Does It Pay to Attend More Selective High Schools? Evidence from China

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Abstract

This research investigates the effect of attending academically selective Chinese high schools on High School General Exams (HSGE) taken at the end of the penultimate year. We leverage administrative data that matches high school preferences of the population of urban middle school graduates in one Chinese prefecture in 2010 with the corresponding register-based high school student records.

Admission is generally driven by ability and we combine a normalizing-and-pooling fuzzy regression discontinuity design (RDD) strategy with a cumulative multi-cutoff RDD setup to address the complexity of the under-funded Chinese public education system. The system provides for an alternative admission channel for lower-ability fee-paying students alongside the dominant merit-based standard channel. In addition, the system provides for contextual admissions for disadvantaged students. Multiple-cutoffs RDD estimates based on publicly announced school-specific admission cut-offs of the city-wide High School Entrance Exam (HSEE) scores set by the local education authorities show heterogeneous effects of attending schools with diminishing degrees of selectivity - from "flagship", "elite", through to "normal', and thence to fee-paying "private" but relatively low quality provision, in a uniform setting.

Cutoff-specific RDDs differ across student types as defined by willingness to pay extra tuition-fees and eligibility for contextual admissions, using a common zero normalized HSEE score cutoff for different application types. The estimated effects on high school leaving exam scores of attending normal public high schools versus low-quality private schools, and of attending elite schools relative to normal public schools are indistinguishable from zero. Indeed, the estimated effect of attending the most selective flagship school, as opposed to elite schools, has a large negative and statistically significant effect. We find that this is driven by the much lower relative performance in science-track subjects by students who barely made it into the flagship school.

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1. Introduction

Academically selective admissions to publicly funded schools are common in both developed and developing countries: for example, “exam schools” in the US, “grammar schools” in the UK, and “key schools” in China. In many places, selection by ability is limited to post-compulsory education. By the very nature of academic selection, students in academically selective elite schools have peers with higher academic ability, on average, than their counterparts who attend non-elite schools - even in the absence of differences in other inputs into the education production. In the developing country context, it is also the case that elite schools typically compare favourably to non-elite schools in terms of school resources and teacher quality due to the underfunding of general education and educational elitism that has prevailed historically.

Understanding the causal effect of attending selective elite schools on student outcomes is not only important for students and parents from a private investment perspective, but also vital for public policy makers who need to justify the very existence of the selective school system and the substantial subsidies that favour elite schools in many developing countries. However, identifying the causal effect is empirically challenging due to both ability sorting and heterogeneous preferences which are usually unobservable to researchers (Dale & Krueger 2002, 2014).

The most convincing empirical approach to identify the causal effect of attending elite public schools to date is based on the Regression Discontinuity Design (RDD, or simply RD) exploiting public admission cutoffs in entrance exams. The idea is that marginal students who scored just above or below the admission cutoff could be regarded as if randomly assigned, such that any differences in outcomes across the two groups can be creditably attributed to the attendance at elite schools. The US evidence suggests that there is very little evidence of a causal effect for marginal students of exposure to high-achieving, and more homogeneous, peers at elite schools on standardised test scores, college enrolment, graduation, and college quality (Abdulkadiroglu, Angrist and Pathak (2014); Dobbie and Fryer (2014)). Similarly, Clark (2010) finds only small and statistically insignificant results on the Grade 9 standardised test scores for marginal students attending grammar schools in the UK. However, he finds that grammar school attendance has large effects on taking advanced courses.

In contrast, RDD evidence from developing countries indicates a large and often statistically significant effect of attending elite schools – see, for example, Jackson (2010) for Trinidad and Tobago, Pop-Eleches and Urquiloa (2013) for Romania, and Dustan et al (2017) for Mexico.

China offers a unique setting, in the context of a hybrid and elitist system for under-funded public schools allowing "school choice with Chinese characteristics" (Wu 2012). Specifically, a dual-channel admission system has been in operation in post-compulsory education since the 1980s, under which the vast majority students are admitted through one of two channels. Both channels are regulated by the government in terms of admissions standards, quotas and the maximum tuition fees (Loyalka et al 2014). Under the dominant *standard channel* , which carries only basic tuition fees (CN¥330, or $48.74, per annum in our 2010 sample),[1] students are admitted in order of HSEE scores and school preferences until the school-specific student quotas set by the local education authorities are filled. The *alternative channel* which accounts for up to one-third of total capacity, admits students who have failed to make the cut for the *standard channel* but scored above a lower cutoff, to the school of choice by paying extra tuition. In our data period these fees were CN¥8000-10000 ($1181.68-1477.10) p.a. This income is retained by elite schools to supplement inadequate government funding (Loyalka et al 2014). Effectively, expressing a willingness to pay to attend a specific school in the school applications (in addition to the *standard channel* preference for the school) gives the student who can afford the extra tuition fee an advantage in terms of a lower entry requirement. In the absence of applications information, an RDD strategy which explicitly accounts for the *actual* admissions channel might still be biased due to potential selection on unobservable school preferences (Dale and Krueger 2002, 2014). Fortunately, we can address this potentially important threat to identification by exploiting the administrative school applications database for the population of urban students taking the city-wide HSEE in a cohort, independent of their high school admission outcomes.[2]

We make several important contributions to the literature. First, we contribute directly to the relatively thin evidence base on the causal effect of attending academically selective elite high

[1] The nominal and PPP exchange rates between the US dollar and Chinese RMB yuan are 6.770 and 3.329 respectively in 2010 (OECD, 2022).

[2] In our sample, around 14% of the elite public high school places in our sample were allocated to students with HSEE scores below the regulated "*selection-fees*" cutoff and pay more substantial unregulated private tuition fees. This is a common practice in China for public high schools, especially elite schools, which use the extra revenue generated to top up teachers' salaries and cross-subsidise the *standard channel* students (Dee and Lan 2015).

schools on students' academic outcomes, in the context of the world's largest public school system. The system allows tuition fee surcharges at the expense of uniform entry standards that would make for equitable access to highly autonomous and academically selective elite schools. The weight of existing evidence from developing countries indicates positive causal effects of elite school attendance in general (Jackson 2010; Eleches & Urquiloa, 2013; Dustan et al 2017). Our RDD results show robust evidence of heterogeneous effects of attending selective high schools in China tha differ by the degree of school selectivity. These range from being indistinguishable from zero at the normal-private and elite-normal schools' thresholds, to being significantly negative at the most selective flagship school vs elite school threshold.

Moreover, our unified empirical setting allows us to reconcile our findings with the existing Chinese evidence based on the RDD approach which tend to focus on a specific type of selective schools (Dee and Lan, 2015; Zhang, 2016; and Hoekstra et al, 2018). Our seemingly counter-intuitive significantly **negative** effect of attending a flagship school contrasts with the positive and significant effect of attending flagship (Tier 1) elite high school in China in Hoesktra et al (2018). We show suggestive evidence that our findings for marginal students who barely made into the flagship school are driven by the excess adverse effect on their High School General Exam (HSGE) scores in the Science track subjects in which flagship and elite schools traditionally have had strong academic records. This finding is also consistent with the prevalence of within-school tracking in elite schools, where only academically strong students are placed into high-achieving classrooms, and a possible rank effect inducing weaker students self-selecting into the less competitive Social Studies track due to concerns over within-class rankings (the *small-fish-big-pond* effect).

Our second main contribution is our empirical approach which accommodates multiple cumulative cutoffs in a unified fuzzy RDD setting that also accounts for school preferences, eligibility for contextual admission, and willingness to pay for *selection-fee* places, in the spirit of Dale and Krueger (2002, 2014), effectively by only comparing students who applied to, and were admitted to, the same set of schools, to their counterparts who also applied to but failed to make the relevant cutoffs required,

Our multiple cumulative cutoffs fuzzy RDD estimates are robust to the cut-off specific normalizing-and-pooling RDD analyses which accounts for school preferences. Our fuzzy RDD estimates are also robust to alternative specifications of the RD estimator, including order of local polynomial density, kernel function forms, bandwidth selectors, as well as variations in the interval bands around the admission cut-offs. Moreover, the findings are also insensitive to covariate controls, and splitting samples by gender or area type.

The remainder of the paper is organized as follows. Section 2 briefly reviews the relevant literature. Section 3 provides the institutional background for our study. Section 4 introduces the data and presents descriptive analysis. Section 5 outlines the identification strategies based on the classic fuzzy regression discontinuity design (RDD), and how this could be extended to a multiple cutoff setting and/or to accommodate heterogeneous treatment effects using a standard normalizing-and-pooling strategy. Section 6 presents the cumulative multiple cutoffs RDD results of heterogeneous effects of attending schools with varying degrees of selectivity in a unified setting. Section 7 shows the cutoff-specific RDDs for each high school application type separately, as well as pooled together following the standard normalizing-and-pooling strategy. The concluding remarks are given in Section 8.

2. Literature review

Understanding the effect of attending publicly funded elite schools (exam schools in the US context) on students' educational outcomes is an important issue for students and their families, as well as policy makers. However, in the absence of randomised experiments, identifying the causal effect is empirically very challenging, due to the complexity of school systems, and above all, the strong impact of self-selection into different school choices on academic outcomes.

A growing number of studies have exploited the Regression Discontinuity Design (RDD) approach, an identification strategy that is arguably the closest to the ideal experiment, by exploiting entrance exams admission cut-offs, which are virtually impossible to manipulate. The idea is that marginal students who scored barely above or below the publicly announced admission threshold could be regarded as if randomly assigned into the treatment group of being admitted to elite schools and the control group of just missing out. Therefore, any differences in school outcomes across the two groups can be creditably attributed to the attendance at elite schools.

By and large, studies from developed countries typically find no significant causal effect. For instance, Abdulkadiroglu, Angrist and Pathak (2014) look at exam schools (selective public schools) in Boston and New York that select students on admissions tests with sharp cut-offs for each school and cohort. They conclude that exam school attendance has little causal effect on test scores or college quality, which they interpret as evidence against effect of peer quality or racial composition on student achievement. Dobbie & Fryer (2014) also use the New York exam schools, but focus on college outcomes which are available for all students rather than just those who attended a public school as in Abdulkadiroglu, Angrist and Pathak (2014). Using fuzzy RDD, they also find that exposure to high-achieving and more homogeneous peers has, if anything, a negative impact on college enrolment, graduation, or college quality for marginal students. This result is robust to gender, middle school type and baseline state test scores.

Clark (2010) presents evidence for the UK using RDD and Instrumental Variables (IV). The "East Ridings database" contains grammar school entrance exam scores taken at Grade 5 and end of compulsory education tests taken at Grade 9 in 1969-1971 for three cohorts of students in one particular UK school district (note the minimum school leave age was 15 then). He finds selective school attendance generates only small and statistically insignificant effects on Grade 9 standardised test scores. This is unsurprising since these courses were only available in publicly funded grammar schools and at private schools in the UK at the time. He also finds, more suggestively, a positive effect on university enrolment – again not surprisingly, since higher education enrolment was largely predicated on performance in the advanced courses.

In contrast, RDD evidence from developing countries tend to suggest significant causal effects. Using administrative data covering all Romanian secondary schools, Pop-Eleches and Urquiloa (2013) present convincing RDD estimates that students who went to more selective schools perform better in high-stakes graduation exams, with the effects often larger and more statistically significant for cutoffs at higher grade levels. Moreover, there is evidence of significant dynamic behavioural responses of students, parents and teachers and equilibrium effects in a setting with ability tracking, using a tailored sample survey. In particular, better qualified teachers are more likely to be matched with higher ability students, both between and within schools, consistent with teaching sorting and ability tracking. Exploiting Mexico City's high school allocation mechanism, Dustan et al (2017) find strong evidence of a trade-off between academic benefit and dropout probability in admission to elite public high schools for marginal students. While admission significantly increases math test scores even using the lower bound estimate, it also raises the risk of dropout partly due to the low transferability between elite and non-elite high schools. Jackson (2010) instruments elite secondary school attendance using discontinuities created by the assignment mechanism for Trinidad and Tobago, accounting for self-selection bias using secondary school preferences. He finds compelling evidence of large positive effect of elite school attendance on secondary school exit exams. Moreover, the beneficial marginal effect of attending schools with brighter peers is higher at high-achievement levels and twice as large for girls than for boys.

Over the last few years, new RDD evidence has emerged on attending elite public schools in China. In a very similar setting to ours, Dee and Lan (2015) examine the effect of elite high school attendance on subsequent academic performance in a city in north central China between 2006 and 2008. Specifically, they focus on "*selection-fee*" students at elite schools, who scored marginally below the (*standard-channel*) admission cut-offs but pay substantial addition fees on top of the basic tuition fee payable by students who score above the cut-off. For these *selection-fee* students, they find consistent evidence of no positive effect of elite school attendance on scores in the annual city exam, study track choice or scores in the high-stakes college entrance exam. However, one important limitation of Dee and Lan (2015) is the inability to account for sorting into the *selection-fee* option, which involved paying about a $3,000 *lump-sum* fee on top of the $125 annual basic tuition fee.

