

Elite Secondary Schools and Student Achievement: Regression Discontinuity Evidence from Kenya*

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Abstract

This paper estimates the causal effect of attending an elite (or high performing) secondary school on student achievement using data from Kenyan secondary schools. The admission of students into government secondary schools in Kenya is centralized and is based solely on student scores on the national primary school exit exam, district quotas, and students' stated preferences. The assignment rules cause students of similar ability and preferences near the implied assignment score cutoffs to be assigned to secondary schools of different quality. We use a regression discontinuity design to obtain causal estimates of the effects of elite school attendance on student progression through secondary school and achievement in the secondary school exit examination. As the assignment rule generates different score thresholds for each district, we can examine whether the effects of attending an elite secondary school differ by the student's initial (primary school) test score. For students whose primary school test scores are near the threshold of an elite school, we find that elite school attendance does not affect timely progression through secondary school or achievement.

Keywords: Education, Kenya

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1 Introduction

Low quality schools can suppress school enrollment and impede student progression and achievement in developing countries (World Bank, 2004). The education literature has not reached a consensus on the impact of various elements of school quality on student outcomes despite the large number of published studies (Hanushek, 1995, 2007). Most of these studies focused on the impact of primary school quality on student achievement with more limited evidence at the secondary school level. Questions about the importance of inputs into secondary school achievement are particularly important to Sub-Saharan Africa where the cost to educate a secondary school student is three to six times the cost to educate a primary school student and the demand for secondary school is estimated to increase by at least 35 percent from 2007 to 2015 (Verspoor, 2008; Lewin, 2008). This increase in demand is partly driven by the implementation of free primary education programs across many countries that increased the number of students completing primary school (Lucas and Mbiti, 2010). With limited resources and rapidly expanding cohorts of primary school graduates transitioning to secondary school, credible evidence on the impact of school quality in African contexts is critical for policy makers charged with both increasing educational access and standards across the system. This paper uses the student assignment algorithm for secondary school students in Kenya to estimate the returns to achievement and probability of graduation from attending an elite secondary school.

The key conceptual difficulty in assessing the impact of school quality on student outcomes is the endogenous selection of students into schools. To address this difficulty, this paper relies on a series of discontinuities in the probability of attending a particular type

of school created by Kenya’s secondary school assignment rules. Students in Kenya are assigned to government secondary schools based on their performance on the national primary school exit exam, district level quotas, and stated preferences for schools. The most selective (or elite) government schools are the National Schools, followed by the Provincial Schools, and then the District Schools. National Schools attract the best students from the country, while Provincial Schools attract the best remaining students from the province, and District Schools admit the best remaining students from the district. To encourage “national unity” there is a maximum number of students from each district that can attend each National and Provincial School. The exact score cut-off for attending a specific type of school is year and district specific, depending on the number of students who express a preference for a particular school and the scores of those students (e.g. a student scoring 400/500 could be placed in either a National or Provincial School depending on how many students with higher scores in his district expressed preferences for the same schools and his district’s quotas for the National Schools).

Given the assignment rule, we use a regression discontinuity design to identify the effect of school inputs on student completion of secondary school and achievement. Intuitively, we can compare students who were barely admitted to a National (or Provincial) School to those who barely missed admission. At the conclusion of secondary school, these students’ outcomes should differ only by the effect of the secondary school quality (which includes the influence of school resources, teachers, peers, and other school-specific influences). Our empirical approach will combine results from multiple “experiments” based on locale-specific admission cutoffs. Because we have a separate discontinuity for each district-school, we are not relying on the lowest ability students within a school for identification since the marginal

admitted student from Nairobi, for example, could be far from the lowest ability student in a National School.

There is surprisingly mixed evidence on the effects of school quality on student achievement. Hanushek (1995) reviews 96 studies that examine the effect of various measures of school quality on student achievement. These studies do not present a consensus on the effect of class size, teacher education, teacher experience, teacher salary, or expenditure per pupil. Additionally, many of the studies cited by Hanushek suffer from identification problems related to endogenous school choice.

