and above), the discount is not significant. The reason

lies in the fact that for small apartments, the schooling privilege accounts for a large share of the value, while the share shrinks for large apartments that are more suitable for families to live in.

Table 4: Baseline Results

	(1) All Apartments	(2) Less than 50 m^2	(3) 50–90 m^2	(4) 90–120 m^2	(5) More than 120 m^2
School levels					
District	–0.0983***	–0.0988**	–0.0857***	–0.0493**	–0.0798
	(0.0292)	(0.0388)	(0.0206)	(0.0230)	(0.0498)
City	–0.103*	–0.344***	–0.363***	–0.0929**	0.0836
	(0.0624)	(0.0956)	(0.0809)	(0.0429)	(0.0895)
Apartment controls					
Area	–0.00308***	–0.0504***	–0.0128***	–0.00112	–0.00133***
	(0.000501)	(0.00404)	(0.000787)	(0.000752)	(0.000508)
Number of bedrooms	0.0112	0.445***	0.126***	0.0191	0.0166
	(0.0120)	(0.0430)	(0.0172)	(0.0151)	(0.0204)
Floor	–0.000330	0.00899	0.00115	0.000623	–0.00193*
	(0.00111)	(0.00654)	(0.00197)	(0.00101)	(0.00104)
Age	–0.0212	0.0314	–0.00271	–0.0214*	–0.0133
	(0.0152)	(0.0192)	(0.0110)	(0.0121)	(0.0252)
Neighborhood controls					
Distance to subway	–0.129***	–0.0958	–0.122***	–0.172***	–0.101
	(0.0478)	(0.0841)	(0.0291)	(0.0416)	(0.0801)
Distance to city center	0.00427	–0.00117	–0.0747***	–0.0136	0.0284
	(0.0313)	(0.0344)	(0.0239)	(0.0280)	(0.0594)
Month fixed effect	Yes	Yes	Yes	Yes	Yes
Boundary fixed effect	Yes	Yes	Yes	Yes	Yes
Constant	3.025***	3.699***	4.058***	2.764***	2.398***
	(0.341)	(0.576)	(0.295)	(0.343)	(0.539)
Number of Observations	6,723,286	691,492	2,085,638	1,704,411	2,241,745
R-squared	0.413	0.438	0.395	0.647	0.671

m^2 = square meters.

Note: Standard errors are clustered by neighborhood. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

How large is the opportunity cost of holding an apartment in a good school district? In the sample, the average price per square meter for an apartment in a city-level key school district is CNY45,234 (around $7,400 using the exchange rate of $1=CNY6.12 at the time of the sampling period). For an apartment of 90 square meters of this type, the total price is about CNY4.1 million. With a discount in rental yield of 0.363 percentage points, the owner loses CNY14,777 in potential rent each year. In Jing'an District, at the city center, a unit price of this type in Q1 2014 was CNY49,366 on average, with a quarter of them exceeding CNY53,000. For those apartments, the annual loss in potential rent may exceed CNY17,000.

In practice, most city-level key schools are too popular, and the number of applicants usually exceeds the capacity. As a measure of control, governments in many districts have deployed restrictive policies to disqualify some of the families. For example, Jing'an District started to require that only one family could enjoy priority privilege for each apartment every 5 years. In many districts, priority is granted to families who owned the apartment earlier. Thus, many families purchase an apartment in good school districts in or before the year of birth of their child to guarantee priority and hold the apartment until the child reaches 6 years old, the age at which they are eligible for primary schooling. For a 6-year period, the potential rent loss for an apartment of 90 square meters is about CNY90,000 in the city on average, and over CNY100,000 at the city center.

4.2 Variation across Time

Based on the results in the previous section, we further investigate the time trend of the willingness-to-pay for good education. To do so, we estimate Eq. (4) on a monthly basis and record the estimates of δ_{1t} and δ_{2t}, where t indicates the period for each month from July 2013 to November 2014. Through this specification, we allow the willingness-to-pay to vary across time. Table 5 lists the estimates of δ_{1t} and δ_{2t} for each month.