Using the population of suburban districts students starting high schools in 2007 in one undisclosed densely populated provincial capital in China, Hoekstra et al (2018) show that the only significant positive causal effect of elite school attendance on high school performance occurs from attending flagship (tier 1) elite high schools, driven by the higher concentration of superior quality teachers rather than peer quality or class size. Specifically, attending the flagship rather than a Tier 2 elite school increased National College Entrance Exam (NCEE) scores by just 0.07 of a standard deviation (SD). Apart from the use of the more high-stakes NCEE as the academic outcome, another important difference from our setting in the paper is that they choose to restrict the sample to suburban districts because suburban students must attend a school in the home district of *hukou* registration, resulting in more significant sorting by peer ability across schools.

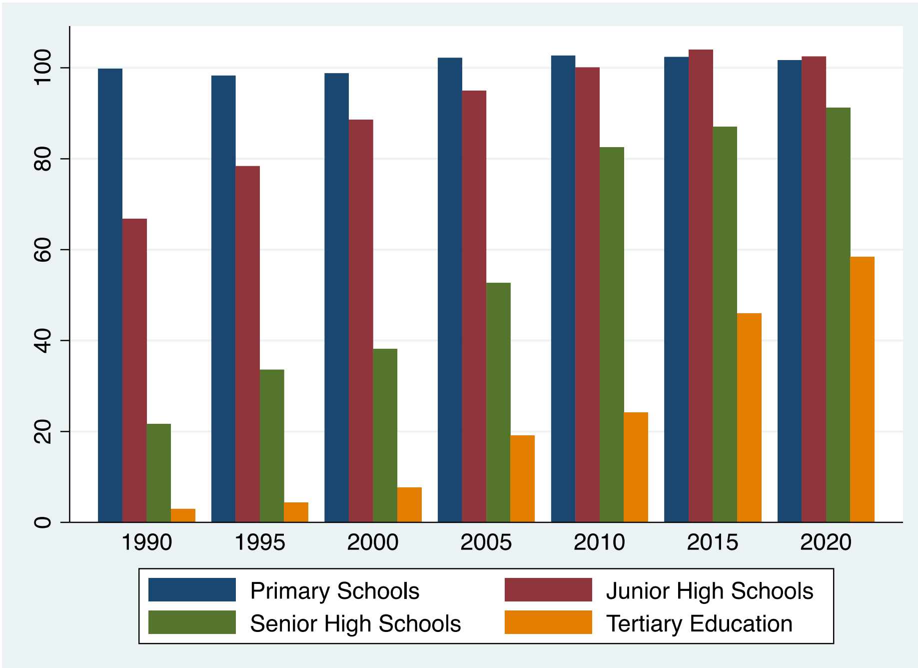
Using administrative data on three cohorts of students from the flagship school in the prefecture of Qinyang in Gansu province, Canaan et al (2022) focus on the impact of within-school tracking on high school academic achievements in China, a practice which is almost universal in high schools according to their own online survey of Chinese university students. The RDD estimates based on the standardised classroom placement exams following flagship school enrolment show that students placed into high-achieving classrooms improve math test scores by a sizeable 0.23 SD, while the effect on Chinese and English are more muted. While placement in high-achieving classrooms has no significant impact on college enrolment as whole, it does significantly increase the NCEE scores, which in turn raised the probability of enrolment in elite universities. Moreover, they show that students in high-achieving classrooms enjoy higher-ability peers, smaller class sizes, and better-quality teachers, as well instructions that delve deeper into topics and at a faster pace.[3]

3. Institutional background

Figure 1 shows the trend in gross enrolment ratios in China by education stages, over the period 1990-2020. The year 1986 marked China's formal launch of nationwide 9-year compulsory education, comprising 6 years (age 6-12) of primary schools and 3 years of middle (junior high) schools (age 12-15) in most regions. This was regarded as a very ambitious target at the time in a country with per capita GDP below $300 and a middle school gross enrolment ratio of barely 40% (Tsang, 1986). However, by 2005 the middle school gross enrolment ratio had leapt to 95%; and the proportion of middle school teachers with at least a two-year college qualification surged to 95.2% from a very low base of 27.1% in 1986. The gross enrolment ratio for senior high schools jumped by almost 30 percentage points from 52.7% in 2005, to 82.5% in 2010. This could be partly explained by a spillover effect of the unprecedented higher education (HE) expansion, which increased the annual enrolment of new entrants into regular HE education institutions from 1.08 million in 1998 to 6.08 million in 2008, but also by an earlier HE expansion in 1992-93 which helped to mitigate the supply of college educated secondary school teachers nationwide (Dai et al, 2022). In 2019, China's HE gross participation rate passed the 50% landmark, with 8.20 million new undergraduates (including both the vocational-oriented colleges lasting 2-3 years and the more selective universities lasting at least 4 years) admitted after taking the NCEE.

[3] Using three cohorts of middle school applicants in a provincial capital between 2002 and 2004, Zhang (2016) shows that attending elite middle schools has no significant effect on high school entrance exam scores, in RDD estimates based on winning a lottery for oversubscribed schools. Note however, that admission to elite middle schools is not academically selective, due to government regulations for the compulsory education stage.

Figure 1: Gross enrolment ratios (%) of China by education stages, 1990-2020



Data sources: Gross enrolment ratios for primary and tertiary education are from UNSCEO Institute for Statistics (2022). Gross enrolment ratio for middle (junior) and senior high schools are from the National Statistics Bulletin of Education Development (MoE, various years).

Performance in the city-wide HSEE, taken at the end of the 9-year compulsory education, is the single most important determinant of access to academic high schools (for students aged 15-18 usually), which is the main pathway to HE in China. The HSEE is graded anonymously, with graders kept in isolated residencies cut off from all means of communications from outside. Each grader only grades parts of a test subject. These strict grading rules make it impossible to manipulate of the HSEE scores around the admission cut-offs which is based on the total HSEE scores over 7 subjects (Dee and Lan 2015).

Despite this phenomenal growth in the number of college graduates, there is little causal evidence of a significant drop in returns to HE, relative to holding a high school qualification alone. However, recent studies have indicated a growing incidence of overeducation among recent graduates, and a widening gap in the HE returns in favour of graduates from the elite universities (Zheng et al 2021).[4]

[4] Elite universities in China typically refer to the Project 985 and 211 universities, which are the top 120 or so highly selective Higher Education Institutions (HEIs) out of a total of nearly 3000.

The Great HE Expansion starting in 1999 significantly intensified competition for high school places which were still highly rationed, through a spillover effect (Dai et al 2021). Using administrative data on over 340,000 students from north-west China who took the NCEE from 2001-2010, Loyalka et al (2017) present compelling evidence showing the largest source of unequal college access emerges from the middle to high school transition. Even to date, no more than half of middle school graduates are enrolled in academic high schools each year, through competitive selections based on the HSEE scores. Those who do not fare well enough in the HSEE can only settle for the vocational track of upper secondary education, which does not prepare them for the demanding NCEE used for HE selection. Consistent with Figure 1, the chance of going to college for high school graduates, become increasingly favourable compared to that of proceeding beyond the compulsory education stage, ever since 2000.

Due to the heavy tracking and severe rationing of academic high school places, the Chinese post-compulsory education system is highly competitive (Loyalka et al 2015). Like most developing countries, education in China had always suffered from chronic underfunding from public resources. Indeed, government expenditure on education as a share of GDP did not reach the target of 4% until 2012, 12 years after the deadline set in the pledge by the central government in 1993.[5] The fiscal constraint was most severe when the education reform began in 1985 to restructure the system of both education governance and education management. Consistent with the wider reform to transition from central planning to a socialist market economy, the financing of education in China has been substantially decentralized and diversified, to mobilize local public and private resources to help fund basic education (Tsang 1996; Rosen 2004). Evidence on the emergence of a teacher labour market since the mid-1990s suggests that teacher recruitment has also become highly market-oriented and competitive in order to attract new college graduates to work in secondary schools (Dai et al 2022).

Similar to other developing countries, China promotes a system of academically selective elite public high schools with usually at least one designated *elite* high school in each county or city district (which has the same status as a county in the administrative hierarchy). At the prefecture level and above, there are also designated *flagship* public high schools (Loyalka et al 2014). These

[5] In 2018, the OECE average share of public spending on education is 4.0% of GDP, of which 0.9% is spent on tertiary education (OECD, 2021).

flagship high schools are very competitive and successful in preparing students for the high-stakes NCEEs that determine access to universities, especially elite universities.

While the dual-channel admissions system has certainly contributed valuable financial resources to China's extraordinary expansion of education in the post-reform era, its impact on equity and intergenerational mobility has also been subject to heated debates by the media, researchers, and parents alike. Indeed, academic selection and selection-fees have been banned at the compulsory education stage in recent years. At the high school level, efforts have also been made by the government to at least limit the adverse effect of the dual-channel admissions system - through increased fiscal budgets for post-compulsory public high schools, rotation of teachers across public high school, as well as tighter regulations on quotas, admission cut-offs and maximum amount of selection-fees allowed, among other things.

In terms of our RDD identification strategy, the publicly announced school-specific "*unified enrolment*" cut-offs are crucial. While the "*selection-fee*" cut-offs are only tentative, the gap with the "*unified enrolment*" cut-offs provide an indication of the competitiveness for places at each school.

4. Data and sample

Our study is based on a novel administrative dataset for the population of high school students enrolled in 2010, in one undisclosed prefecture in north central China.[6] The prefecture under study (the identity is withheld under the data access agreement), has a population of well over 2 million in 2019. It is middle ranked in terms of economic development in the country, with a per capita GDP of nearly $9,000 at nominal exchange rate in 2020 current price, only slightly below China's national average of $10,500. The prefecture consists of an urban area and a more rural area, each with its own HSEE. The urban area has a donut shape, with a central district and the immediate

[6] We focus on the 2010 higher school entry (or HSEE exam) cohort in the main analysis, for several reasons. First, it is the only cohort for which we have the school-specific admission cut-offs for the *selection-fee* mode, in addition to the *unified-enrolment* mode. Second, this is also the only cohort of students for which we have access to the administrative school census available from 2012 onwards, which collects information on the total number of students, classes, and teachers, as well of expenditures of schools, when this entry cohort of students are still in the final year of high school. Third, we only have full documentation on the details of the high school application procedures from 2009 onwards.

suburban district, as well as a semi-urban County Z surrounding it. Students from the four subordinate counties in the prefecture who are not part of our urban sample take a different HSEE and generally can only be enrolled into a differential set of high schools, except for the only flagship school and one of the two elite schools open to the whole prefecture.[7]

For 2009, the only year we have full information of HSEE statistics from administrative sources, around 36,500 students were registered for the HSEE across the whole prefecture, of which 5% were repeating middle school graduates. Urban students accounted for 42.0% of all students registered. The total enrolment quota for academic high school education was 16,000, of which 75% were reserved for public schools, with the remaining 25% for the less selective private schools which are perceived as having lower quality. In addition, vocational high schools were given a total enrolment quota of just under 8,000, implying that no more than 65.5% (i.e. 24 out of 36.5 thousand) of middle school leavers could proceed to the post-compulsory education stage.

The sample used in this paper covers the whole population of high school students from the urban area of the prefecture. We exclude students attending high schools outside the designated urban catchment areas, which violated the admissions guidelines.[8] All students in the urban sample share the same set of 18 high schools available to apply. Since our focus is on the effect on the attending selective academically oriented high schools, we drop anyone with an HSEE score below 400, which is the official cutoff for public high schools from the analytical sample.

Appendix B presents a detailed description of the high school application procedure for our urban sample. One important advantage of our data is the availability of the high school applications administrative database for the population of urban students taking the city-wide HSEE in the cohort, independent of their high school admission outcomes.[9] This allows us to account for potential school sorting based on high school preferences which are typically unobserved in RDD studies of school choice.

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[7] Each subordinate county has one elite high school, which admits its "home students" as defined by their *hukou* status.
[8] About 3% of urban elite school enrolees attend high schools in two subordinate counties, which lie outside the designated urban areas, implying less than perfect compliance to the official guidelines..
[9] We achieved a perfect match in nearly 97% of the cases, based on the full date-of-birth, gender and full name in Chinese. Of the 3% of cases with missing application records, 46% can be explained by "Other" (unregulated selection-fee) admissions route or clearing.

Our analytical sample with matched school preferences consists of 5,239 students after excluding ethnic minority students who account for only 0.4% of urban students.[10] For each student, the data contains scores of the city-wide HSEE (*zhongkao*), as well as the High School General Exam (*huikao,* the HSGE hereafter) taken at the end of the 2nd year of high school before students are separated into Science or Social Studies tracks in the final year to focus on preparation for the track-specific NCEE exams, as well as background information of the parents such as *hukou* and employment status. Passing the HSGE at the end of the second year of high school is a prerequisite for proceeding onto the final year of high school, hence a proxy for high school completion, regardless of the student's choice of academic track (Loyalka et al 2017).[11]

For the majority of students, we have administrative records of the mode of admission, which allows us to distinguish between those paying basic tuition fees and those paying extra "*selection-fees*". For each high school, we also have annual records of numbers of students and classes, per student expenditure, and summary teacher characteristics including credentials and average salaries, etc, from 2012, the year when the 2010 was still in the final grade (Grade 12) of high school.

