Estimating Parents' Valuation on Elite School in China*

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1 Introduction

The Chinese economy has rapidly developed over the past 25 years. While the poverty rate declined from 60% in 1978 to 10% in 2014[1], disparities have grown as people from different socioeconomic classes have benefited from the growth at different rates, leading to an increase in income inequality (Dollar, 2007). As Doepke and Zilibotti (2019) argued, greater income inequality has driven parents to be more attentive toward their children's educational success. Since the quality of primary education is a key determinant of later academic achievement (Hoekstra et al., 2018), competition for places in the best primary schools in China is increasingly intense.

Furthermore, though admission to public primary schools is residence-based in urban areas, homeowners have precedence over renters in the admissions process. In practice, parents must own a property within the school attendance

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[1]Data Source: World Bank.

zone to send their kids to the most desirable schools, which contributes to skyrocketing housing prices (Chan et al., 2020).

There is substantial literature exploring how much parents value school quality. Most studies have found a positive relationship between school quality and house prices; one standard deviation increase in school test scores usually raises local housing prices by 2–4%. (Black and Machin, 2011; Nguyen-Hoang and Yinger, 2011). However, in China, there are no standardized tests at the primary and middle school level, and schools are forbidden to release the test scores to the public. Therefore, in contrast to the tradition of research using student standardized test scores (e.g., Black, 1999; Figlio and Lucas, 2004; Gibbons et al., 2009; Fack and Grenet, 2010) as the measurement of school quality, it is unlikely to use test scores to measure school quality in China. Therefore, little rigorous research has been done to estimate the school-quality premium in housing markets in China. In this paper, we aim to provide an estimation for house price premium associated with better school quality based on the historical classification of key (magnet) schools and non-key schools using the best available data on urban areas of China.

In China, the key (magnet) school system began in the late 1970s, and it has exerted a profound influence on basic and higher education. Historically, key primary schools were given priority in the assignment of teachers, equipment, and funds. These schools constituted only a small percentage of all schools[2] and were considered the most prestigious schools in China. However, the system raised serious problems, such as harming the goal of education equity and fostering vicious competition among young children. As a result, the authorities formally prohibited key schools at the primary and junior secondary education stages in the 1990s. Zheng et al. (2016) found that a historical key school con-

[2]According to the National Education Survey in 2004, there are approximately 30,000 key primary schools out of 36,620,000 primary schools nationwide.

tributed an average house price premium of about 8.1% in Beijing, while Zhang and Chen (2018) found a price premium of 6.5% in Shanghai. However, these studies mainly relied on simple OLS regressions and failed to prove a causal relationship between key school classification and housing prices.

In this paper, we use the Beijing 2014 Education Reform as a quasi-experiment and apply an event-study-style estimation of parents' valuation in the access to key school resources by comparing the housing price differences between historical key schools and non-key schools. Furthermore, we also utilize the variation of policy changes in this reform to isolate parents' valuation of exposure to (perceived) better and (perceived) worse education resources. Based on the estimation results, parents are willing to pay 5.51% or $77.36 per square foot to obtain full access to the benefits associated with key schools for their children. Meanwhile, parents with kids enrolled in key schools seem to be insensitive about sharing the educational resources with peers from non-key schools. The results are robust to various specifications.

The rest of the paper is organized as follows. Section 2 provides an overview of related literature. Section 3 describes the background and details of the Beijing 2014 Education Reform. Sections 4 and 5 introduce the methodology and data collected. Section 6 provides the empirical results, and Section 7 outlines the robustness check results. Lastly, Section 8 presents the conclusion.

2 Literature Review

There is a long tradition of economists using data on housing prices as a means of eliciting the prices of local amenities (Sheppard, 1999). Tiebout's model (1956) provides a theoretical foundation for the capitalization of public goods such as education into housing prices. Rosen's model (1974) describes a market equilibrium in which consumers choose an optimal bundle of commodities, such

as house characteristics and local amenities (e.g., school quality). In this equilibrium, given consumer preferences and income set the marginal benefit of improving any part of the bundle (e.g., living in a location with a better school) and equal the utility costs of the additional expenditure involved. Therefore, holding all else equal and estimating how much housing expenditures change with marginal changes to one attribute (e.g., school quality) can be interpreted as the marginal willingness to pay for that particular attribute (Black and Machin, 2011).

A great deal of literature has been devoted to the effect of school quality on housing prices. However, estimating the causal relationship between school quality and housing prices is complicated by the endogeneity of school performance in residential choice; this is because paying different housing prices causes people to sort themselves into diverse residential communities, and pupils from wealthier neighborhoods tend to have higher academic achievements. Therefore, in a traditional hedonic approach, housing prices are simply regressed on school performance and controlled for housing and neighborhood characteristics, and they are likely to be biased due to endogeneity problems. Additionally, unobservable neighborhood and housing attributes may also lead to bias in the estimation process. To control for potential endogeneity bias, Black proposed the method of adopting a boundary discontinuity design (BDD). She compared housing prices on different sides of the shared border of a primary school attendance zone and found that parents were willing to pay 2.5% more for a 5% increase in test scores. This result relies on the crucial assumption that while school quality changes discontinuously across the borders of school districts, other housing and neighborhood characteristics are sufficiently similar along the boundaries.

However, Kane et al. (2006) noted that there might be systematic differences

in the characteristics of the population and quality of housing on either side of a school district boundary, which could lead to biased results when simply applying BDD. As a result, several empirical papers have sought to examine the relationship between school choice and property value by further developing the BDD approach using matching. Fack and Grenet (2010) developed a matching framework to compare sales across school attendance boundaries in Paris and found that one standard deviation of public school test score raises housing prices by 1.4%. Similarly, using British data, Gibbons, Machin and Silva (2013) found significant effects of school quality on housing price by matching identical properties across school admission boundaries. Alternatively, Bayer et al.'s (2007) work embedded BDD in a heterogeneous residential choice model to estimate household preferences for school and neighborhood attributes in the presence of sorting and their results were substantially lower than the previous finding[3]. Moreover, in contrast with the cross-sectional estimations in previous empirical studies, a few papers (Bogart and Cromwell, 2000) have also examined changes in school boundaries over time and adopted the difference-in-difference approach to deal with endogeneity. However, some studies found significant effects of test scores on housing prices (Brunner et al., 2002; Clapp, Nanda and Ross, 2008), whereas others did not (Clapp and Ross, 2004).

Even in previous studies documenting a positive relationship between test scores and housing prices, the magnitude has varied significantly across data and models. Furthermore, as pointed out by Black and Machin (2010), one potential limitation of using such simple difference-in-difference (DID) estimation is that the changes in test scores might also coincide with unobserved changes in neighborhood characteristics. Some studies have relied on exogenous policy change to overcome the endogeneity issue. For example, Machin and Salvanes

[3]In their paper, they found that households are willing to pay less than 1% more in house prices when the average performance of the local school increases by 5%.

(2010) explored the housing price difference before and after the introduction of a new policy where students were able to select their preferred school. Their results showed that the impact of school performance on housing values was lower following the reform.

In the existing literature, it is standard to measure school quality using test scores, and the analyses mentioned above have all been based on the assumptions that test scores are an accurate measurement for school quality and that parents know about them. Several papers have also tried to identify which school characteristics are valued by parents. A few school characteristics have been tested, including parental valuations of expenditures per pupil (Oates, 1969; Rosen and Fullerton, 1977; Hayes et al., 1996; Brunner et al., 2002; Dobbie and Fryer, 2013), peer quality (Rothstein, 2006; Clapp et al., 2008; Dobbie and Fryer, 2013; Burgess et al., 2015), teacher and principal qualifications (Rothstein, 2006; Dobbie and Fryer, 2013), and student-teacher ratio (Weimer and Wolkoff, 2001). However, mixed evidence has been found for parents' preferences regarding individual school characteristics.