Table 5: Discount in Rental Yield for Apartments Less than 50 Square Meters: Monthly Estimation

	July 2013	August 2013	September 2013	October 2013	November 2013	December 2013
District level	–0.0360	0.000363	–0.00967	–0.0669	–0.139**	–0.110**
	(0.0420)	(0.0420)	(0.0451)	(0.0421)	(0.0572)	(0.0510)
City level	–0.250*	–0.296**	–0.394***	–0.329***	–0.339***	–0.301***
	(0.129)	(0.118)	(0.0708)	(0.0564)	(0.0927)	(0.0882)
	January 2014	**February 2014**	**March 2014**	**April 2014**	**May 2014**	**June 2014**
District level	–0.0848	–0.104**	–0.112***	–0.135***	–0.183***	–0.136***
	(0.0545)	(0.0525)	(0.0382)	(0.0403)	(0.0620)	(0.0408)
City level	–0.420***	–0.485***	–0.517***	–0.417***	–0.332**	–0.399***
	(0.137)	(0.122)	(0.0875)	(0.0963)	(0.129)	(0.120)
	July 2014	**August 2014**	**September 2014**	**October 2014**	**November 2014**	
District level	–0.133***	–0.126***	–0.143***	–0.135***	–0.128***	
	(0.0424)	(0.0478)	(0.0465)	(0.0411)	(0.0416)	
City level	–0.383***	–0.408***	–0.327***	–0.352***	–0.296***	
	(0.0998)	(0.140)	(0.115)	(0.115)	(0.112)	

Note: Standard errors are clustered by neighborhood. The control variables are the same as in Table 4. *** p<0.01, ** p<0.05, * p<0.1.

Source: Authors.

We first look at the time trend for δ_{2t}, the discount in rental yield for apartments in city-level key school districts. During the second half of 2013, the discount fluctuated between 0.25 and 0.35 percentage points. At the beginning of 2014, the discount escalated to 0.4–0.5 percentage points, with a peak of 0.517 in March, but decreased to 0.35–0.4 percentage points in the second half of 2014. The time trend for δ_{1t}, the

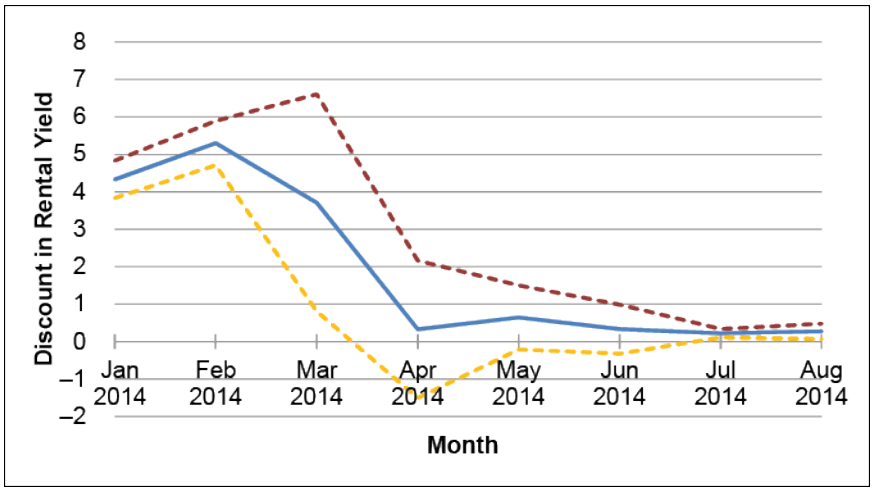
discount in rental yield for apartments in district-level key school districts, is similar but with a much smaller magnitude and statistical significance.

4.3 A Natural Experiment

In April 2014, the government of Jing'an announced a new policy to curb the problem of excess demand for city-level key school enrollment. According to the policy, only children from one family can enjoy priority privilege to enter a key primary school per apartment every 5 consecutive years. That is, if a family sells their apartment right after their child enters school, the buyer of the apartment should wait for another 5 years before his/her child can enjoy the same privilege. The new policy greatly reduced the turnover of apartments in key school districts and mitigated the pressure of congestion of key school enrollment.