Table 1 presents the background information on all high schools which specify the whole urban area of prefecture, including the surrounding County Z, as the catchment. There are a total of 7 public and 11 private high schools. Of the 7 public high schools, 3 are classified as elite high schools including one flagship school.

For historical reasons, all elite (*key*) high schools in the prefecture are publicly owned. As the most prestigious elite school in the whole prefecture, School F stands out as the only school in Tier 1 in the admissions system. Therefore, the publicly announced threshold for Tier 1 admissions is strategy-proof, in the sense that it is a virtually risk-free choice for everyone, as students are allowed to make up to 13 choices with at least two reserved for Tier 1 (see Appendix B). All other public schools, including elite schools E1 and E2, are placed in Tier 2 of the admissions system. In the following analysis, we will label F as the **flagship school** and label E1 and E2 as **elite**

[10] Ethnic minorities are excluded because of the very small sample size as well as potential eligibility for bonus HSEE points.
[11] We do not have HSGE scores for Maths, Chinese and English, which are track-specific and taken in the final year of high school. While it would be desirable to have the HSGE scores for those key subjects, accounting for the academic track choice would add further complications to the identification strategy.

schools, respectively. All other public high schools are labelled as **normal public schools**. While being allowed to enrol students from across the entire prefecture, all private schools are placed in the lower Tier 3. A detailed description of admission procedure (with the timeline) based on the 2009 documentation is presented in the Appendix B.[12] It is worth noting that F and E1 are open to all students in the entire prefecture, including students in the four subordinate counties outside the urban catchment area. This explains their exceptional sizes, with over 4,400 and 3,700 students spread across three grades (Grades 10-12) in 2012, respectively.[13]

Table 1: High schools in the 2010 Urban Sample

	School type	Catchment	Admission tier	High-school student numbers in 2012	High-school Average class size in 2012	Senior-rank teachers (%)	Unified enrolment cut-off	Selection-fee cut-off (tentative)	Sample share (%)
Flagship Public High Schools:									
F	Provincial key & provincial exemplary	Prefecture-wide	1	4,488	62.3	32.1	**623**	606	21.9
Elite Public High Schools:									
E1	Provincial key & provincial exemplary	Prefecture-wide	2	3,717	60.0	27.8	590	544	18.5
E2	Provincial key & provincial exemplary	Urban & County Z	2	2,859	63.5	9.3	**587**	532	12.0
Normal Public High Schools:									
N1	Provincial exemplary, non-boarding only	Urban & County Z	2	1,330	66.5	28.2	567	526	4.8
N2	Normal	Urban & County Z	2	1,561	55.4	11.9	567	518	7.8
N3	Normal	Urban & County Z	2	1,969	54.7	24.0	550	496	9.5
N4	Normal, non-boarding only	Urban & County Z	2	1,937	64.6	19.0	**532**	482	8.0
Private High Schools:									
P1-P11	Non-elite	Prefecture-wide	3	-	-		-	-	17.5

Note: F, E1, E2 and N4 are dedicated high schools (with Grades 10-12 only). While N1, N2 and N3 also have middle school sections (Grades 7-9), the student numbers and average class sizes in the last two columns only refer to the high school section. N1 and N4 only admit non-boarding students, due to capacity constraints. N3 is unique in targeting

[12] It was emphasized in the 2009 documentation that all admissions must strictly follow the rules and guidelines as set by the national and provincial education authorities regarding student numbers, HSEE requirements, fees changed and deadlines. All new enrolments at academic high schools must be approved by the prefecture-level admissions office. Students who do not comply with the admissions rules are warned that they might not be able to take the HSGE on which the nationally-recognized HS Diploma depends.

[13] As the only so-called "experimental middle school", N1 has the status of a "provincial exemplary high school", but without also being a "provincial key high school" as the flagship school F, and two elite schools, E1 and E2. N1 is also a non-boarding only school and a complete secondary school with its own middle school section. For these reasons, N1 is treated as a non-elite school in the following analysis.

children of employees in the state-owned coal mining corporation, who normally attend the affiliated middle school. Senior-rank teachers refer to teachers in the school (including the middle school department if any) with Senior-grade (*gaoji*) or Special-grade (*teji*) Teacher titles which have equivalent status as university associate and full professors, respectively.

Applications to high schools in the prefecture are made after taking the city-wide HSEE scores which are taken at the end of Grade 9 (the final year of middle school), but **before** the scores are known (see the timeline in Appendix B). Students who intend to continue their education beyond the compulsory education stage, list up to 13 school choices in total, in the application form. Corresponding to the distinction between the alternative and the standard channel under the dual-channel admissions system (Loyalka et al, 2014), the so-called "*selection-fee*" option for a specific school is regarded as a separate choice from the so-called "*unified or assignment enrolment*" route, for the same school. A centralised and computerized admission system then proceeds sequentially, by the tier of the schools. Each (public) school is given a strict quota on the maximum number of students it can admit.

The publicly announced school-specific admission cut-offs then mandate the minimum total HSEE scores required of the student to be admitted through the *standard-channel*, thus only subject to basic tuition fees. Within each admission tier, schools select students in turn according to the order of school preferences in the application form. Oversubscribed schools enrol students in descending order of the students HSEE scores. Students who are not yet admitted then are considered by their next preferred school. And so on.

If the student fails to get any offer from all preferred schools in one tier, the application will then be passed on to her preferred schools in the next tier. After the conclusion of the main round of admissions, there is a clearing round for schools which have not filled up their quotas.

It is also worthnoting that N2 has an identical "*unified enrolment*" cut-off as N1, a provincial exemplary school. It is quite plausible that the lack of boarding option might be a factor in explaining N1's lowest student share among all public schools in our urban sample.

Figure 2 shows the geographical location of all high schools and middle schools in our urban sample. Virtually all high schools are located in the urban centre (denoted as the CBD) in the map.

Table 2 shows the sample distribution by admission modes, for public and private schools separately. In the former category, we can also distinguish between flagship, elite and normal schools. Only the "*unified enrolment*" and "*assignment*" modes can be characterised as *standard-channel* admissions based on academic merit.

Figure 2: Geographical location of high schools and middle schools by school type

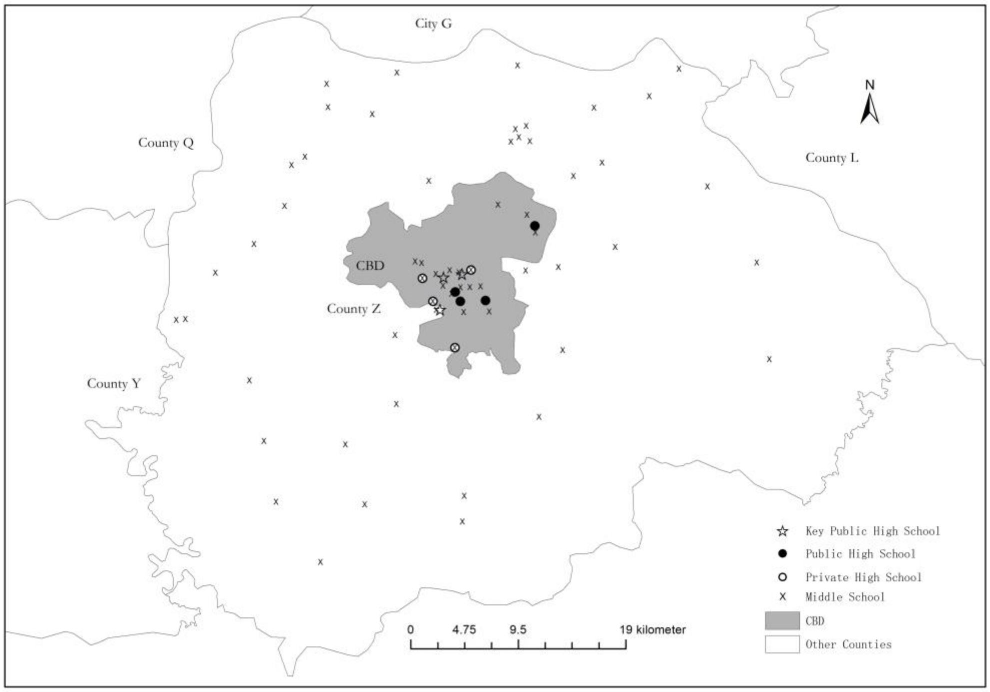


Table 2: Distribution of admission mode (%), by high school type

	Public Schools by Type			All Public Schools	All Private Schools	All Schools
	Flagship School	**Elite Schools**	**Normal Public Schools**			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Standard Channel:						
Unified-enrolment	57.6	68.7	83.6	71.2	93.3	75.3
Assignment (CA)	11.2	5.7	-	5.1	-	4.2
Alternative Channel:						
Selection-Fee (regulated)	19.0	13.8	10.7	14.1	4.7	12.5
Other (unregulated)	12.2	11.8	5.7	9.7	2.1	8.3
Total	100.0	100.0	100.0	100.0	100.0	100.0
Observations	1,148	1,597	1,576	4,321	918	5,239

The so-called "*unified enrolment*" entry, accounting for 71.2.% and 93.3% of public and private school students in the sample respectively, entitles the student to basic tuition fee status according to the HSEE performance, at only CN¥330 per annum. The so-called "*assignment*" mode was first introduced in 2009, and expanded in subsequent years, to allow top graduates from underrepresented middle schools, who scored marginally below the HSEE cut-off, to enjoy basic-tuition entry to flagship and elite public high schools nonetheless. Similar to the "contextual admissions (CA)" educational policies in the US and elsewhere, this was an important equity-enhancing policy initiative, keenly promoted by the government in recent years. While the regulated alternative channel of the "*selection-fee*" mode accounts for less than 5% of private school students in the sample, it accounts for 10.7% of normal public school places, rising up to 13.8% and 19.0% for elite and flagship schools respectively. In 2010, *selection-fee* cost CN¥10000 and CN¥8000 on top of the basic tuition fees per annum at the flagship and elite schools, respectively. The residual category of "Other" refers to the *unregulated alternative-channel*, capturing all students with missing values on the admission modes. These entrants are typically students with HSEE scores well below the official "*selection-fee*" cutoffs, and are charged privately much higher fees by the elite schools, which keep all these private fees for the purpose of subsidizing their teachers whose salaries are subject to public sector pay scales (Dee and Lan 2015).[14]

Figure 3 shows the standardised HSEE and HSGE scores by entry mode, for flagship and elite schools only. As expected, the flagship school has significantly higher scores in both HSEE and HSGE than elite schools. Regardless of the school type, *unified-enrolment* entry students perform better than the *assignment* entry students in HSEE, but only marginally so at the flagship school. On the other hand, *selection-fee* entry students' HSEE scores are significantly below those of their basic-tuition peers, by at least 0.15 SDs regardless of school type. Finally, students enrolled through "other" channels have by far the lowest HSEE scores, even below the mean of all HSEE takers. These students admitted through the unregulated alternative channel pay substantially more than the regulated "*selection-fees*", with the excess fees positively related to the deficit to the official cut-off points (Dee and Lan, 2015). The standardised HSGE scores also display a very similar pattern, with a substantial gap between *standard-channel* students paying basic tuition fees and *alternative-channel* students paying extra fees.

[14] In the setting of Dee and Lan (2015) which is fairly similar to ours, the private fee ranged from $6000 to $10000, well above the $3000 regulated "*selection-fee*", with the exact amount determined by the bargaining power of the student's parents. In their RDD specification, they also allow for the interaction of the continuous HSEE scores with the eligibility indicator.

Importantly, Figure 3 suggests that the value added of attending elite schools, as measured by the difference between the standardised HSEE and HSGE scores, vary by the school type which proxies selectivity. At the flagship school, there appears to be a robust negative gradient regardless of the admission mode. In contrast, there is no evidence of a consistent negative gradient for elite schools, for all admission modes except for the "other" category. This pattern is striking and justifies our distinction between the flagship school and elite schools in the formal analysis.