However, in China, there is no standardized test at the primary school and middle school levels to discourage intense competition among children, and primary schools are forbidden from publicizing test results. Furthermore, there is only limited data on school characteristics. As a result, little rigorous research has been done to estimate the school quality premium in housing markets in China. Previous studies have tried several different measurements for school quality. For example, Chan et al. (2020) used mathematics and language tournament performances as an indicator of school quality. However, tournament performance may not be an accurate measure for schools where students enter such tournaments voluntarily. Furthermore, from 2006 to 2016, only 38 schools out of 1,239 schools in Beijing participate in tournament competitions, which

further indicates the limitation of using tournament performance due to the potential selection problem. Other attempts have also been made using the historical classification of key schools and non-key schools. Zheng et al. (2016) found that, on average, a historical key school contributed a price premium of about 8.1% in Beijing, while Zhang and Chen (2018) found a price premium of 6.5% in Shanghai. However, these studies largely relied on simple OLS regressions and did not prove a causal relationship between key school classification and housing prices.

In this study, we utilized a natural experiment based on the Beijing 2014 Education Reform and adopted a DID-style empirical strategy to estimate the reform's impact on housing prices. This paper contributes to the literature of capitalization of school quality into housing prices, as well as parents' valuation of school characteristics. This study approach offers several advantages. Firstly, there is no property tax in China and public schools are funded through municipal funding, which prevents the endogeneity of school quality. Secondly, one residential address is affiliated with only one primary school, which avoids estimation bias because of school selection. Lastly, only homeowners—and not renters—have the privilege of sending their children to local public schools. Therefore, holding all else equal, housing price differences across school type accurately reflect parents' valuation of different schools.

3 Background

3.1 Housing Market in China

When the People's Republic of China was founded in 1949, a system of public housing allocation was in place, with housing construction financed mainly by both local and central governments. Residents in urban areas only had to pay

a small rent to obtain the right to live in these houses. Most urban residents lived in housing units constructed and owned by their employers (Huang et al., 2020).

Since 1978, China has carried out reforms of housing commercialization that can be divided into the following phases. In the first phase from 1978 to 1998, the State carried out exploratory reforms of housing commercialization, gradually sold public housing to individuals, and began to establish a multi-level housing supply system with guaranteed housing and commercial housing. In 1998, the State issued further regulations to deepen the housing market reforms, stopping the distribution of housing and gradually monetizing housing distribution. In line with other reforms that transformed the public housing system into a private housing system during this period, housing provisions were less frequently included in employee compensation, and the private housing market therefore expanded (Hiroshi, 2006).

The second phase lasted from 1999 until 2005. After the liberalization of the real estate market, China's housing investments maintained rapid double-digit growth for seven consecutive years and gradually became a pillar industry of the national economy. According to Fang et al. (2015), the residential housing market, as measured by residential house sales volume, grew by about 15% per annum between 2002 and 2013.

Lastly, the third phase has lasted from 2006 to the present and is mainly characterized by State macro control. Housing market supply is dominated by enterprises, while the State regulates the price of housing mainly through the adjustment of real estate policies. Currently, housing that was formerly public but that has since been privatized can also be traded in the market.

3.2 "*Hukou*" and School Admission

Hukou is the household registration system in China, which dates to the Qin dynasty (375 BC). It serves as a means for population counting, taxation, and the recruitment of soldiers. Hukou provides basic information about the population, such as citizenship, kinship, and the legal address of residents living in the country (Wang, 2004).

In mainland China, citizens are required from birth to choose the hukou registration location of one of their parents as their hukou. They can move their hukou location for schooling and employment, but this is strictly regulated by local governments, and certain other restrictions (e.g., paying tax to local governments for over three years) are imposed. Each person's hukou file and self-held hukou book are the basis for establishing citizenship, issuing identity cards and passports, and declaring legal status and kinship. Like the population registration system in other countries (e.g., Social Security Number in the US), hukou provides individuals with legal proof of citizenship and serves an important role in enumerating demographic information.

Hukou was also designed to facilitate the distribution of public goods under the planned economy. From the 1950s to the 1980s, China implemented a planned economy, creating a system of universal rationing of individual goods and relying on a household registration system for ration management. In 1958, the central government promulgated the first household registration law, which established a strict system of household registration that included seven population registration systems (permanent residence, temporary residence, birth, death, moving out, moving in, and other change). All individuals were divided into two categories: "agricultural hukou" and "non-agricultural hukou". The authorities imposed a permanent subsidized rationing supply of basic necessities for non-agricultural hukou holders, who made up a minority of the population

(between 15% and 25%). In contrast, the rural population, which comprised the majority of the population, had largely been left out of the rationing supply because it had been allocated with land to take on the role of food producers.

Notably, the classification of "agricultural hukou" and "non-agricultural hukou" is purely location-based rather than occupation-based. Many people who live in suburban areas are not engaged in agriculture at all but still have an agricultural hukou; there are also many people from rural areas who work in cities but cannot obtain a non-agricultural hukou. The transition between hukou types can only happen under certain circumstances, such as by marriage. Over the past three decades, as the market economy has evolved, the function of allocating food and other necessary goods under the hukou system has deteriorated. Nonetheless, the allocation of other resources to the urban population remains significant, particularly in the areas of housing, healthcare, education, employment, and eldercare. As a result, hukou somewhat hinders the development of cities and the urbanization of rural areas because of the inefficient distribution of resources. Starting in 2005, a series of policies have been introduced to abolish the boundaries between agricultural and non-agricultural hukou and to begin the establishment of a unified urban and rural hukou registration system.

On the other hand, even within the same type of hukou, if someone lives in a place other than their hukou-registered city, they are considered an alien and cannot enjoy the various welfare benefits available in that place, including adequate schooling and employment opportunities. To resolve this problem, on July 30, 2014, the State Council initiated a reform to liberalize the restrictions on hukou registration in cities. The reform aims to abolish the hukou restrictions in towns and small cities, gradually remove the restrictions on middle-sized cities, and relax the restrictions in big cities. However, the restrictions on hukou in megacities like Beijing and Shanghai will remain strict.

Following the economic reforms and opening up of 1978, economic growth has maintained a high demand for labor in cities, and this demand is filled by migrant workers from rural areas or small towns. However, migrants' children are usually left in their hometowns and are cared for by a remaining parent or grandparents. According to the Fifth National Population Census, 22.9 million children between the ages of 0 to 14 live without either one or both of their parents. For those children who migrate with their parents without a local hukou, they have much more limited access to educational opportunities than their local counterparts. Restricted space and the desire to ensure local interests discourage local governments from enrolling migrant children in public schools. As a result, the children of migrant workers are sent to private schools that specifically cater to migrants. However, these institutions usually have lower education quality. School facilities are often in poor condition, and many teachers are unqualified. The difficulties faced by migrant children cause high dropout rates, particularly in the middle school years: in 2010, only 30% of migrant children were enrolled in secondary education (Chan, 2015).

3.3 School District Houses (*Xuequfang*) in China

School District House (*Xuequfang*) in China refers to a property, which resides within a school (mainly key primary and secondary schools) attendance zone that enrolls students in the affiliated school without having to meet other conditions (e.g., tests, extra fees, etc.).

Before 1986, school admission was based on standardized test scores, and students with high scores were admitted to key (magnet) schools. However, the flaws of this exam-oriented education system, including its intense focus on examinations, rote memorization, and cramming instead of cultivating knowledge and responsibility (Pepper, 2000), were widely criticized. Furthermore, the

implementation of the one-child policy in 1979 also increased the expectations parents put on their children and further exacerbated the pressure to succeed in school.

As a result, the central government enacted the Compulsory Education Law in 1986. Since then, entrance exams have been abolished for compulsory education stages, and a nearby school admission policy has been implemented. The original intent of this policy was to enable children from ordinary families to gain access to quality educational resources, but it did not work as intended. School admission is now based on hukou location (Feng and Lu, 2020; Huang et al., 2020), resulting in the emergence of school district houses and driving high prices for the real estate market. Since key schools are regarded as a scarce resource, the property within the school district becomes a valuable investment commodity. On the one hand, the investor's children can enjoy the high-quality education resources affiliated with the school district. On the other hand, the investor also obtains the benefits of property appreciation. Even when the real estate market is down, school district houses are less affected by the business cycle because of the inelastic demand for quality education.