To investigate how the policy affected the rental yield, we take the Jing'an subsample during January–August 2014. As shown in Figure 1, after the announcement of the policy, we see a sharp drop in the discount of the rental yield in the Jing'an market because of price slumps in the many listed apartments that are not qualified for key school enrollment in the near future.

Figure 1: Discount in Rental Yield for Jing'an District for Apartments Less than 50 Square Meters



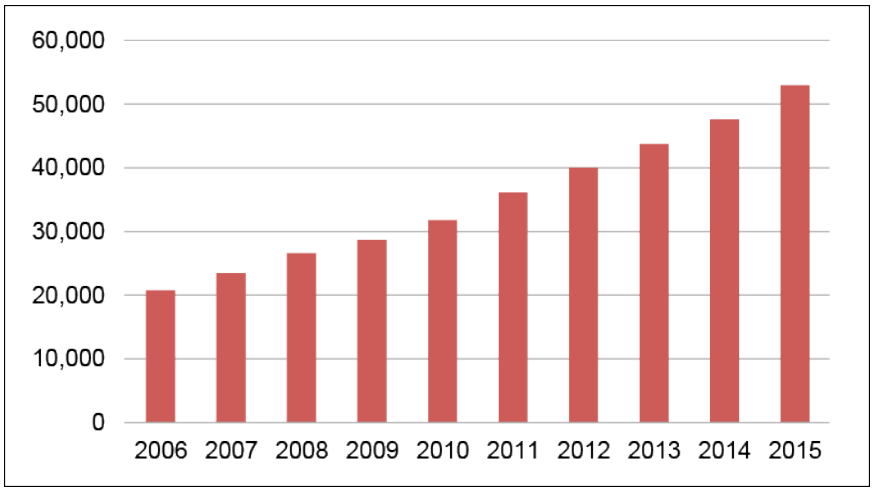
Note: Discounts are in absolute values. Dotted lines represent the 95% confidence interval.
Source: From data collected from online brokers by the authors.

5. PAYING TOO MUCH OR TOO LITTLE?

We showed in Section 2 that families under credit constraints with higher initial wealth can enjoy good education for their children at a lower cost compared to those without credit constraints. In the empirical analysis, our estimation of the cost is around CNY90,000 in the city on average and about CNY100,000 at the city center. If we divide the cost by 5 years (the length of the primary school period), the annual cost turns out to be CNY18,000–CNY20,000. In this section, we evaluate this amount using two approaches.

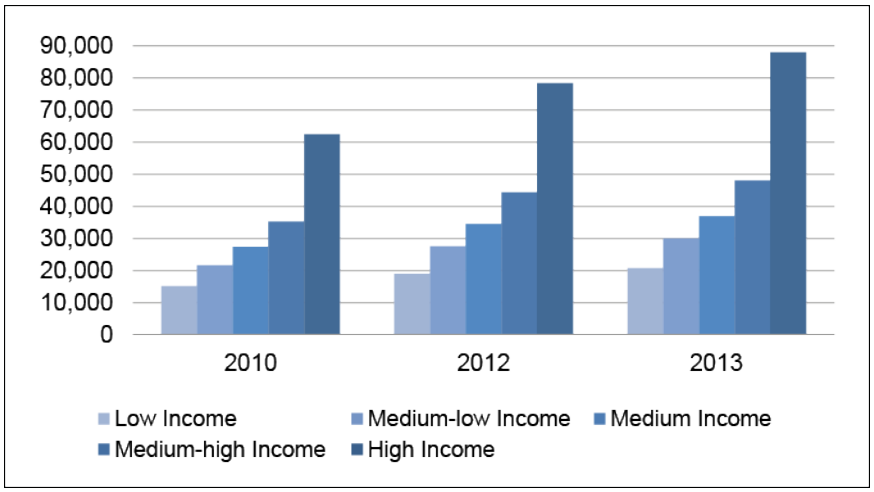
We first compare the cost with household income. Figure 2 shows the per capita disposable income of urban residents in Shanghai in nominal terms. It is clear that income growth has been fairly rapid during the past decade, reaching CNY52,000 in 2015. Moreover, there are great discrepancies between different income groups. As Figure 3 shows, dispensable income for the highest income group is about twice the mean and four times that of the lowest income group. Although income data by group are not available for 2014 and 2015, we can estimate that the disposable income for the highest income group exceeded CNY100,000 in 2015. Meanwhile, the PRC has a high, although declining, labor force participation rate among urban married women of around 70% (Hare 2016), so we should expect an annual family disposable income of around CNY170,000 for the high-income group. In this sense, the annual cost of good education only accounts for 10.5%–12% of the disposable income of the high-income group, which is affordable for many families in the city.