Figure 3: Standardised HSEE and HSGE scores by entry mode, flagship vs elite schools

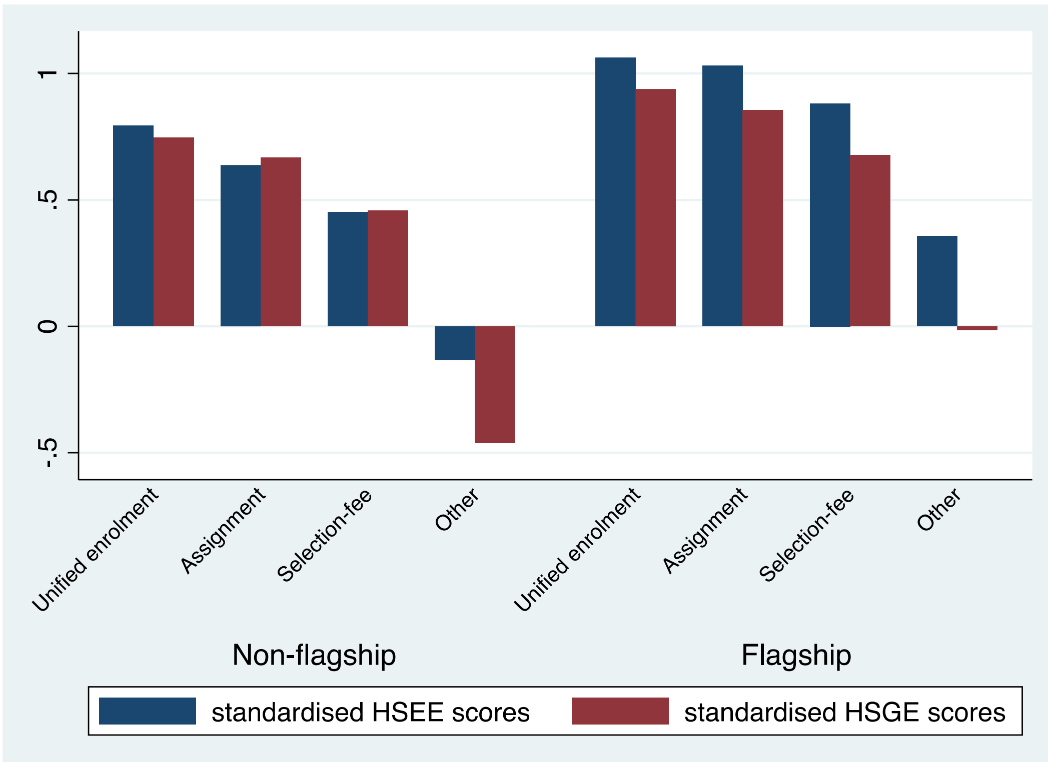


Table 3 present summary statistics of the urban sample, by school status. Of all 5,239 urban students with HSEE scores of at least 400 starting high school in 2010, 2,745 (or 52.4%) were enrolled in a flagship or elite school, all publicly owned. For the remaining students enrolling in non-elite high schools, 36.8% attended a private high school.

The maximum attainable HSEE total score in 2010 is 690 points, consisting of 120 each for Chinese, Maths and English (including 20 points for listening comprehension), 150 for

Comprehensive Sciences, 100 points History and Society, 50 for Moral Ethics and 30 for Physical Education.[15]

Table 3: Means by school status

	Flagship or Elite Schools	Other Schools	Difference
School characteristics:			
Private (*minban*) school	0.000	0.368	-0.368***
Private school outside urban area	0.000	0.039	-0.039***
Flagship school (F)	0.418	-	0.418***
Elite schools (E1 & E2)	0.582	-	0.582***
(Adjusted total) HSEE (*zhongkao*) score			
Standardised total score	0.758	0.094	0.664***
HSEE Total score	586.1	518.4	67.7***
>=623: above flagship *unified-enrolment* cut-off	0.181	0.000	0.181***
587-622: Between F and E2 *unified-enrolment* cut-offs	0.496	0.046	0.450***
532-586: between E2 *unified-enrolment & selection-fee* cut-offs	0.200	0.470	-0.269***
400-531: between E2 *selection-fee* & normal public high school cut-offs	0.122	0.484	-.295***
Standardised HSGE (*huikao*) scores			
Raw total scores	483.0	427.4	55.6***
Standardised total scores	0.645	0.014	0.630***
Student characteristics:			
Age	15.79	16.02	-0.233***
Boy	0.459	0.446	0.013
Parental characteristics:			
Father unemployed/redundant/retired	0.037	0.019	0.018***
Father agricultural *hukou*	0.323	0.454	-0.131***
Father non-agricultural *hukou*	0.506	0.286	0.220***
Father status missing	0.134	0.240	-0.106***
Father CCP/Political Party member	0.251	0.105	0.146***
Mother unemployed/redundant/retired	0.057	0.030	0.027***
Mother agricultural *hukou*	0.362	0.478	-0.116***
Mother non-agricultural *hukou*	0.381	0.144	0.237***
Mother status missing	0.200	0.348	-0.148***
Mother CCP/Political Party member	0.063	0.018	0.045***
Observations	2,745	2,494	-
Share of sample (%)	52.4.11	47.6	-

Note: ***,** and * indicate statistical significance at 1%, 5% and 10% respectively.

[15] To be eligible for elite schools, students must also obtain a minimum pass mark of 30 points out of 50 in Laboratory Abilities, which is not included in the total HSEE score.

The gap in the (adjusted) HSEE total scores between flagship or elite schools and their less selective counterparts is 67.7 points.[16] This corresponds to a gap in the standardised HSEE total scores of 0.664 SDs in favour of former. The HSEE scores of 18.1% of flagship and elite school students were above the *unified mode* admission cut-offs (623 in total score) for the flagship school, compared to 0% of attendees at non-elite schools. Another 49.6% of elite school students have total scores below 623 but above 587, the cut-off for E2, which we term the "elite school" cut-off. Interestingly, 4.6% of non-elite school attendees are found in this HSEE score band. This might be because they were not offered a place at their preferred elite school and/or they chose a non-elite school due to characteristics such as proximity to home.

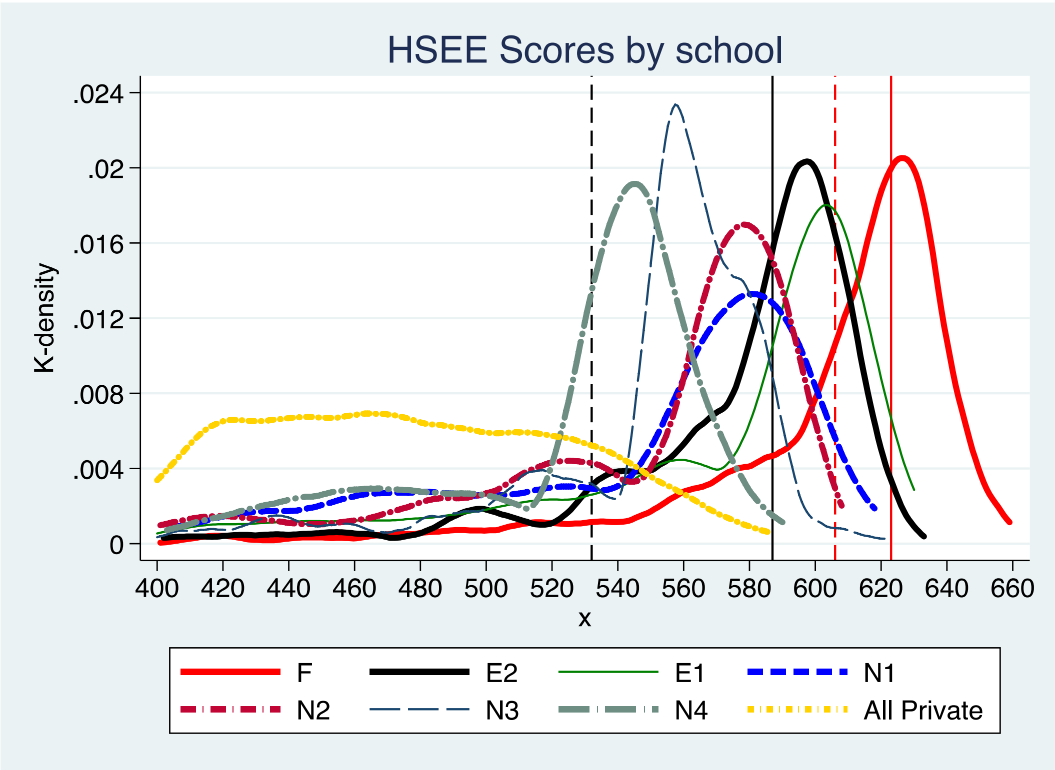
Furthermore, 20.0% of flagship or elite school attendees and 47.0% of non-elite school attendees respectively, have HSEE scores below 587 but above 532, the *selection-fee* cut-off for E2. Students in the latter group could have been enrolled into elite schools, in principle, if they had chosen the *selection-fee* option at a specific elite school in their applications (and paid for the privilege). Indeed, the 26.9% gap in favour of non-elite school attendees in this HSEE score band is highly statistically significant. In total, 32.2% of all elite school attendees failed to achieve the elite school cut-off for *unified-enrolment*, consistent with a significant minority of elite school places been allocated based on criteria other than HSEE scores alone, through the *assignmen*t, *selection-fee* or "other" channels.

Flagship and elite school students are on average 0.23 years younger than their non-elite counterparts, but are virtually equally likely to be male. Moreover, there are notable differences in parental characteristics between school types. Flagship and elite school students are much more likely to have parents (of either gender) with a non-agricultural *hukou*, or Chinese Communist Party or other political party memberships, a proxy for high social and cultural capital in the Chinese society. Somewhat surprisingly, the gaps in parents unemployed, redundant, or retired for either parent are higher for elite school attendants, presumably due to the inability to distinguish between these very different characteristics.

[16] Fewer than 0.8% of students in the sample received 5 or 10 bonus points on top of their raw total HSEE score, for honours such as provincial-level model student or student leader. Moreover, 1.6% of students and 1.2%, respectively, received special considerations for being the best students in the middle school and provincial-level talents in art or sports. The art and sport talent category can get up to 50% discount from the admission cut-offs for *unified-enrolment*.

Figure 4 shows the distribution of the standardised HSEE scores for the 7 public high schools individually and all private schools grouped as a whole. The flagship school, F, is clearly the most selective as measured by the entry scores. The two elite schools, E1 and E2, almost overlap each other. N1 turns out to have significantly lower mean and more dispersed distribution of HSEE scores than all elite schools. Consistent with the same admission cut-offs reported in Table 1, the distribution for N2 is very similar to that for N1. This graph lends strong support to the use of the publicly announced admission cut-offs for *unified enrolment* entry to F (623) and E2 (587), as the relevant cut-offs for enrolment to the flagship and elite schools, respectively.

Figure 4: Raw HSEE scores by school



Note: Vertical lines indicate the HSEE admission cut-offs at 623 (F), 587 (E2) and 567 (N1) points. HSEE total score truncated at 400, the official threshold for public high schools.

Figure 5A: HSEE scores distribution by admission mode, the flagship school

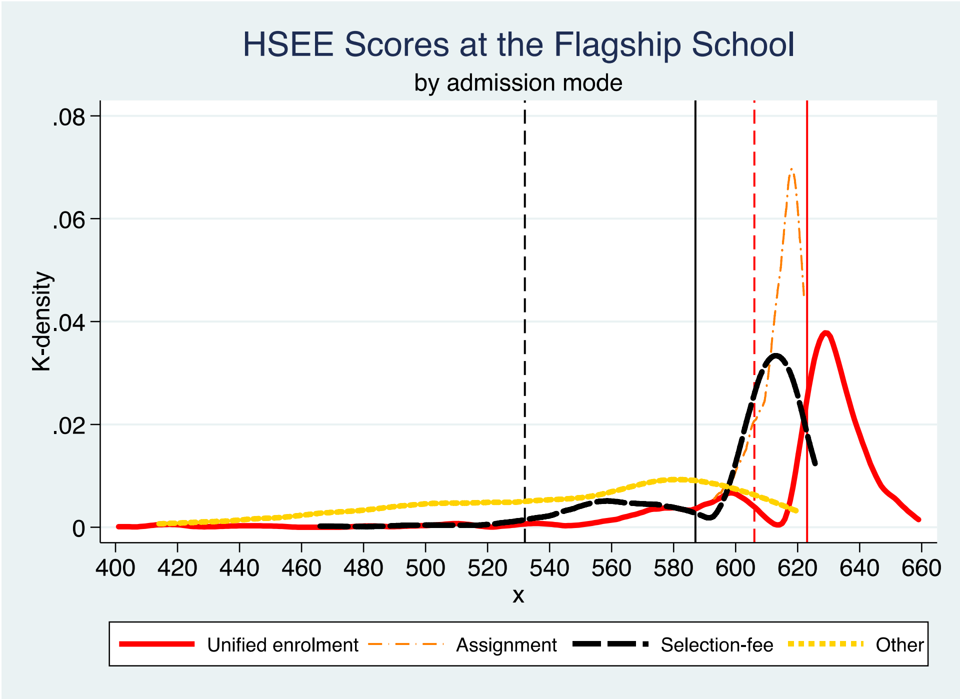
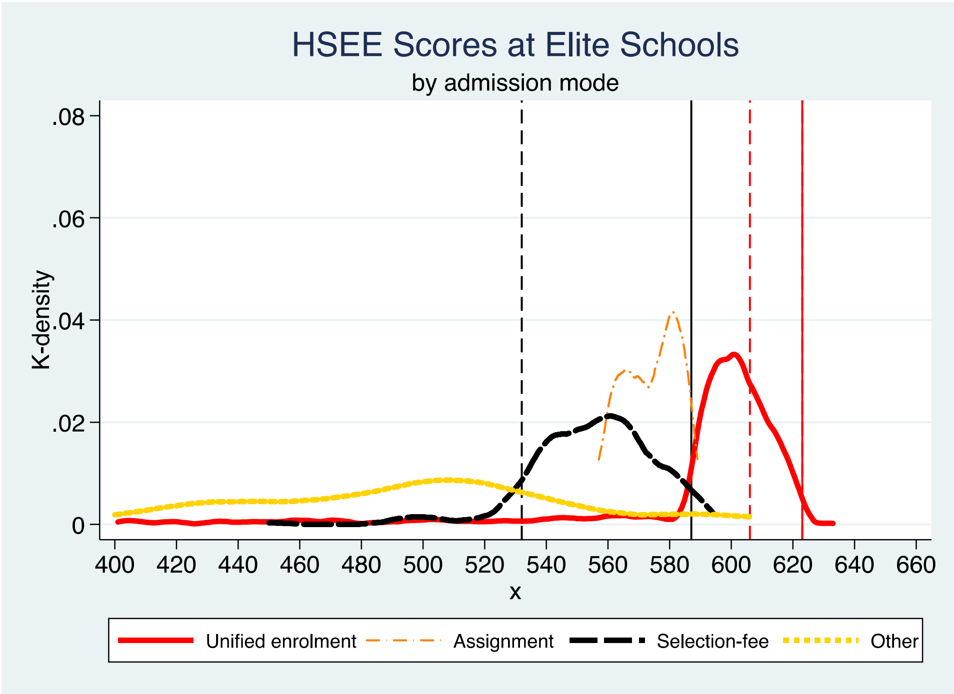