Moreover, unlike typical residence-based admission systems in other countries, homeowners and renters are not treated the same way regarding the right to school attendance. In practice, because renters have a hukou registration with another city, only homeowners can send their children to schools that are in high demand (Chan et al., 2020), strengthening the relationship between housing prices, access to education, and school quality.

Previously, the location-based rule was widely condemned as parents used power, money, and connections to send their children to prestigious schools (Dello-Iacovo, 2009). However, in the past decade, education policy has required that students attend nearby schools, thereby strengthening the link between

school quality and housing prices (Feng and Lu, 2020). With the introduction of the second-child policy, the demand for quality education resources continues to expand, and the price of school district housing is bound to rise accordingly. People who own a (key) school district house enjoy capital appreciation, while people who cannot afford a house are further blocked from the market, exacerbating household wealth inequality.

3.4 Beijing 2014 Education Reform

As in the rest of China, education in Beijing is predominantly public. According to the Beijing Municipal Commission of Education, there were only 24 private schools out of a total of 1,160 schools in Beijing (Zheng et al., 2016). Compared to tuition-free public schools, these private schools charge annual tuition fees ranging from $\$10,000$ to $\$50,000$ and aim to send students overseas for high school and university.

The capital of China, Beijing, consists of 16 districts that can be divided into 137 subdistricts. In contrast with the United States, a district is regarded as a county-level division, and a subdistrict is regarded as a township-level division. As shown in Table 1, even at the same division level, district size and population density can vary substantially. For example, Dongcheng District and Xicheng District have a similar density to Manhattan, while Chaoyang, Haidian, Fengtai, and Shijingshan Districts have a similar density to Queens in New York City[4]. As noted in the previous chapter, education in China is funded by a centralized municipal fund. The district-level governments are responsible for supervising public schools and the assignment of pupils and educational resources.

There are no standardized tests at the primary school level. Furthermore, to discourage competition, no performance statistics like test scores or rankings

[4]Manhattan County's population density is 71,341 people per square mile versus 20,767 per square mile for Queens. Data source: 2010 US Census.

are publicly available for the compulsory education stages. Since there are no entrance examinations for primary or middle schools, residence-based enrollment to local public schools can be violated by charging extra admission fees and opening specialized classes to attract out-of-district students. To equalize access to public schools, the government of Beijing passed a strict policy to guarantee students' enrollment in nearby schools. An information collection system was put into effect that records the entire process of student enrollment, including information regarding students' residences, current school, and how they enrolled in the primary and middle schools. As a result, the whole enrollment process has become much more transparent, eliminating potential manipulation of school choice. Furthermore, a number of educational policies have been enacted by the district-level government to further improve school quality in primary education.

Firstly, numerous formerly non-key schools were shut down, and students were assigned to corresponding key schools (a process termed "Re-designation"). Each pair of schools were in the same neighborhood at an average distance of 150 meters. The original campuses of non-key schools were reconstructed and taken over by the corresponding key school. Additionally, teachers from the non-key schools were randomly reassigned to other primary schools in the city. Students in the same grade from both schools were shuffled around to create new classes.

Secondly, a "School Federation" was established to ally low-quality schools with existing elite schools, enabling the key school to share teaching resources and best practices with non-key schools (Huang et al., 2020). As a result, students who are enrolled in non-key schools can also obtain partial access to the educational resources in a key school. These key schools must share all educational resources with affiliated non-key schools. Teachers from key schools are

obliged to give lectures half of the time to students in allied non-key schools, and students from non-key schools are granted access to resources and equipment in the paired key schools, including libraries and labs. Meanwhile, pupils in both key schools and non-key schools have remained the same.

Lastly, the policy of creating a couple of "Nine-Year-Straight" schools has resulted in increases from 50% to 100% in the admission rates of non-key primary schools to top middle schools[5]. The detailed policy descriptions are listed in Table 5. Before the establishment of "Nine-Year-Straight" schools, the admission from primary schools to middle schools is residence-based; one residential address is linked with several in-zone middle schools, and a lottery will be run by the local government to randomly assign students to each middle school. The admission rate to top middle schools is similar across school districts with an average of 50%. With the creation of "Nine-Year-Straight" schools, students who live in the corresponding middle-school district will be directly admitted to top middle schools.

4 Data

We constructed our dependent variable, school district house price, from transaction-level secondhand housing sales data from Beijing. The data was purchased from Lianjia.com, which is one of the biggest real estate brokerage companies in China and which covers more than 60% of the market share of the Beijing real estate market. For each transaction, we obtained detailed information, including addresses, coordinates, the number of bathrooms and bedrooms, building year, and lot size. Due to constraints of data availability, the sample period was set from January 2012 to January 2019 and contained 32,387 transactions in total.

[5]Here, I define "top" middle schools as those with scores in the 1st quartile of the high school entry exam grade distribution.

Similar to megacities in the United States, it is most common for people in Chinese megacities to live in condominiums in medium or high-rise buildings, and a residence complex (*xiaoqu*) can be defined as the most fundamental organization unit of the neighborhood (Huang et al., 2020). Furthermore, school admission is usually affiliated with residence complexes (RCs). Prior to open enrollment each year, each public primary school distributes admission brochures specifically listing the names of designated RCs eligible to enroll students. Therefore, we manually matched RCs to corresponding schools using the school admission brochure from the sample period and recorded changes in corresponding schools if they were subject to any policy impacts mentioned in the last section. After excluding RCs with less than three transactions in any year within the sample period and removing outliers in the top or bottom 1% of the price distribution, we obtained a final sample of year-RC-level observation and the sample size is 4,438. Standard errors were all clustered at the RC level.

For school data, we applied web scraping techniques to extract individual primary school information from government websites, including address, coordinates, number of classes, number of teachers, number of elite teachers[6], number of students, and admission rate to each middle school. In total, we obtained detailed information for 85 primary schools, 28 of which were former key schools. The summary statistics are shown in Table 2.

However, it is important to note that the former key primary schools did not appear to be superior to ordinary schools in most observed school characteristics (see Table 2), but these schools did have better performances as measured by tournament medals (see Table 4). However, using tournament performance may not be an accurate measure since participation in tournaments is voluntary (Chan et al., 2020). However, due to the lack of public data on standardized

[6]Teachers in China are evaluated by local governments each year. Based on their teaching quality, top teachers will be awarded with titles of "Elite Teacher".

test scores, it can reflect the difference between key schools and non-key schools to an extent (Huang et al., 2020).

5 Methodology

This study employed an event study approach to examine the effects of the three policy options mentioned in the previous section on housing prices. The baseline model specification is defined as

$$p_{istg} = \lambda_s + \delta_t + \sigma_g + \alpha X_i + \beta_{2011-2013} D_{istg} + \beta_{2015-2018} D_{istg} + \epsilon_{istg} \qquad (1)$$

where p is the mean house price of residential complex i in subdistrict s in year t under policy option g. λ_s controls for subdistrict FE; δ_t controls for year FE; σ_g controls for treatment group FE and X_i is a set of housing characteristics. D_{istg} are dummy variables assuming value one on event year t and zero otherwise, where t can take the value from 2011 to 2013 and 2015 to 2018.

Based on Section 3.4 and Table 5, we exploited the impact of different policy options on housing prices. Though on average, there is no significant difference in multiple observable school characteristics between key primary schools and non-key primary schools (as shown in Table 2), we disentangle the treatment effects by interpreting these as changes in parents' perceptions of school quality. For example, regarding the policy of "Re-designation," pupils have full access to the educational resources of corresponding key primary schools, which can be used to estimate parental valuation of full exposure to more elite schools. Under the "School Federation" policy, we can identify parents' valuation of pupils' partial accessibility to the benefits associated with a key school. Lastly, the policy regarding "Nine-Year-Straight" schools indicates parents' valuation of admission to top middle schools without changing perceptions of the quality

of primary school their child is currently enrolled in.