Figure 2: Per Capita Disposable Income in Shanghai
(CNY)



Source: Shanghai Statistical Yearbook.

Figure 3: Per Capita Disposable Income in Shanghai by Income Group
(CNY)



Source: Shanghai Statistical Yearbook.

We then compare the cost of schooling with private school tuition. Based on the authors' internet survey of information on 30 private schools, tuition varies greatly. At the bottom, there are several schools that charge CNY14,000 per year, while schools at the middle charge CNY26,000–CNY45,000 per year, and the top schools charge around CNY80,000 per year. In this sense, the cost of attending city-level key public schools is similar to the tuition of private schools at the lower end. It is not clear whether these public schools are comparable to the top private schools, but they should not be parallel to private schools at the bottom. In this sense, the cost of attending a key public school is lower than its value.

6. CONCLUDING REMARKS

In this paper, we explored the capitalization of the quality of public education in housing prices in Shanghai. A unique feature of the market is that only families who own a property have priority privilege for school attendance, while tenants do not. Thus, in order to attend famous public schools, families need to purchase an apartment within the specific area years before their children reach the age of schooling. Meanwhile, most families are subject to credit constraints as the banks impose a maximum mortgage rate, which varies from 30%–70%.

Using a theoretical model, we showed that when there are no credit constraints, it does not matter whether the family is required to purchase an apartment in advance or simply pay a fee on enrollment. However, when credit constraints are present, families with low early-period income may suffer from the inability to purchase housing, which drives down the equilibrium asset price. This could benefit families with a high early-period income since they need to pay less for the asset. The equilibrium is neither efficient, due to the presence of credit constraint, nor equalizing, since opportunities for better school enrollment are biased towards families with high early-period income compared with the pay-on-enrollment equilibrium.

We then utilized datasets from the housing market in Shanghai, including both the resale and rental markets. As there are few apartments that are simultaneously listed for sale and for rent, we applied a neighborhood-wise hedonic pricing model to predict the rental yield for each listed apartment and then regressed the rental yield on a set of dummies indicating school quality. We find significant differences between the school districts of ordinary and key schools. The opportunity cost of holding an apartment with a low rental yield can be regarded as the cost of school entry, and our estimates show the cost is about CNY90,000 in the city on average, or about CNY100,000 at the city center. If we divide the cost by 5 years, the annual cost turns out to be CNY18,000–CNY20,000, which is fairly low compared to the city's family disposable income for the top quintile or compared to the annual tuition of the top private schools.

The strict rule of public school enrollment seems politically correct as it keeps the public schools "free"—no tuition fees or other fees are explicitly charged. However, as long as there are differences in education quality, the differences are inevitably capitalized in one form or another. The strict rule has helped to prevent corruption in school enrollment, but has worsened social inequality in terms of intergenerational mobility and posed a potential threat to the vitality of the city.

Currently, per-student fiscal spending is already equalized in all primary schools in the city. However, due to their historical backgrounds, schools still differ in the quality of their teachers and their reputations. If the municipal government wishes to further equalize quality, more affirmative policies are needed, and this may take time. Alternatively, it could be better to let tenants enjoy the same privileges as owners. This would improve the credit constraints for families, especially new migrant families that suffer from insufficient early-period income, and reduce the risks to the housing market in districts with famous schools. Also, implementing property taxes could mitigate the inequality since they would lead to a decline in housing prices, which would partially ease the credit constraints.

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