Figure 5B: HSEE scores distribution by admission mode, elite schools



Note: Elite schools include E1 and E2. Solid and dashed red vertical lines indicate the *unified-enrolment* and *selection-fee* cut-offs at 623 and 606 respectively for the flagship school. Solid and dashed black vertical lines indicate the *unified-enrolment* and *selection-fee* cut-offs at 587 and 532 respectively for elite schools. HSEE total scores are truncated at 400, the official threshold for normal public high schools.

Figure 5A and 5B focus on the standardised HSEE scores distribution by admission mode, for the flagship and elite schools respectively, to disentangle any composition effect. The patterns are very similar, with basic-fee paying students admitted through "*unified enrolment*" having significantly higher entry scores than *selection-fee* students. The "*assignment*" mode students only dominate the *selection-fee* mode students at the elite schools. The residual "Other" entry students have by far the lowest and the most dispersed entry scores for both tiers of elite schools.

5. Identification strategies

Compared to other quasi-experimental methods such as differences-in-difference (DD) or Instrumental Variables (IV), the regression discontinuity design (RDD) has many desirable properties including simplicity, transparency, and objectiveness (Hahn et al 2001; Lee & Lemieux 2010; Villamizar-Villegas et al 2021). It is easy to falsify and straight forward to interpret. Moreover, RDD requires very little information for identification when there is an explicit design for the treatment mechanism, and can be viewed as a localized randomised trial (see e.g. Cattaneo et al 2020a).

For student *i*, we standardise the adjusted HSEE score S_i around the *k-th* (k = 1, 2, 3) most academically selective school type, using the *unified-enrolment* admissions threshold $\underline{S_k}$:

$$S_{ik} = \frac{HSEE_i - S_k}{Standard\ Deviation\ of\ HSEE_i} \quad k = 1,2,3 \tag{1}$$

In this paper, we investigate the effects of attending high schools with diminishing degrees of selectivity, from "flagship", "elite", through "normal", and thence to "private" schools. S_1(=623), S_2 (=587) and S_3 (=523) hence correspond to the *unified-enrolment* admission cut-offs for F, E2 and N4 in Table 1, respectively. Note that the corresponding *unified-enrolment* admission cutoff for E1 is 590, virtually indistinguishable above that for S_2 while that the least selective normal school N4 is significantly below other normal schools. The gap between S_1 and S_2 is approximately 0.35 SD while that between S_2 and S_3 is about 0.63 SD.[17]

The outcome variable as measured by the standardised HSGE score for student *i* around selective school type *k* admission cutoffs can be modelled as

[17] Since all sample members were from the same middle school graduation cohort, there is no time variation.

$$HSGE_{ik} = \beta_k T_{ik} + \gamma_k Z_{ik} + e_{ik} \quad \text{where } T_i = I(S_{ik} \geq S_k) \tag{2}$$

where T_{ik} denotes the treatment status which takes the value of 1 for attending elite school type k and 0 otherwise, the vector $\boldsymbol{Z_{ik}}$ denotes exogenous (or "pre-intervention") covariates, and e_{ik} is the error term. The standardised HSEE score S_{ik} re-centred around the relevant admission cutoffs S_k is the *running variable* which determines the treatment status in a fuzzy manner.

This standard fuzzy RDD set up identifies the average treatment effect of attending academically selective school type k on standardised HSGE scores around the relevant admission threshold. To the extent that the standardised HSEE scores around the publicly announced admission cutoffs are as if randomly assigned, the fuzzy RDD estimates can be interpreted as the value-added of attending elite school type k, for students who had barely scored above the required HSEE cutoff relative to those who had barely missed out.

The unique setting of the Chinese education adds significant complexities to a straightforward application of the fuzzy RDD strategy. In this paper, we will first present in Section 6 a cumulative multiple cutoffs RDD analysis under a unified setting which highlights the heterogeneity in the effects of attending academic high schools with increased degrees of selectivity, while ignoring the heterogeneity in school preferences. This is followed up by the cutoff-specific RDD analyses in Section 7 for each high school application type separately, as well as pooled together following the standard normalizing-and-pooling strategy.

The multiple cutoff RDD framework is still at the research frontier of econometrics (see Cattaneo et al 2020, and references therein). Whereas not well suited to deal with heterogeneous treatment effects, it offers the framework needed to undertake multiple cutoff RDD analysis under a unified setting. This is particularly attractive in our context, as we are interested in the potentially highly heterogenous treatment effects with varying degrees of selectivity.

Whereas the multiple cutoff RDD analysis overlooks the heterogeneity in application types, we present the cutoff-specific RDD analyses in Section 7 for each high school application type, as proxied by the eligibility for contextual admissions and the willingness to pay for the opportunities to attend more selective schools, separately as well as pooled together, following the well-developed normalizing-and-pooling strategy (Cattaneo et al 2016 etc.).

6. Multiple Cutoff RDD Analysis

Empirically, we start off by applying the cumulative multiple cutoffs RDD (Cattaneo et al 2016; Cattaneo et al 2020b) setup which allows multiple cutoffs (3 in our case), at the cutoffs for normal public schools vs private schools, elite vs normal public schools, and flagship vs elite schools respectively, and provide robust bias-corrected inferences for cutoff-specific RD treatment effects in a unified setting. Note that the validity of this approach relies on quite restrictive assumptions (Cattaneo et al 2016).

Table 4 present the multiple cutoff RDD estimates at the 3 cutoffs, which are treated as cumulative as different school types could be regarded as somewhat different due to the different degrees of selectivity (Cattaneo et al 2020).[18] Under this parsimonious specification, we do not attempt to account for heterogenous treatment effect arising from school preferences at each cutoff based on the (lowest) pre-announced dominant *unified* admissions cutoffs for each school type. For students who barely managed to pass the HSEE cutoffs required, the RDD estimates suggests a modest positive effect on attending the more selective school types, at the normal-private and elite-normal cutoffs by 17-18 percentage points, although these are not statistically significant at conventional levels. On the other hand, students who barely pass the flagship threshold (of 623 HSEE points) are 41.5 percentage points more likely to attend the flagship school than their counterparts who barely missed out, and hence qualify for a unified-enrolment place at either elite school requiring 590 and 587 points respectively.

Table 4: Multiple Cutoff RDD estimates

	Normal vs Privat	***Elite vs Normal***	***Flagship vs Elite***
Running variable (HSEE):			
Cutoff	532	587	623
Range	400-560	561-605	606-659
Attend more selective schools (1st stage)	0.182	0.169	0.415
P (Robust biased-corrected)	0.131	0.180	0.000***
Bandwidth est (left / right of cut-off)	31.19/14.72	11.28/6.28	7.47/11.60
Effective # of Observations	823	722	539
Standardised HSGE score (2nd stage)	-0.078	0.025	-0.324
P (Robust biased-corrected)	0.525	0.374	0.004***
Bandwidth est (left / right of cut-off)	47.55 / 17.65	17.74 / 12.77	6.91 / 11.18
Effective # of Observations	1,098	1,207	505

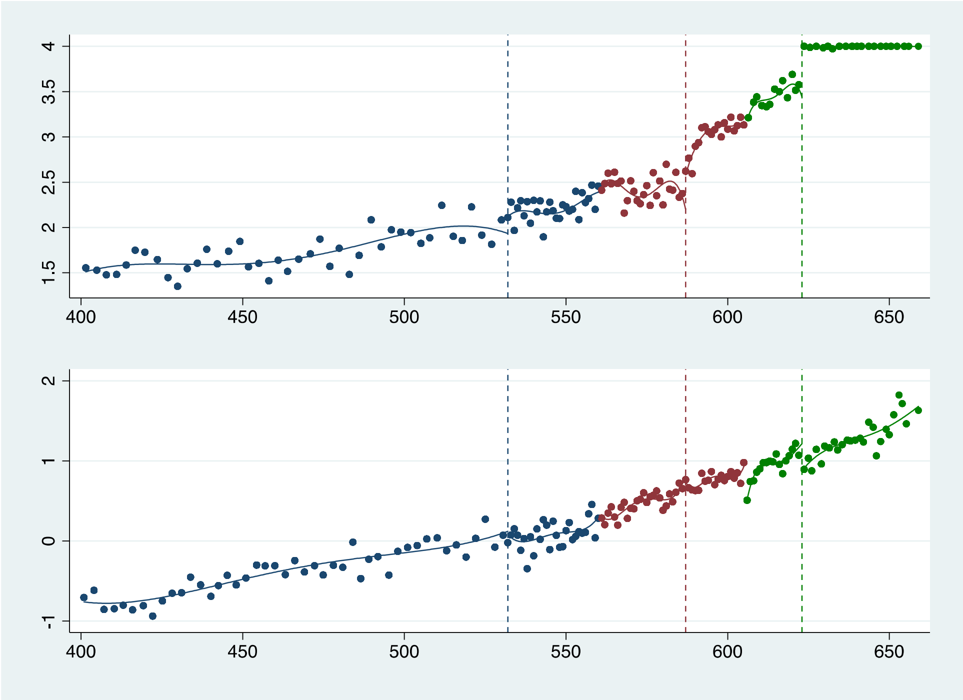
[18] We use non-overlapping ranges of the HSEE scores for each cutoff, with end points determined by the middle points between adjacent cumulative ordered cutoffs, as recommended by Cattaneo et al (2020, p 1241).

Note: ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Moreover, the RDD effect of attending more selective high school on the standard HSGE scores are also statistically insignificant for the first two cutoffs, with point estimates close to zero, suggesting a zero value-added effect of attending normal or elite schools for marginal students, conditional on HSEE scores. What is really striking is the substantial negative value-added effect of attending the flagship school vs elite schools. The magnitude of the negative effect of attending the flagship school is substantial, at -0.32 SD, and statistically significant at the 1% level.

Figure 6 visualizes Table 4, by plotting the school type (coded as 1-4 in ascending degrees of selectivity starting with private schools) and the standardized HSGE scores against HSEE, the running variable. Consistent with Table 4, the graph shows strong positive discontinuity in school attendance and large negative discontinuity in HSGE scores, only at the flagship-elite margin. In contrast, there appears to be no visible discontinuity at the normal-private and elite-normal schools thresholds.

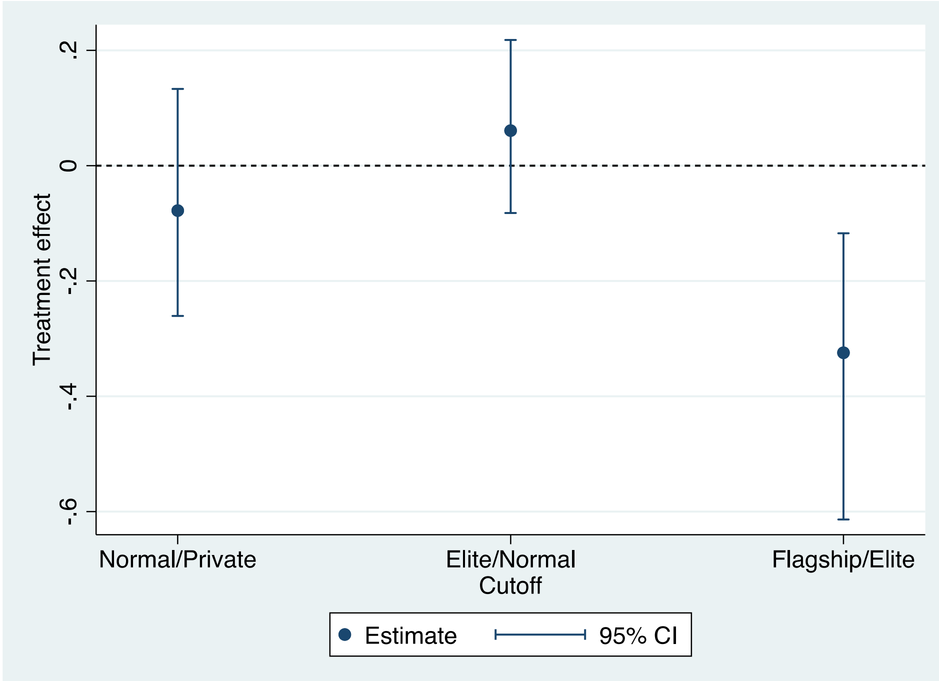
Figure 6: Multiple Cutoff RDDs



Note: The upper and the lower panel show the discontinuity in attending more selective school types and the corresponding effect on standardized HSGE scores at various HSEE (running variable) cutoffs, respectively.