Furthermore, the "Re-designation" and "School Federation" policies enable the identification of the treatment effects for both key schools and non-key schools. After the implementation of the reform, parents perceive key schools more negatively because they need to share educational resources with non-key schools. On the other hand, non-key schools gain access to (perceived) better educational resources from key schools, so expected teaching quality increases due to the reform.

6 Empirical Results

6.1 Results for Non-key School

The baseline regression results regarding "Re-designation" are shown in Table 6. As seen in the corresponding figures (Figure 1 through Figure 3), the parallel trend between the treatment group and control group holds for all three policy groups. As shown in Table 6, relative to the control group, housing prices associated with non-key schools increased significantly after the reform ($68.73 per sq. ft, $p < 0.01$) and the increment is consistent in the following years.

The estimated difference-in-difference estimate for non-key schools involved in the "School Federation" reform is shown in Table 7. The estimated coefficients are not as significant as those under the "Re-designation" policy. However, the magnitude is still very large, ranging from $68.65 per square foot to $132.39 per square foot in the years following the reform. Lastly, Table 8 reports the estimation results of the "Nine-Year-Straight Admission" policy. After controlling for pre-reform admission rates to top middle school, the coefficients are still large, significant, and long-lasting.

To assess the magnitude of the effect of each policy on housing prices for non-

key schools, we pooled all the treatments into a single difference-in-difference regression and plotted the results 4 using the percentage change in housing price (with log housing price as the outcome variable). Based on Figure 4, the average housing price is 9.16% higher under the policy of "Nine-year Straight Admission", while the premium is 5.51% for "Re-designation" and 1.43% for "School Federation". This implies that keeping all other things equal, parents are willing to pay 9.16% ($131.78 per square foot) more to guarantee their children's admission to a top middle school. Furthermore, keeping the probability of admission to a top middle school equal, parents are still willing to pay 5.51% ($77.36 per square foot) to grant their children full access to the resources of key schools, while the housing premium of partial access is small and insignificant. Our results have similar magnitude comparing to other studies[7] (Zheng et al., 2016; Chen, 2018).

6.2 Results for Key School

In contrast with our original expectation, sharing resources with pupils from non-key schools did not seem to significantly affect parents' valuation of the quality of key schools. According to Table 6 and Table 7, housing prices associated with affected key schools did not respond significantly to either "Re-designation" or "School Federation," which indicates that parents are not concerned with whether key schools become more accessible to pupils from non-key schools. From Figure 4, we can also observe that there is no significant deterioration of parents' valuation on key schools when access to their resources is shared with pupils from non-key schools.

[7] Zheng et al. (2016) found that a historical key school con- tributed an average house price premium of about 8.1% in Beijing, while Zhang and Chen (2018) found a price premium of 6.5% in Shanghai.

7 Robustness Check: Excluding the One-Bedroom Sample

Due to a lack of data on the characteristics of homebuyers, we were unable to classify families with school-age children and those without. Therefore, under the assumption that a family with children would be more likely to purchase a condo with more than one bedroom, we can check the robustness of the estimation results by excluding the sample data with less than two bedrooms. The difference-in-difference coefficients are plotted in Figures 5 through 9.

The figures reveal that for both key schools and non-key schools, the parallel trend of housing prices holds in the reduced sample. Furthermore, the magnitude and significance remain almost the same in the reduced sample to their results in the full sample.

8 Conclusion

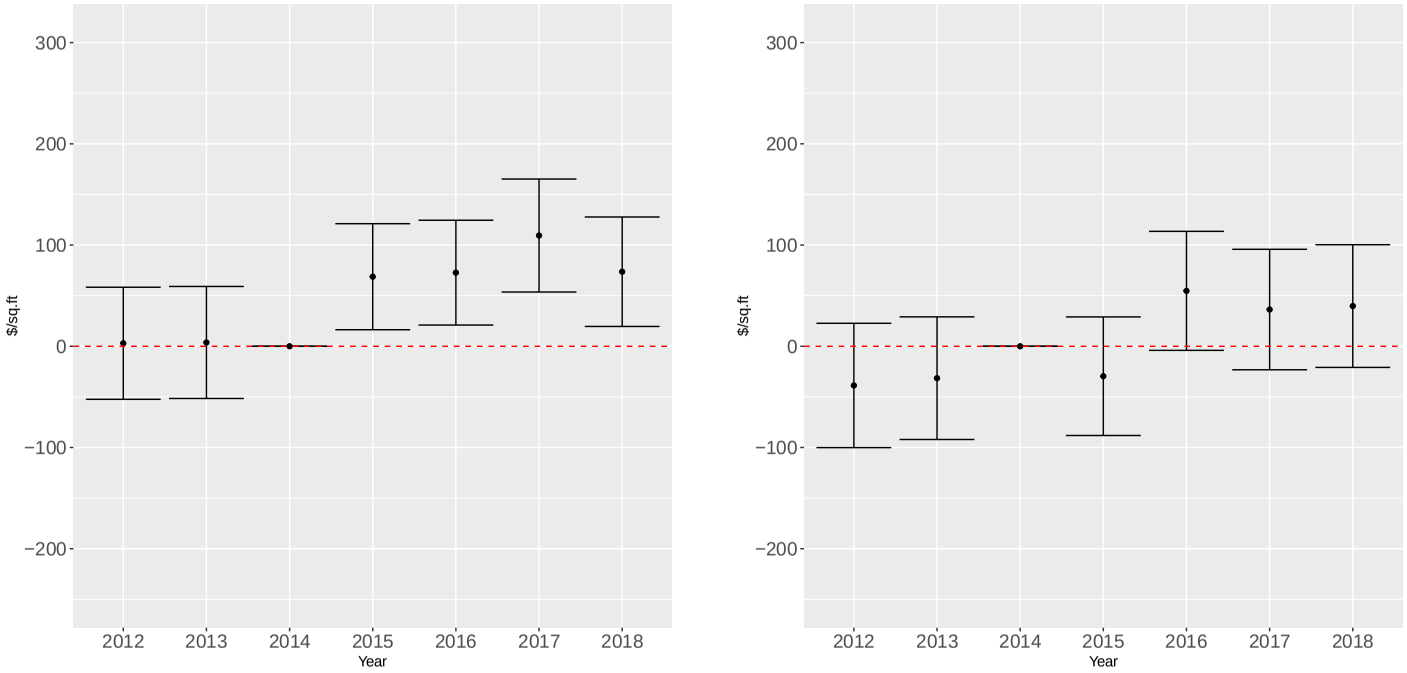
This paper aimed to provide an estimate of the housing premium for school quality as perceived by parents. We used three different policy options and studied the individual DID estimates for each policy to capture the quality premium. Based on the best available data, there is no significant observable difference in educational resources between key schools and non-key schools in terms of expenditures per pupil, student-teacher ratios, teacher qualifications, and so on. However, based on the estimation results, parents are still willing to pay 5.51% or $77.36 per square foot to provide their kids with full access to the benefits associated with key schools. The largest premium indicates that parents are results-driven: they are willing to pay a premium of approximately 9.16% to guarantee their kids' admission to top middle schools while keeping everything else equal. Our estimates also suggest that parents are not sensitive

to increased accessibility of key schools to pupils from non-key schools.

Our empirical findings present important policy implications. Although the reforms aim to regulate extra admission fees and to equalize access to education for students in Beijing, they actually strengthen the education-housing prices relationship and drive housing prices up for properties associated with "better" education resources. As a result, people compete for education resources through housing markets, which further increases inequality in accessing education. Therefore, in future educational policy reforms, policymakers must be more careful in evaluating the potential capitalization of parents' valuation of education into housing prices.