A common identification approach in the US has been to use randomization induced by oversubscribed schools and lotteries to correct for endogenous school choice. Cullen et al. (2005) exploit the randomized lottery system used in Chicago public schools to examine the causal impact of transferring to a better or higher achieving school and find no impact of attending a better school on test scores. Other examples include Abdulkadiroglu et al. (2009) in Boston, Dobbie and Fryer (2010) in Harlem, and Angrist et al. (2010) in Lynn.

A number of recent papers have examined the impact of attending better quality or more selective schools in a variety of different countries that use similar tiered or “ability grouped” secondary school systems. Similar designs exploiting admission quotas have been used by Jackson (2009) in Trinidad and Tobago, Clark (2008) in the UK, Pop-Eleches and Urquiola in Romania (2008), and De Hoop (2010) in Malawi. However, even within this set of studies that use credible research designs, there is very mixed evidence of the impact of attending a better quality school. Jackson (2009) and Pop-Eleches and Urquiola (2008) find that students who attend better schools obtain higher test scores, whereas Clark (2008) and De Hoop (2010) find no effect of selective school attendance on test scores. Of this group,

our paper is the first to combine the exact assignment rule, more than one effective score threshold within a school, and the entire universe of students, schools, and test scores in a country.

Our study builds on the prior papers examining the returns to selective schooling and provides more complementary evidence to the debate on the impacts of selective schooling. We obtain credible estimates of the effects of school quality on student achievement through a regression discontinuity approach. In a small interval around the cutoff, the students will be essentially identical, hence we can more credibly attribute any differences in outcomes to differences in school placement. Given the presence of multiple discontinuities across multiple districts, we pay particular attention to heterogeneous treatment effects of attending a selective school. Our estimates indicate that attending better schools is neither associated with an improvement in the probability of timely progression through secondary school nor academic achievement.

2 Secondary Education in Kenya

2.1 Background

Upon completion of eight years of primary school, students in Kenya take the Kenya Certificate of Primary Education exam (KCPE) and can continue their education with four years of secondary school.¹ In 2004, almost 655 thousand students graduated from the approximately 21 thousand primary schools. Four years later in 2008, 35 percent of this cohort

¹Along with the KCPE/KCSE system a parallel system of private schools whose curriculum culminates in an International General Certificate of Secondary Education (IGCSE). These private schools cater to international students and are a separate system from the KCPE/KCSE schools. Students in such schools do not appear in our data.

graduated from one of 5158 secondary schools. Across all grades the 2004 secondary gross enrollment rate was 48 percent with a 40 percent net enrollment rate (World Bank, 2004).

Kenya has three tiers of government secondary schools. The elite government schools, National Schools, are the most prestigious secondary schools in the country. These eighteen single sex boarding schools admit approximately 3000 of the top primary school candidates from across the nation.² Relative to other schools, they have better facilities, offer a larger variety of courses, and provide a higher quality peer group. The almost 1000 Provincial Schools, the second tier, admit the top 80,000 remaining students from within a province. The approximately 3000 District Schools, the bottom tier, draw students from the district who could not gain admission into national or provincial schools. Over 100 thousand students graduated from District Schools in 2008. For students who opt out of government schools but wish to continue their education, Private Schools follow the same curriculum and utilize the same teaching materials as public schools. The quality of private schools varies. Although there are some elite private schools, in general the schools are of lower quality than the National and Provincial Schools. In 2008 only 12 percent of secondary school graduates graduated from the 859 private schools.