Figure 7 highlights the RDD treatment effects across the cutoffs, with 95% confidence intervals.

Figure 7: Heterogeneous Treatment Effects, with 95% confidence intervals



7. Cutoff-specific RDD Analysis

7.1. Main results

In this section we will present the cutoff-specific RDD analyses pooling over application types, for the flagship-elite, the elite-normal, and the normal-private cutoffs respectively, following the standard normalizing-and-pooling strategy (Cattaneo et al 2016). Within each cutoff, we distinguish between up to 4 different application types (though some combinations might be non-binding, i.e. being observationally equivalent to other type in the cutoff score). We will focus on the flagship-elite school cutoff, the only statistically significant effect (but with a surprisingly large negative size) identified in the multiple cutoff setting, while leaving much of the results for the elite-normal and normal-private schools cutoffs in the Appendix.

From an econometrics perspective, conditioning on actual fee-paying and contextual admissions status is problematic, as they are likely to violate the key Stable Unit Treatment Value Assumption (SUTVA) which rules out interference between units (Cattaneo et al 2016). For instance, scoring above the HSEE cutoff for the *standard-channel* precludes admissions through the *selection-fee* mode for the same school (type), independent of the willingness to pay indicated in the school applications. To address this problem, we will estimate RDD for each application type, at each relevant cutoff. The intuition is that within each application type, everyone has similar school preferences such that a comparison of students barely above and barely below the type-specific HSEE admissions cutoff set by the local education authorities can recover the true causal treatment effect of attending a more selective school (Dale & Krueger 2002, 2014; Cattaneo et al 2016). Note that conditional on HSEE score (the running variable), willingness to pay selection-fee and eligibility for contextual admissions (determined by teacher assessments and performance across three years of middle schools) in the school applications stage are less likely to violate SUTVA than actual fee-paying and contextual admissions status. Then the type-specific RDD estimates are pooled across all application types, to derive the pooled RDD estimate for attending the relevant academically selective school type S_k (k=1,2,3).

As described in the Appendix B, the application for the only flagship school F in the prefecture is fairly straightforward, compared to that for the other public high schools. As the only school in Tier 1, this is effectively a strategy-proof free shot for anyone who considers oneself as having a realistic chance of scoring above the *unified-enrolment* flagship cutoff, at the application stage which is after the HSEE exam but before the announcement of the admission cut-offs by the local education authorities. It is worth noting that the timing of the high school applications stage implies considerable uncertainty, as the HSEE results will only be released after the conclusion of the high school online applications.

We start with 2,722 applicants with HSEE scores at 567 or above, which guarantees a *unified-enrolment* place at the most selective normal school (N1 and N2 in Table 2). Note this range allows sufficient common support for the flagship *selection-fee* cutoff (606) and the contextual admissions cutoff (593). We further exclude 7.5% of applicants who did not apply for the flagship school through any of the four routes (namely talent, contextual-admissions, unified-enrolment and selection-fee) and the 1.7% of applicants who applied for the talent route which might give them more substantial discounts in HSEE score requirement. The resulting sample of 2,471 flagship school applicants to be used in the RDD has a mean HSEE score of 603.2, and a realized probability of flagship and elite school admissions of 38.9% and 41.4% respectively.[19]

[19] The non-applicants and the talent-mode applicants have mean HSEE scores of 582.3 and 601.6, respectively. This suggests that non-application is driven by very low subjective probability of flagship school admissions.

The school preferences which are typically unobservable in RDD studies of school choice can be fully characterized by the applicants' eligibility for the contextual admissions route which is determined by the middle school attended and the teacher assessments and annual exams in middle schools, as well as the willingness to pay for the *selection-fee* route places. The former gives HSEE discounts of up to 30 score points relative to the *unified-enrolment*, at 593 instead of 623; however, the discontinuity is very fuzzy as actual admissions depend on both middle-school-specific and overall quotas for contextual admissions.[20] The *selection-fee* route only gives a discount of 17 score points, possibly driven by excess demand for the flagship school compared to *selection-fee* route at elite schools which allows discounts of 46 and 55 scores respectively. Whereas contextual admission eligibility reflects neighbourhood effect (arising from the usual requirement that children attend the nearest catchment school during compulsory education stage) and relative performance throughout the middle school education, the willingness to pay, on the hand, are more directly related to the credit constraint and general preference for education of the family.

Figure 8 compares the mean standardized HSEE and HSGE scores in the top panel, and the high school admissions outcomes in the bottom panel, by the 4 application types. For those not eligible for contextual admissions, there is no visible difference in the mean HSEE scores, but willingness to pay increases the chance of flagship admission by over 3-fold. Even for applicants eligible for contextual admissions, willingness to pay boost flagship admissions by nearly two-fold. On the other hand, contextual admissions eligibility increases chances of flagship admissions by about 100% and 30% for applicants not willing and willing to pay, respectively.

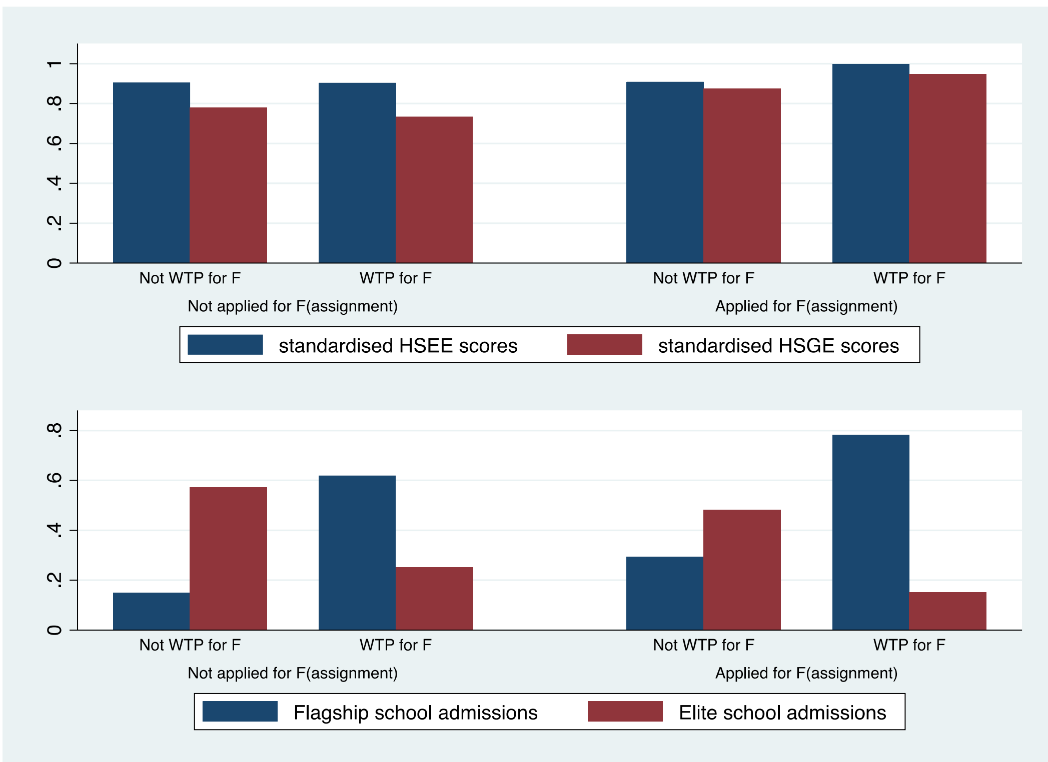
Figure 8 indicates that school preferences clearly matter for high school admissions and potentially educational outcomes, even conditional on the HSEE scores. This implies that overlooking the typically unobserved school preferences in most RDD studies on school choice are likely to result in biased pooled estimates of the causal effect of attending more selective schools in empirical research.

Given the advantage of our data which contains matched applications record, we now explore in Table 5 heterogeneous treatment effects by application types, separately and pooled, following the now well-established normalizing-and-pooling strategy (Cattaneo et al 2016). We control for

[20] Table 5 shows that almost 1300 applicants accounting for 52% of all flagship school applicants are eligible for contextual admissions, which is 8 times the total quota allocated to this route. Moreover, we don't have middle-school-specific quotas to simulate the admissions outcomes.

exogenous (pre-treatment) covariates throughout, to improve the precision of the RDD estimates. Table A1 in the Appendix show that the continuous measure in age (derived from detailed date of birth), gender and county/district of *hukou* all easily pass the covariate balance test at the flagship school *unified-enrolment* cutoff, with robust p-values of at least 0.45. Since some parental background characteristics, especially the CCP/political party memberships for both parents fail the test, we choose not to include any of them as covariates. Our preferred RDD specification in the following is the Local Linear RD point estimator p(1) using the Epanechnikov kernel function with two-way MSE-optimal bandwidth selectors.

Figure 8: Standardized HSEE/HSGE scores and admissions outcomes, by application type



Within each application type, applicants are regarded as having the same school preferences, such as the differences between applicants who are admitted through barely scoring above the application-type-specific HSEE cutoff and those barely scoring below the cutoff and hence missed out give the unbiased causal effect of attending the relevant selective school type, conditional on school preferences as proxied by the application type (Dale & Kreguer 2002, 2014). Pooling across application types with different type-specific normalized cutoffs then gives the unbiased pooled causal effect.

For applicants who are neither eligible for contextual admissions nor willing to pay for the selection-fee route in Column 1, there is virtually a sharp discontinuity at the 623-points cutoff, with admission probability jumping by 98.1 percentage points. Indeed, one cannot reject a null of perfect compliance at any conventional significance level. For this group who are admitted purely based on HSEE scores, the effect of barely making it to the attending flagship school is a negative 0.42 SD on HSGE scores, significant at almost 1% significance level. In Column 2, scoring above the highly fuzzy cutoff of 593-points for contextual admissions increases flagship admission probability by merely 6.7 percentage points, although significant at the 1% level. The corresponding value-added estimate of flagship attendance is large but negative, and in excess of 1 SD in absolute value, though insignificant statistically. The two groups of applicants willing to pay but differ in contextual admissions eligibility all have statistically insignificant RDD estimates, in both flagship school attendance and its effect on HSGE exam scores.

The last columns show the pooled estimates, without and with normalizing with respect to the application-type-specific cutoffs. While the naïve un-normalized specification shows that barely scoring above a common cutoff of 623-points would increase flagship school attendance by 40 percentage points, its effect on HSGE scores is a substantial -0.63 SD, both of which significant at 5% significance level at least. The preferred specification in the last column following the recommended normalizing-and-pooling strategy is qualitatively similar to the naïve specification, but different in magnitudes. The estimated effect of barely passing the type-specific thresholds increasing flagship attendance by 34.2 percentage points, with flagship school attendance decreasing HSEE scores by -0.76 SD. Note that the naïve specification fails the RD manipulation test, which formally test for manipulation of the assignment variable in an RD (McCrary 2008), at the 5%. This strongly indicates misappreciation of the naïve model, due to the crucial assumption of the random assignment of the cutoff in the RDD design failing to hold across all application types.

Therefore, overlooking heterogeneity in school preferences across application types results in model misspecification, as well as over-estimation of the effect of barely passing the (pooled) admission cutoff on school attendance and consequently in the under-estimation of the causal effect of flagship attendance on HSGE scores, by around 20%.

Figure 9 presents the RDD plots for the normalizing-and-pooling specification, confirming the positive jump in the effect of the running variable on flagship attendance but a negative discontinuity in the flagship attendance effect on the outcome variable.