There are a few limitations to this study to note. Firstly, the selection of schools impacted by each policy might not be random, and the decision-making process of the government is unknown and inaccessible. However, we compared the characteristics of in-zone housing prices affected by each policy and did not find any significant difference across policy groups (Table 3). Secondly, since there are no standardized exams during the compulsory education stages (primary and middle school), we lack direct measures of school quality. Under the current quasi-experiment set-up, we identified the intensity of parents' valuation of perceived school quality. Lastly, we do not have individual-level data that can be linked with the school that pupils attended. As a result, it is hard to interpret the motivation for parents' willingness to pay for access to resources in key schools. In the next chapter, we use national panel data to uncover the underlying causes of the housing price premiums estimated here.

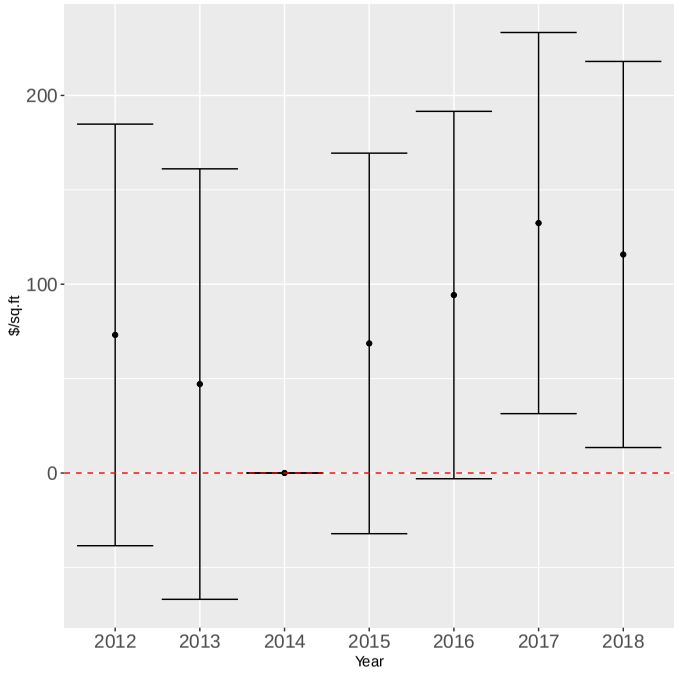
Figure 1: Re-designation



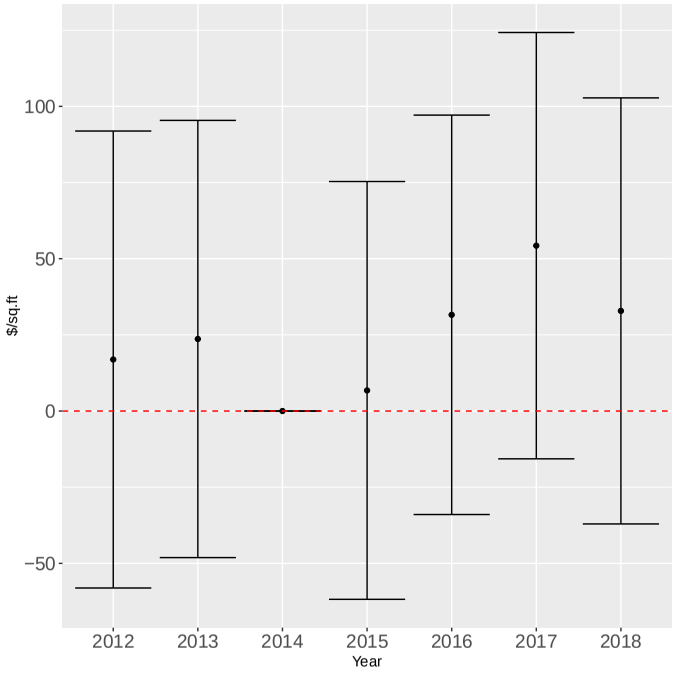
(a) Non-key school

(b) Key school

Figure 2: School Federation



(a) Non-key school



(b) Key school

Figure 3: Nine-year Straight Admission

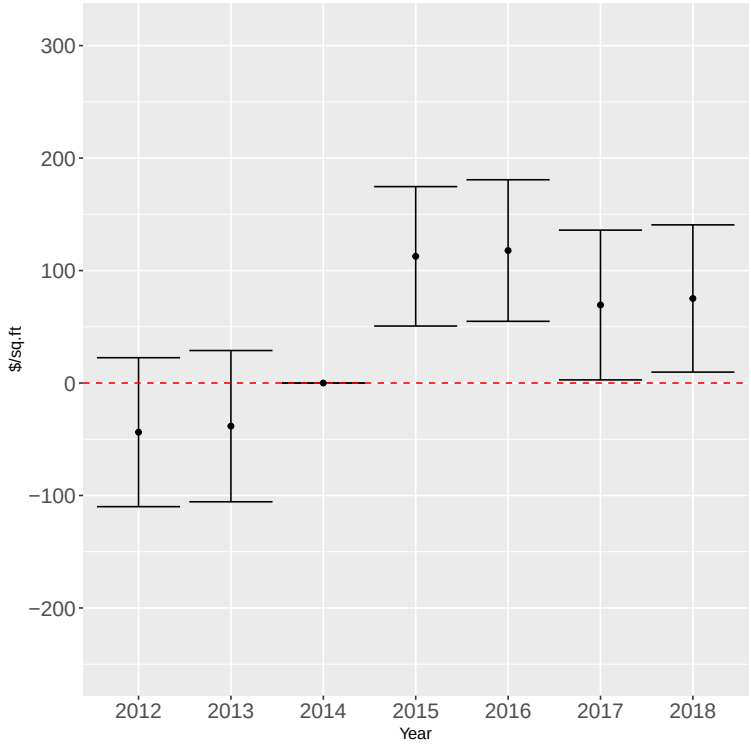


Figure 4: Regression Results for All Policy Option

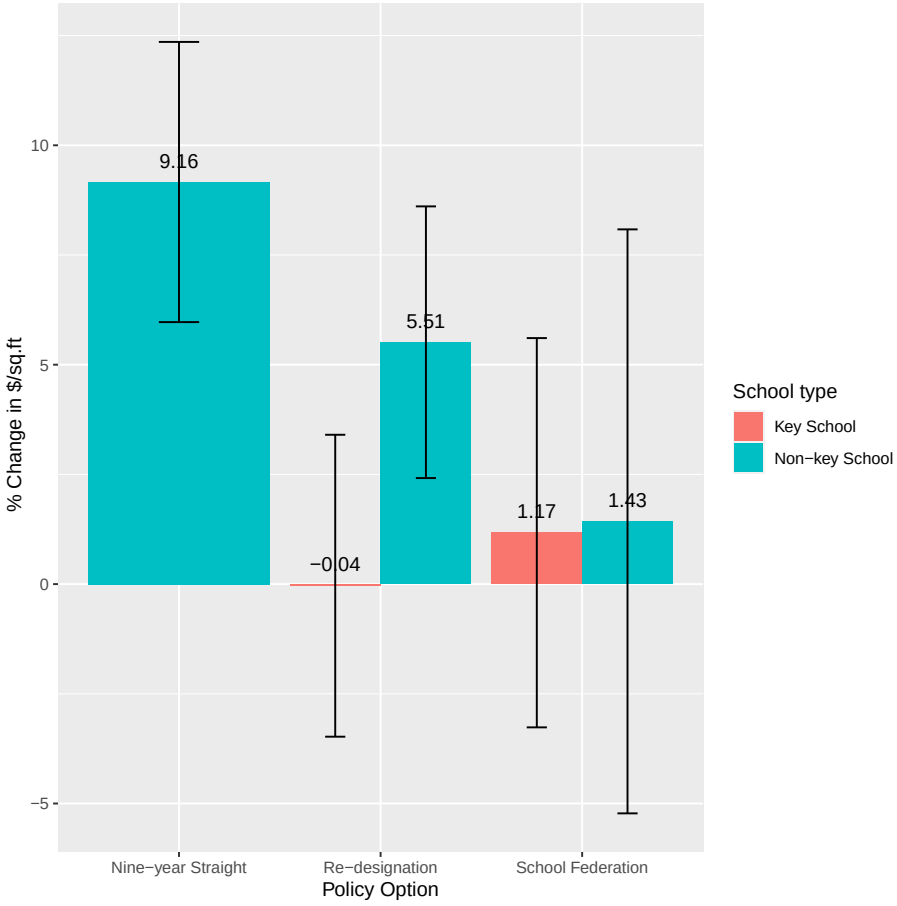
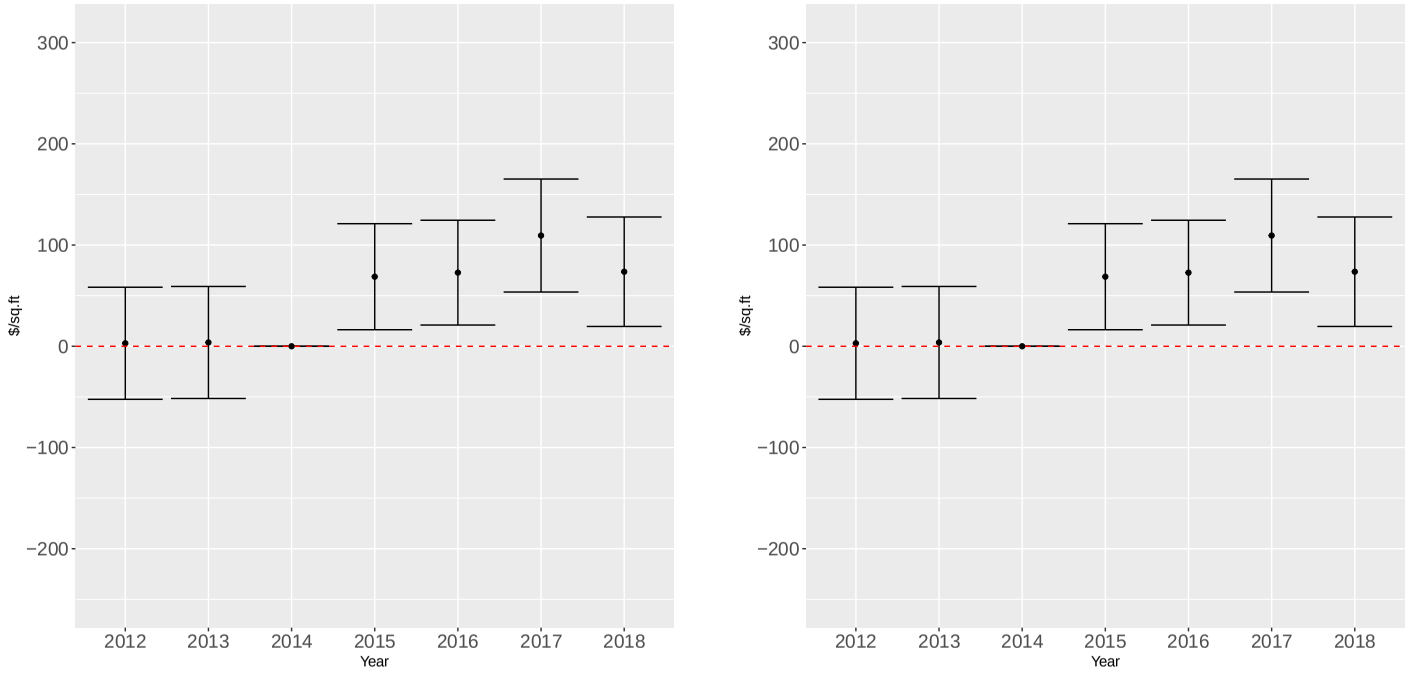


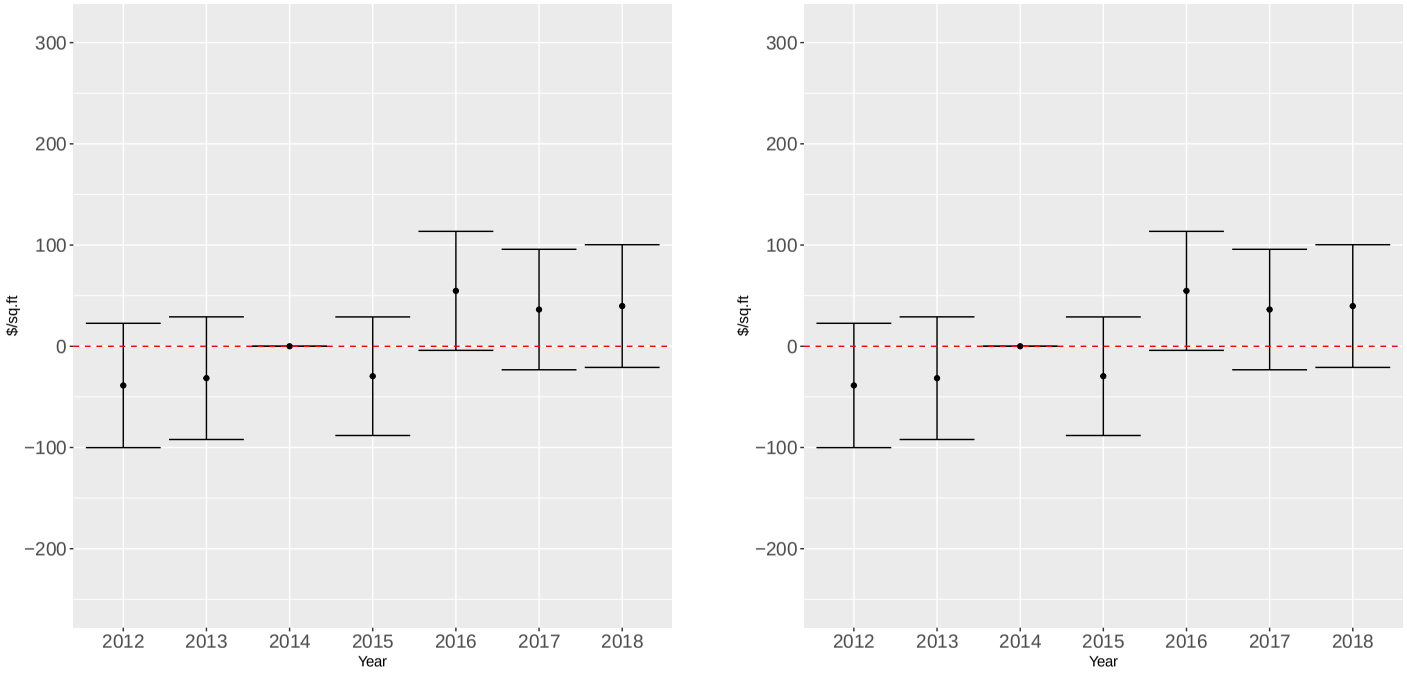
Figure 5: Re-designation for Non-key Schools



(a) Sample with ≥ 2 bedrooms

(b) Full Sample

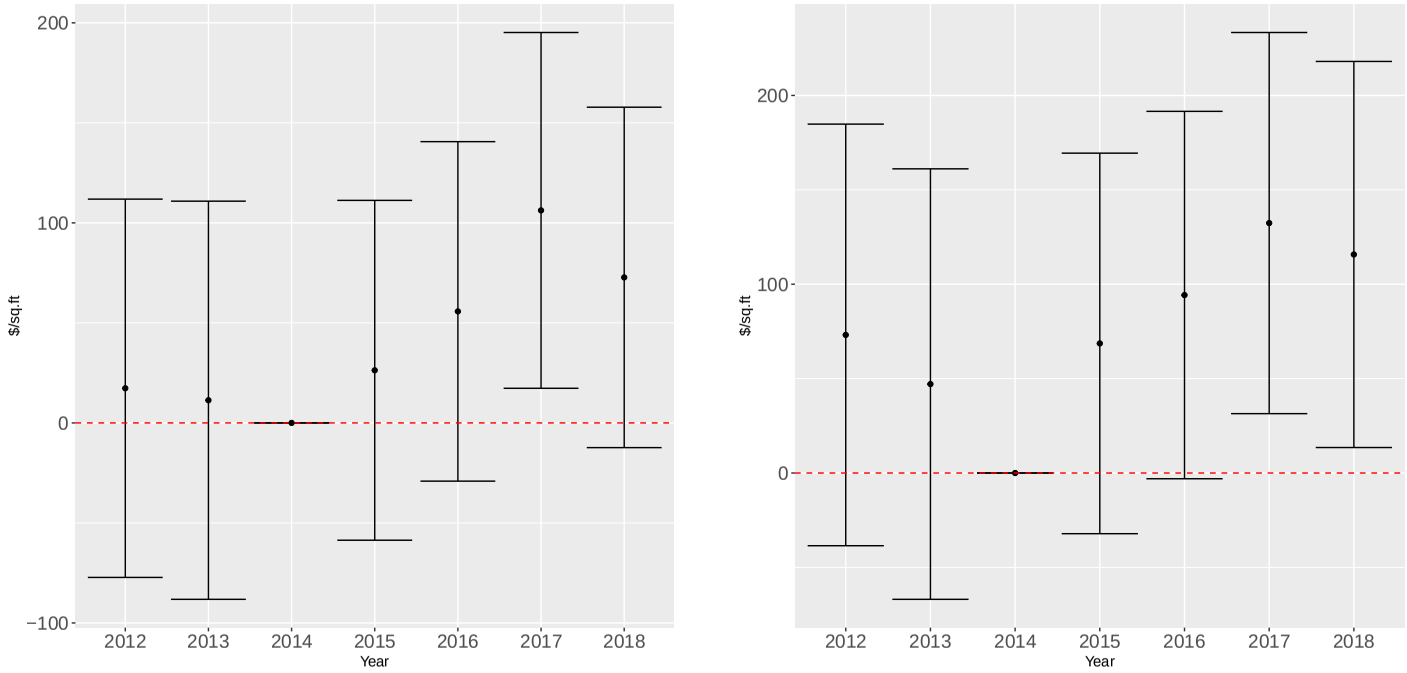
Figure 6: Re-designation for Key Schools



(a) Sample with ≥ 2 bedrooms

(b) Full Sample

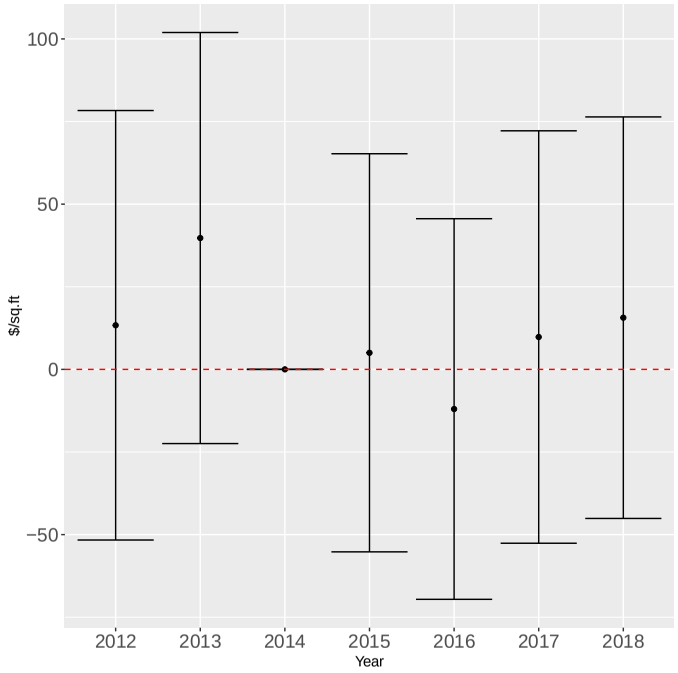
Figure 7: School Federation for Non-key Schools



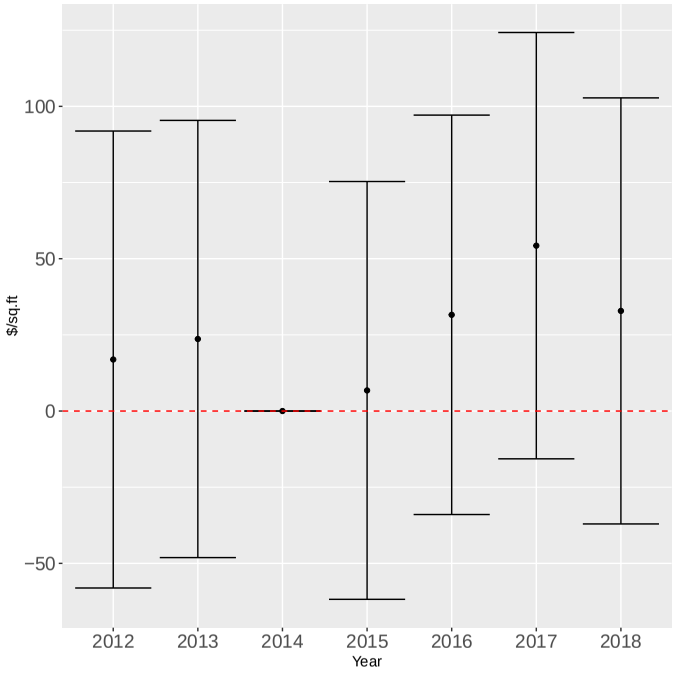
(a) Sample with ≥ 2 bedrooms

(b) Full Sample

Figure 8: School Federation for Key Schools

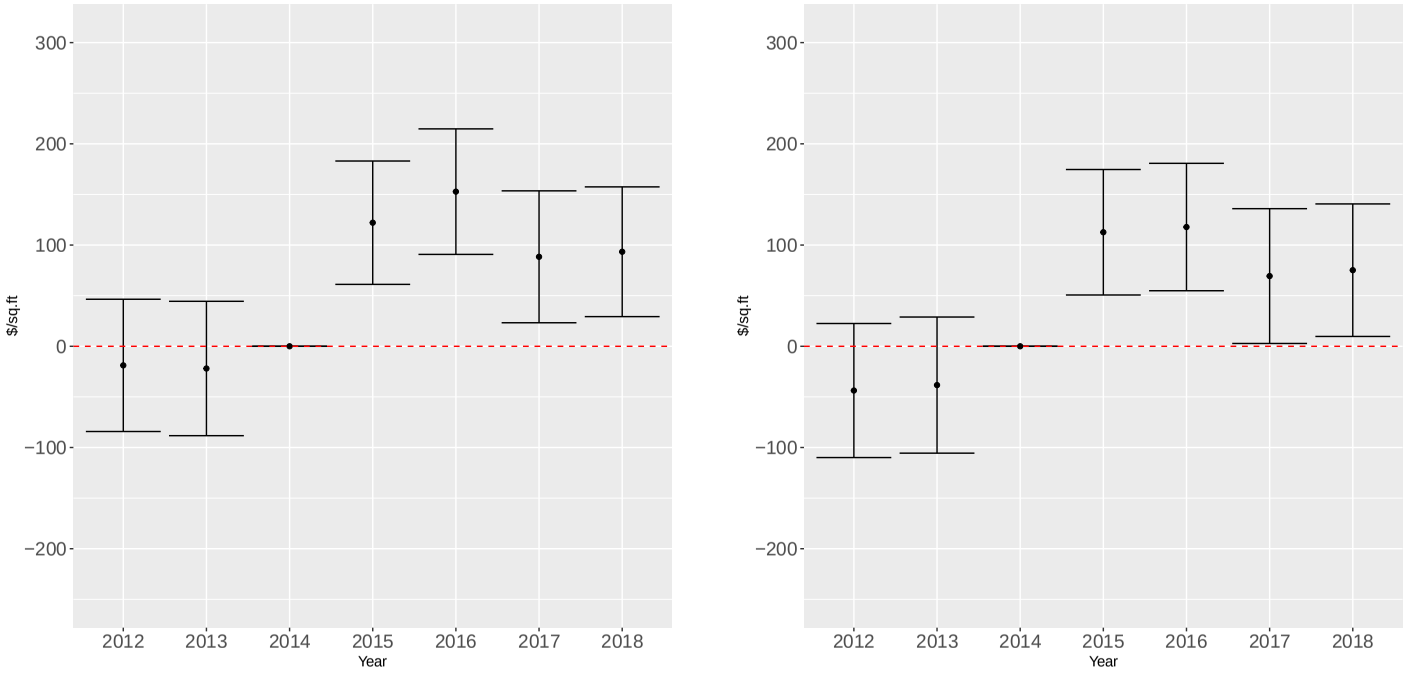


(a) Sample with ≥ 2 bedrooms



(b) Full Sample

Figure 9: Nine-year Straight Admission



(a) Sample with ≥ 2 bedrooms

(b) Full Sample

width=1

Table 1: Demographics in Beijing (by district)