Figure 9: RDD plots at the normalized-and-pooled flagship-elite school cutoff

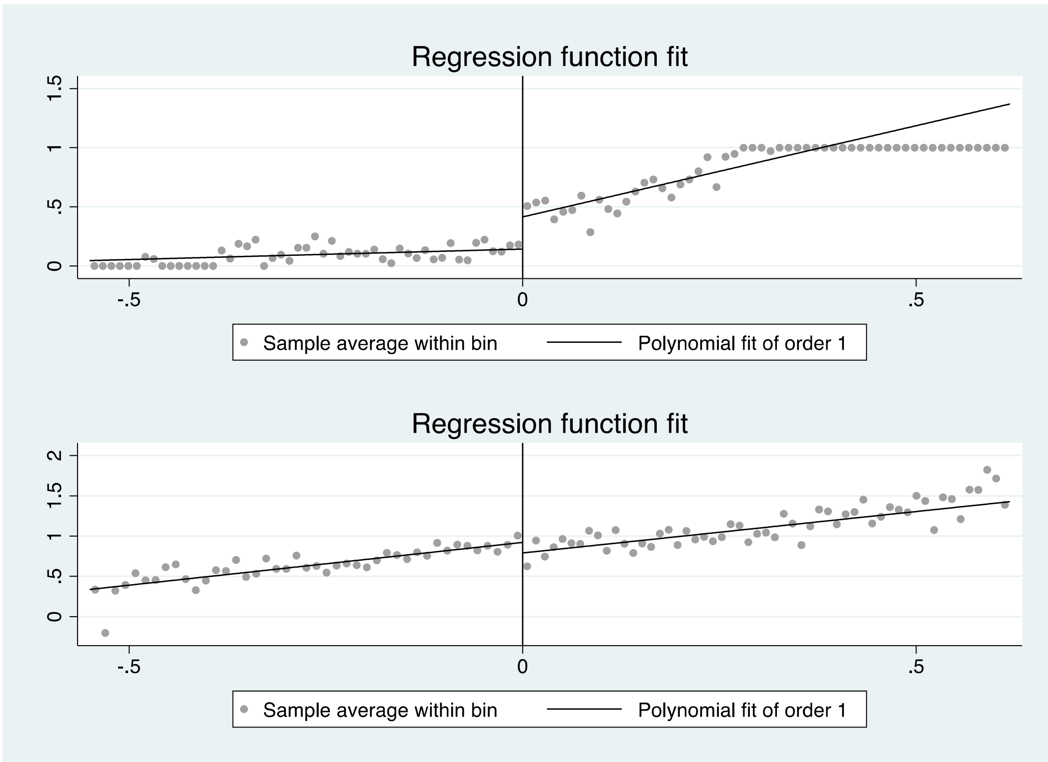


Table 5: Heterogeneous treatment effects by application types, separately and pooled, Flagship School Cut-off

	Subsample analysis by application types				*Full sample analysis*	
Models	***Not eligible for CA & not willing to pay***	***Eligible for CA & not willing to pay***	***Not eligible for CA & willing to pay***	***Eligible for CA & willing to pay***	***No normalizing***	***Normalizing & pooling***
Cutoff	623	593	606	593	623	623/593/606
HSEE (running variable) mean [range]	601.2 [567, 655]	601.5 [567, 655]	601.0 [567, 659]	610.6 [567, 656]	603.2 [567, 659]	603.2 [567, 659]
Elite school attendance	.981	.067	.175	-0.013	.400	.342
S.E	.029	.039	.154	.176	.062	.056
P (Robust)	0.000***	0.008***	0.441	0.784	0.000***	0.000***
P-value (RD manipulation) test	0.614	0.808	0.046**	0.133	0.027**	0.931
Std. HSGE score (SD)	-.421	-1.052	-3.623	6..649	-.633	-.755
S.E	.151	1.926	3.934	93.108	.195	.253
P (Robust)	0.012**	0.870	0.281	0.678	0.006***	0.004***
Obs	859	768	331	513	2,471	2,471
Sample share (%)	34.8	31.1	13.4	20.8	100.0	100.0

Note: Conditional on HSEE scores no less than 567 (cutoff for unified-enrolment for the most selective normal school). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

7.2 Robustness checks

Our preferred RDD specification is the normalizing-and-pooling model presented in the last column of Table 5, with the Local Linear RD point estimator p(1) and the Epanechnikov kernel function with two-way MSE-optimal bandwidth selectors. Table 6 shows the robustness of this benchmark specification with respect to alternatives - including order of local polynomial density, kernel function forms, bandwidth selectors, as well as the narrowing of symmetric interval bands around the cutoffs.

Panel A checks the effect of omitting the covariates. Compared to column 1 which reproduces the benchmark specification, excluding covariates only result in slightly larger standard errors in both stages as predicted. However, the point estimates are statistically insignificantly different.

Panel B shows that using higher orders local polynomial density instead of the Local Linear RD point estimator p(1) does not affect the statistical significance of the effect of flagship attendance. However, both the point estimates and the standard errors become larger. Imposing a common running variable range potentially results in the running variable having highly unbalanced values around the cutoffs, due to the significant variations in the cutoffs across application types. Panel C checks the robustness of the benchmark specification to imposing symmetric interval lengths around the application-type-specific cutoffs. The results suggest that while imposing symmetric interval lengths increase the magnitude of the second-stage RDD estimate (the negative effect of flagship school attendance on HSGE scores), narrowing the interval lengths makes hardly any difference. It is worth noting that with interval lengths of 0.25 SD (corresponding to approximately 25 HSEE score points), an elite school place is effectively guaranteed conditional on the application type for applicants who missed out on the flagship school admission.

Panel D suggests using the alternative triangular or uniform kernel function results in larger standard errors and somewhat larger point estimates of the flagship school attendance effect. However, the differences with the benchmark specification are insignificant statistically.

Panel E tests the robustness of the RDD estimates with respect to the common (one-way) MSE-optimal bandwidth selector, and to both the two-way and one-way CER (coverage error-rate) optimal bandwidth selectors, as opposed to the two-way MSE-optimal bandwidth selector *msetwo* in the benchmark specification. The large and significant negative flagship attendance effect holds across all alternative bandwidth selectors, but with both larger point estimates and larger standard errors. Overall, Table 6 show remarkable robustness of our benchmark model over alternative specifications, which if anything, tend to be marginally less precisely estimated.

Table 6: Robustness with respect to alternative specifications, Flagship School Cut-off

Panel A: With and without covariates

	With covariates	**Without covariates**
Elite school attendance	.342	.324
S.E	.056	.061
P (Robust)	0.000***	0.000***
Std. HSGE score (SD)	-.755	-0.794
S.E	.253	0.296
P (Robust)	0.004***	0.012**
Obs	2,471	2,471

Panel B: Higher orders of local polynomial density

	p(2)	**p(2)**	**p(4)**
Elite school attendance	.349	.367	.350
S.E	.065	.083	.104
P (Robust)	0.000***	0.000***	0.003***
Std. HSGE score (SD)	-.813	-1.015	-1.370
S.E	.298	.388	0.585
P (Robust)	0.008***	0.007***	0.020**
Obs	2,471	2,471	2,471

Panel C: Imposing symmetric interval lengths (in SDs)

	Within 0.35 SD	**Within 0.25 SD**
Elite school attendance	.347	.348
S.E	.066	.065
P (Robust)	0.000***	0.000***
Std. HSGE score (SD)	-.898	-0.894
S.E	.316	0.308
P (Robust)	0.006***	0.005***
Obs	2,009	1,623

Panel D: Alternative kernel functions

	Triangular	**Uniform**
Elite school attendance	.339	.323
S.E	.056	.065
P (Robust)	0.000***	0.000***
Std. HSGE score (SD)	-.779	-.908
S.E	.260	.331
P (Robust)	0.004***	0.008***
Obs	2,471	2,471

Panel E: Alternative bandwidth selector

	mserd	**certwo**	**cerrd**
Elite school attendance	.343	.338	.355
S.E	.061	.066	.074
P (Robust)	0.000***	0.000***	0.000***

Std. HSGE score (SD)	-.820	-.860	-.971
S.E	.286	.324	0.358
P (Robust)	0.006***	0.009***	0.008***
Obs	2,471	2,471	2,471

Note: Bandwidth selection procedures ***msetwo*** and ***mserd*** specify (two) separate and common Mean Squared Error-optimal bandwidth selectors respectively, while ***certwo*** and ***cerrd*** specify (two) separate and common coverage error-rate (CER) optimal bandwidth selectors, respectively.

7.3 *Heterogenous Effects by Gender, Area Type, and Academic Track*

In Table 7 we further explore the heterogenous treatments by gender, for the full range of sample with HSEE scores at 567-points or higher and the restricted sample with interval lengths of 0.25 SD around the cutoff. Scoring just above the cutoffs has a larger effect on flagship school attendance for girls. On the other hand, the negative effects of attending the flagship school are larger for boys, though these are not precisely estimated. Regardless of the sample, attending flagship school has a statically significant on HSGE scores for girls.

Table 8 explores the heterogenous treatment effect by *hukou* area type and interval lengths. As Figure 2 indicates that virtually all public high schools are located in the urban centre of the prefecture, one might be concerned at our RDD estimates could be biased if rural students from County Z (as proxied by the location of their middle schools) might have systematically different preferences from their more urban counterparts due to the longer distance, despite the availability of boarding in most high schools. Therefore, we examine the heterogeneity of RDD with respect to area type, as defined by home district/county of *hukou* registration, and interval lengths in Table 8. The results show that rural *hukou* students with HSEE scores barely above the cutoff have a larger increase in the probability of attending flagship, up to 100% when narrower interval lengths are imposed, compared to their urban *hukou* counterparts. Moreover, the negative effect of flagship school on HSGE scores is also more pronounced for rural *hukou* students.

The HSGE contains seven subjects which can be classified into two tracks, according to their relevance to the NCEE. The Social Studies track includes Politics, History and Geography, while the Science track includes Physics, Chemistry, Biology, and Informatics. While high school students must study courses in both tracks in the first two years of high school, they have to make up their minds on the specific track to specialise in before Grade 12 and take the track-specific NCEE which determines the subject-specific university degree course at a particular HE institution.

While we do not observe students' actual track choice in our sample, it is nevertheless informative to explore the heterogenous effect of elite school attendance on track-specific subject performance. Tables 9 present the heterogeneous treatment effects by academic track, for the full sample and the restricted subsample with interval lengths of only 0.25 SDs. The results suggest that the adverse effect of attending the flagship school for marginal students is more pronounced in Science track subjects, as the negative estimates for the Social Studies track subjects are always smaller in magnitude and only statistically significant when restricting to the 0.25 SD interval lengths.

Table 7: RDD estimates by gender and interval lengths, Flagship School Cut-off

HSEE range/Interval lengths	**Full range (HSEE 567-659)**		**Within 0.25 SD of cutoff**	
Gender	**Boys**	**Girls**	**Boys**	**Girls**
Elite school attendance	.197	.419	.275	.391
S.E	.081	.073	.108	.090
P (Robust)	0.026***	0.000***	0.024**	0.001***
Std. HSGE score (SD)	-1.157	-0.591	-1.346	-0.808
S.E	0.763	0.242	0.817	0.339
P (Robust)	0.168	0.028**	0.108	0.021**
Obs	1,108	1,363	728	895

Table 8: Heterogenous effects by *hukou* area type and interval lengths

HSEE range/Interval lengths	**Full range (HSEE 567-659)**		**Within 0.25 SD of cutoff**	
***hukou* area type**	**Urban**	**Rural**	**Urban**	**Rural**
Elite school attendance	.290	.471	.280	.574
S.E	.068	.085	.081	.115
P (Robust)	0.000***	0.000***	0.008***	0.000***
Std. HSGE score (SD)	-0.606	-1.146	-0.828	-1.107
S.E	0.362	0.310	0.477	0.337
P (Robust)	0.112	0.001***	0.057*	0.005***
Obs	1,796	675	1,185	438

Table 9: Heterogenous effects by academic track and interval lengths, Flagship School Cut-off

HSEE range/Interval lengths	Full range (HSEE 567-659)		Within 0.25 SD of cutoff	
Academic Track-specific standardised HSGE scores	**Social Studies**	**Science**	**Social Studies**	**Science**
Flagship school attendance	.338	.341	.353	.348
S.E	.058	.057	.068	.066
P (Robust)	0.000***	0.000***	0.000***	0.000***
Std. HSGE score (SD)	-0.310	-0.861	-0.673	-0.913
S.E	0.291	0.303	0.355	0.354
P (Robust)	0.260	0.008***	0.036**	0.018**
Obs	2,471		1,623	

7.4 Discussions on the flagship attendance effect

Our finding of a lack of positive causal effect of attending elite schools is different from the general evidence from developing countries suggesting a significant positive effect of attending the flagship school on academic outcomes. However, it is more consistent with the existing Chinese evidence based on the RDD approach (Dee and Lan, 2015; Zhang, 2016; and Hoekstra et al, 2018).