District Name	Area ($mile^2$)	Population (2010 census)	Density ($\backslash mile^2$)
Dongcheng	15.68	919,000	58,609.69
Xicheng	17.95	1,243,000	69,247.91
Chaoyang	181.78	3,545,000	19,501.60
Haidian	164.48	3,281,000	19,947.71
Fengtai	117.45	2,112,000	17,982.12
Shijingshan	34.67	616,000	17,767.52
Mentougou	514.02	290,000	564.18
Fangshan	720.74	945,000	1,311.15
Tongzhou	335.91	1,184,000	3,524.75
Shunyi	378.38	877,000	2,317.78
Changping	552.13	1,661,000	3,008.35
Daxing	390.74	1,365,000	3,493.37
Huairou	987.38	373,000	377.77
Pinggu	415.05	416,000	1,002.29
Miyun	901.78	468,000	518.97
Yanqing	764.48	317,000	414.66
City of Beijing	6,492.62	19,612,000	3,020.66

Data Source: National Bureau of Statistics of China

Table 2: Comparison of School Characteristics

	Year of Found	No.Teacher	No.Elite Teacher	No.Students	No.Classes	T-S Ratio	Elite T-S Ratio	Expenditure Per Pupil
Non-key	1978.03	140.76	8.86	1897.50	53.55	0.08	0.00	1.75
Key	1766.00	170.29	9.14	2226.18	57.96	0.08	0.00	2.77
p-value	0.29	0.29	0.94	0.40	0.65	0.38	0.56	0.31

Data Source: Beijing Municipal Commission of Education

Table 3: Comparison of Housing Characteristics

Treatment Group	Policy Option	Whether affiliated to Key School	$/sq. ft	Lot Size (sq. ft)	# of Bedroom	# of Bathroom	Year Built
1	Re-designation	N	656.42	689.64	1.93	1.04	1989.82
			(166.83)	(277.23)	(0.71)	(0.23)	(10.46)
1	Re-designation	Y	694.28	729.89	1.96	1.06	1990.70
			(199.03)	(271.84)	(0.68)	(0.26)	(9.08)
2	School Federation	N	536.80	673.39	1.65	1.12	1998.21
			(153.68)	(331.58)	(0.75)	(0.33)	(9.87)
2	School Federation	Y	640.60	641.44	1.85	1.00	1990.75
			(216.84)	(176.78)	(0.69)	(0.15)	(6.31)
3	Nine-year Straight	N	647.49	745.58	1.96	1.07	1993.50
			(202.41)	(275.89)	(0.71)	(0.27)	(9.93)
Full Sample			614.89	728.26	1.88	1.08	1993.34
			(184.08)	(307.35)	(0.74)	(0.29)	(10.41)

Data Source: Lianjia.com from 2012 to 2014.

Table 4: Number of Tournament Medals by School Type in Beijing

Number of awards	Non-key Primary Schools	Key Primary Schools	Total
0	2,404	1,114	3,518
1	20	76	96
2	0	12	12
3	0	20	20
4	14	60	74
5	0	14	14
6+	18	62	80
Total	2,456	1,358	3,814

Data Source: Huang et al. (2020), Table 1

Table 5: Policy Details in Beijing 2014 Education Reform

Abbreviation	Policy Option	Num. of Treated Key Schools	Num. of Treated Non-key Schools	Total Treated Schools
Re-designation	Shut down non-key primary schools and assign students to corresponding key primary schools	10	10	20
School Federation	Key schools are required to share teaching resources with assigned non-key schools.	5	5	10
Nine-year Straight	Elaborate the admission rate of non-key schools to top middle schools from 50% to 100%	0	12	12

Table 6: Event Study Results for "Re-designation"

	Dependent variable: USD per square foot	
	(1)	(2)
	Non-key School	Key School
Treated Non-key School	−30.909	
	(19.685)	
Treated Key School		73.708***
		(21.745)
$2012 \times Treated$	2.966	−38.706
	(28.241)	(31.323)
$2013 \times Treated$	3.766	−31.515
	(28.222)	(30.897)
$2015 \times Treated$	68.729**	−29.570
	(26.715)	(29.876)
$2016 \times Treated$	72.753***	54.745*
	(26.407)	(29.983)
$2017 \times Treated$	109.411***	36.301
	(28.467)	(30.355)
$2018 \times Treated$	73.649***	39.733
	(27.578)	(30.915)
2012	−860.918***	−862.768***
	(10.063)	(9.800)
2013	−666.690***	−669.692***
	(10.052)	(9.807)
2014	−655.717***	−662.916***
	(9.963)	(9.711)
2015	−558.250***	−552.750***
	(9.556)	(9.294)
2016	−258.853***	−260.343***
	(9.577)	(9.288)
2017	37.889***	40.468***
	(9.867)	(9.669)
Observations	4,130	4,130
R^2	0.977	0.977
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 7: Event Study Results for "School Federation"

	Dependent variable: USD per square foot	
	(1)	(2)
	Non-key School	Key School
Treated Non-key School	−46.879	
	(35.963)	
Treated Key School		−73.878***
		(24.807)
$2012 \times Treated$	73.144	16.911
	(56.937)	(38.241)
$2013 \times Treated$	47.104	23.644
	(58.142)	(36.587)
$2015 \times Treated$	68.646	6.762
	(51.394)	(34.964)
$2016 \times Treated$	94.262*	31.581
	(49.618)	(33.425)
$2017 \times Treated$	132.391**	54.281
	(51.477)	(35.678)
$2018 \times Treated$	115.753**	32.863
	(52.142)	(35.655)
2012	58.180***	58.986***
	(19.043)	(19.540)
2013	259.065***	257.876***
	(18.829)	(19.390)
2014	270.521***	269.537***
	(18.467)	(18.434)
2015	306.928***	308.662***
	(18.206)	(18.642)
2016	581.324***	581.839***
	(18.027)	(18.480)
2017	877.788***	877.267***
	(18.475)	(18.924)
2018	790.482***	791.854***
	(18.427)	(18.885)
Observations	2,189	2,189
R^2	0.969	0.970
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 8: Event Study Results for "Nine-year Straight Admission"

	Dependent variable: USD per square foot
Treated	79.398***
	(23.294)
2012 × *Treated*	−43.715
	(33.774)
2013 × *Treated*	−38.344
	(34.294)
2015 × *Treated*	112.656***
	(31.617)
2016 × *Treated*	117.805***
	(32.099)
2017 × *Treated*	69.362**
	(33.961)
2018 × *Treated*	75.175**
	(33.388)
2012	−851.771***
	(11.693)
2013	−662.138***
	(11.658)
2014	−654.423***
	(11.591)
2015	−557.140***
	(11.124)
2016	−257.638***
	(11.094)
2017	38.998***
	(11.481)
Pre-reform Admission Rate of Top Middle School	555.972***
	(12.528)
Observations	3,903
R^2	0.790
Note:	*p<0.1; **p<0.05; ***p<0.01

Table 9: Quantity of Supply of Housing

Year	2011	2012	2013	2014	2015	2016	2017	2018
# of houses on the list	490	3,504	3,051	3,380	6,856	7,680	3,775	3,651
# of houses sold	547	3,453	3,048	3,378	6,817	7,148	3,425	4,571

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