On the other hand, our finding of a large negative effect of attending a flagship school is more at odds with the positive and significant effect of attending tier 1 (flagship) elite school in China suggested by Hoesktra et al (2018). The difference is likely to be explained, in part, by the different settings. First, while we can only study the effect on the High School General Exam scores, their focus is on the performance in the more high-stakes NCEEs which is the sole determinant of access to elite universities in China. Previous studies in the US context suggest that achievement gains are likely to be more pronounced in high-stakes exams (see. e.g. Jacob, 2007; Corcoran et al 2011). Second, while they restrict the sample to suburban students who can only attend a school in the district or county of *hukou* registration, our sample includes all students in the whole urban area including the suburb and the immediately adjacent semi-urban county, which implies greater choices and more intensive competition for the flagship school. Third, we also allow for admission routes other than *unified-enrolment*, which includes contextual admissions and fee-paying which enable student with lower HSEE scores to attend the same schools.

Another potentially important channel underlying the negative and significant effect of attending flagship schools which is largely overlooked in the previous literature, is the almost universal within-school tracking in high schools in China (Dee and Lan 2015; Canaan et al 2022). Marginal students who are barely eligible for the (flagship) elite school are highly unlikely to be placed in high-achieving classrooms according to the classroom placement exams which take place less than three months after the HSEE exam (Canaan et al 2022). Canaan et al (2022) also show that the school resources are disproportionately concentrated on high-achieving classrooms in the flagship school they study, suggesting that flagship schools place more emphasis on preparing their best students for the NCEE, the sole determinant of access into China's elite universities. It is worthnoting that Chinese system with strong teaching tracking and ability sorting is very similar to that of Romania, a country also was historically influenced by the elitist Soviet educational system (Pop-Eleches & Urquiloa 2013).

Dee and Lan (2015) provide direct evidence that *selection-fee* students who score barely above the lower *selection-fee* admission cut-off are no more likely to study in the Science track than student attending non-elite schools with similar HSEE scores. This implies that marginal students fail to take full advantage of attending elite schools which tend to have strong academic records in the sciences, partly because of concentration of higher-quality teachers. While we do not observe students' academic track choice in our data, the results in Table 9 are consistent with Dee and Lan (2015) in the sense that marginal students at elite schools, are found to fare relatively well (or less badly) in the Social Studies subjects.

More generally, the negative effect of attending flagship schools is consistent with the "*small-fish-big-pond*" effect (see Marsh et al. 1995; Murphy and Weinhardt 2020; Denning et al 2022). To the extent that ranking matters, marginal students who are barely eligible for flagship schools might choose to study in the relatively weaker Social Studies track to avoid stigma or intense competition (Dee and Lan 2015; Canaan et al 2022).

It is also conceivable that marginal students prefer flagship schools on the basis of academic returns which are not measured by HSGE scores (e.g. elite school education might better prepare the marginal students from advantaged SES backgrounds for overseas studies) even when they do not fare well in the Chinese HE system. The literature on private schools also suggest that the non-academic returns could be important, for instance through social networks as schoolmates in flagship schools are expected to become local elites in the future in a society with strong social norms and low social mobility.

7.5 The Effects at the elite-normal and normal-private school cutoffs

To avoid repetition, we only present the corresponding normalizing-and-pooling RDD estimates accounting for school preferences at the elite-normal and normal-private school cutoffs in Tables A2 and A3 in the Appendix, respectively. Both tables are fully consistent with the accumulative multiple cutoffs RDD results in Section 5 earlier, with no statistically significant effects on HSGE scores found for attending more selective schools, whether in application type-specific or pooled specifications.

8. Conclusions

Using novel administrative data for the population of urban students in one prefecture in north central China who started high school in 2010, we present new evidence on the causal effect of attending academic more selective high schools on High School General Exam (HSGE) scores. Normalizing-and pooling RDD estimates based on publicly announced admission cut-offs of city-wide High School Entrance Exam (HSEE) scores accounting for school preferences as revealed in the high school application show very large, statistically significant **negative** effects for marginal students, of attending the flagship school, which is by far the most academically selective high school in the whole prefecture, on HSGE scores relative to attending elite schools which are less selective. This implies that these marginal students could have fared better, had they chosen to attend less selective elite schools charging only basic tuition fees and hence avoid paying extra *selection-fees* or the more substantial unregulated private tuition fees charged by the flagship school. In contrast, students who barely score above the cutoffs at the elite-normal and the normal-private school thresholds appear to perform just as well in general in the HSGE scores, relative to their counterpart who just missed out the cutoffs.

These results are robust to alternative specifications of the RDD estimator, including the order of local polynomial density, kernel function forms, bandwidth selectors, and variations in the interval lengths around the admission cut-offs. Moreover, the findings are also insensitive to covariate controls, and splitting samples by gender or area type. Furthermore, the cutoff-specific normalizing-and-pooling RDD estimates are also consistent with the cumulative multiple cutoffs RDD estimates.

As far as the HSGE are concerned, our fuzzy RDD results suggest that it does not really pay to attend elite high schools in China, for students who are at the margin of the *standard-channel* admission cut-offs, regardless of the degree of school selectivity or school preferences. In particular, attending the flagship school is shown to have large and precisely estimated adverse effects for marginal students. More generally, our findings indicate that attending more academically selective schools has no value-added at best, and potentially may even harm students' academic achievement at the flagship schools.

Our findings have important implications for students and parents, as well as policy makers. They suggest that the widely held belief that intense competition and superior peer quality at more academically selective school can only enhance attendants' academic achievements could be quite misleading. Specifically, paying substantial *selection-fees* or the even more substantial private tuitions fees to send marginal students to over-competitive elite schools could be counter-productive.

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Appendix A:

Table A1: Covariate Balance Tests at the flagship-elite school cutoff

	RD Effect	**Robust p-value**
Age	-.069	.588
Boy	-.090	.473
CBD	.006	.776
Suburb	-.048	.494
County Z	.038	.563
Parental characteristics:		
Father unemployed/redundant/retired	-.002	.808
Father agricultural *hukou*	.014	.725
Father non-agricultural *hukou*	-.080	.308
Father status missing	.061	.285
Father CCP/Political Party member	-.238	.006***
Mother unemployed/redundant/retired	.037	.256
Mother agricultural *hukou*	-.071	.400
Mother non-agricultural *hukou*	-.027	.742
Mother status missing	.102	.098*
Mother CCP/Political Party member	-.095	.036**
Obs	2,722	

Note: Same as the pooled sample for in Table 5, i.e. conditional on HSEE scores no less than 567 (cutoff for unified-enrolment for the most selective normal school). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

A) The Elite-Normal School Threshold

Table A2: Heterogeneous treatment effects by application types, separately and pooled

Sample	***Subsample Analysis***			***Full sample Analysis***		
Models	***Not Eligible for CA & not willing to pay***	***Eligible for CA & not willing to pay***	***Willing to pay***	***No normalizing***	***Normalizing & pooling***	***Normalizing & pooling, Interval Lengths 0.25 SD***
Normal school attend.	.221	.283	.072	.329	.431	.154
S.E	.130	.112	.129	.072	.054	.107
P (Robust)	0.200	0.033**	0.697	0.000***	0.000***	0.465
Std. HSGE score (SD)	-1.058	.267	.083	.042	-.236	-.938
S.E	.945	.757	3.137	.260	.225	1.430
P (Robust)	0.190	0.869	0.953	0.928	0.245	0.397
HSEE (running variable) mean [range]	575.9 [467, 622]	575.1 [471, 621]	558.3 [467, 622]	568.1 [467, 622]	568.1 [467, 622]	568.1 [467, 622]
P-value (RD manipulation) test	0.228	0.194	0.605	0.946	0.199	0.199
Cutoff	587	557	532	587	587/557 /532	587/557 /532
Obs	705	480	912	2,097	2,097	918

Note: Conditional on HSEE between 467 (cutoff for selection-fee admissions mode for the least selective normal school) and 622 (right below the unified admissions cutoff for flagship) and have applied to at least one elite school under the unified mode.). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

B) The Normal-Private School Threshold

Table A3: Heterogeneous treatment effects by application types, separately and pooled

Sample	***Subsample Analysis***		***Full sample Analysis***		
Models	***Not willing to pay***	***Willing to pay***	***No normalizing***	***Normalizing & pooling***	***Normalizing & pooling, Interval Lengths 0.25 SD***
Normal school attend.	.460	-.222	.295	.173	.113
S.E	.077	.123	.068	.070	.134
P (Robust)	0.000***	0.078*	0.000***	0.054*	0.630
Std. HSGE score (SD)	-.228	-.923	-.114	.058	.626
S.E	.261	.779	.349	.596	2.003
P (Robust)	0.744	0.297	0.987	0.919	0.603
HSEE (running variable) mean [range]	503.6 [400, 556]	485.8 [400, 556]	495.4 [400, 556]	495.4 [400, 556]	519.1 [457, 556]
P-value (RD manipulation) test	0.195	0.707	0.252	0.532	0.532
Cutoff	532	482	532	532/482	532/482
Obs	1,024	872	1,896	1,896	882

Note: Conditional on HSEE below 557 (cutoff for contextual admissions mode for elite school E2) and have applied to at least one normal school under the unified mode.). ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels respectively.

Appendix B: High School Applications

Timeline of the Admissions Process

Using 2009 high school admissions in the prefecture (which is fully documented) as an example, the timeline of the admissions process is follows:

(1): Exam: The High School Entrance Exam (HSEE) exams were conducted on 20^{th}-22^{nd} June.

(2): Application: After the exam but before results are known, students complete the High School (HS) application form in late June/early July. Admission proceeds strictly by the order of group, then mode (*unified enrolment*>*assignment*>*selection-fee*), then order of school preferences. There are 5 groups with up to 13 entries in total for academic high schools.[21]

- Group 1 (*variable a1*): *talent* mode. 1 entry (optional). For students with sports/art talents only (the very few qualified students only need to exceed 50-60% of the *unified-enrolment* cut-off).
- Group 2 (*variables a2 & a3*): *assignment* (Contextual Admissions) mode, 2 entries (optional). Only relevant for students with 3-year full history in the designated disadvantaged middle schools (weak as defined by previous cohorts' HSEE performance of the school). Note that both the quota (%) and the CA cut-offs are preannounced. In the unlikely event that the quotas were not filled, then any remaining places will go to Group 3 below.
- Group 3a (*variable a4*): Flagship school F, *unified-enrolment* mode only. This is a strategy-proof option that any academically able student would have chosen. All students who make the pre-announced *unified-enrolment* mode cut-off get a place, regardless of their Group 3b choice (for the *selection-fee* mode).
- Group 3b (*variable a5*): Flagship school F, *selection-fee* mode only. This is optional choice to indicate the willingness to pay the selection-fee to attend F, if HSEE is below the cutoff for the unified-enrolment (i.e. Group 3a) but above the *selection-fee* cut-off. Note that both

[21] Students can also apply to 6 other post-compulsory education options beyond academic high school education in the following order: general teacher (*normal*) schools, 5-year advanced vocational college, kindergarten/special-education teacher schools/colleges, Tier 1 general technical secondary schools, Tier 2 general technical secondary schools, and other vocational high (secondary) schools. For each option, applicants can choose 1 preferred institution and 1 reserved institution.

the quota for the selection-fee mode and its cut-off threshold were also announced before admission process starts.

- Group 4a (*variables a6-a9*): All other public high schools including elite schools E1 & E2, *unified-enrolment* mode only.
- Group 4b (*variables a10-a11*): All other public high schools including elite schools E1 & E2, *selection-fee* mode only. These two choices are optional, but can be used to indicate willingness to pay to attend up to two public high schools (not necessarily elite)
- Group 5 (*variables a12-a13*): Tier 3 schools only (private or rural high schools only), 2 entries.

Note that all the parameters are set by the local education authorities, and there is little opportunity for manipulation by the schools or students. Perhaps the only exception is the unregulated "Other" mode students (as in Figures 3 and 5) who scored below the *selection-fee* mode cutoff and therefore had to pay the unregulated higher tuition fees set by the high schools.

Currently we are only using the 2010 cohort. But there is scope to add the 2009 cohort which follows the same admissions procedure. The main reform between 2009 and 2010 is the expansion of the *assignment (CA) mode* share for flagship and elite schools.

(3) ***Centralised admission procedure*** (for all academic high schools): On July 7th, the City Education Bureau released the HSEE results to the District Admissions Service and the middle schools from which students graduated, together with the Tier 1 (Flagship School F only) admission cut-offs (for *unified-enrolment*). Students can check their results in person, by phone or online. Between 8th-12th July, students can request to have their scores re-checked for a fee (by filling in a form)

  - Tier 1 admission (only applies to Flagship School F) between July 13-15

- After the conclusion of Tier 1 admission, with a full list of admissions announced online and in local newspapers, the City Education Bureau released the Tier 2 admission cut-offs for all remaining public high schools, including elite schools E1 and E2.
- Tier 2 admission took place during 15th-16th July. This concludes the elite school admission stage.
- After the conclusion of Tier 2 admissions and the public release of the full admission lists, the City Education Bureau released the admission cut-offs for lower tiers.

- Clearing *(bulu):* There is also a round of clearing at the beginning of August for unfilled general HS places (virtually irrelevant for elite schools).

(4) Admissions of other types of post-compulsory education only procced after the conclusion of academic high schools by the 20th August, also strictly according to the listed preferences in the application form.