A newsletter published by the Nomadic Kenyan Children's Education Fund (NKCEF) vividly described the differences between the three tiers of government schools (NKCEF, 2004). The described District boarding school had electricity only in the administration building, and students had to use their own kerosene lanterns to study in the evening. Each dorm room housed 18 students, the whole dorm shared one sink and one latrine, and

²Six government schools cater to students with physical, visual, or auditory disabilities. Even though these schools admit students from the entire country, we do not consider these schools in the National School category.

students provided their own dishes in the dining room. The school library had older books and newspapers and a rudimentary computer lab with six donated computers that ran on a generator. The newsletter further described a Provincial school in the same community as one with similar physical facilities to the District school but with a greater number of buildings having electricity. According to the NGO, the Provincial School had 820 students and 34 teachers, 24 of whom were university graduates. The newsletter finally described a National School as one that “[i]n stark contrast to the District and Provincial schools, ... boasts a large, bright dining hall and assembly building, faculty housing, a computer center and a several-storied library with large plate glass windows” (NKCEF, 2004). These descriptions capture the vast differences in quality of education across tiers, but substantial variation in school quality and facilities exist within the Provincial and District School tiers.

Schools also differ in the breadth of the curriculum offered and qualification of teachers. While there are 30 subjects in the national curriculum, most schools offer fewer than 12 subjects due to the high cost of acquiring the facilities and instructors. The National Schools offer an average of sixteen subjects, the average Provincial School offers about twelve subjects, and District and Private schools each offer about eleven subjects. Almost all National Schools offer computer studies, French, and German while few Provincial or District schools offer these classes. In National Schools, 80 percent of teachers have degrees beyond secondary school, compared with 68 percent in other schools. National School teachers are twice as likely to hold advanced degrees and have on average one additional year of teaching experience.

The 2003 Ministry of Education guidelines stipulated that tuition and boarding fees at

National Schools be 26,900 Ksh, while the fees at Provincial Schools were set at 20,900 Ksh.³ However schools continue to charge fees far in excess of these guidelines. In 2008, a National School in Nairobi charged about 70,000 Ksh, while a Provincial school charged 50,000 Ksh which is almost triple the amount set by the government. National Schools receive more funds from the government than Provincial Schools, but we do not have data on government expenditures to these schools to assess the size of these differences.

Timely progression through secondary school should take four years (Forms 1 - 4). At the conclusion of secondary school students in all school tiers take the Kenya Certificate of Secondary Education examination (KCSE). Students take seven to nine subject exams out of the 30 possible examination subjects. English, Swahili and Math are compulsory subjects as are at least two sciences, one humanity, and one practical subject.⁴ The maximum score on the KCSE is twelve points. A student score is the average of the compulsory subjects, the top two science scores, the top humanities score, and the top practical score. All seven scores are counted if a student only takes seven exams. The lowest two subject scores, conditional on fulfilling requirements, are not counted towards the overall KCSE score for students who take exams in nine subjects. Admission to universities is based on performance in this examination. Students scoring above a C+ (7 out of 12) can gain admission to the public universities, however due to increasing demand for limited university places, students now need a B+ (10 out of 12) average to be certain of admission and certain university subjects (e.g. pre-medicine) have even higher requirements. The KCSE score is also important for students who do not aspire to a university degree. Some job advertisements require a

³This translates to approximately \$360 in National Schools and \$280 in Provincial schools.

⁴Sciences include Biology, Physics or Chemistry. Humanities include Geography, History and Religious Studies. Practical subjects include Computer Studies, Commerce, Art and Design, Home Science, Carpentry, Metalwork, Music, Accounting, French, Arabic and German among others.

minimum KCSE score in order to apply.

2.2 Selection into Secondary Schools

Students are admitted to secondary school based on their scores on the KCPE, preferences, and district quotas. Each National School has a district quota – a set number of students that will be offered a place from each district.⁵ When students sit for the KCPE at the conclusion of primary school they rank their top two National School and top two Provincial School choices. Once the exams have been scored, students are ranked within a district. The highest ranked student receives his first choice of schools and the selection continues down the ranked students, filling the district quota for each National and Provincial School. If a student's preferred National Schools are full, then he is admitted to a preferred Provincial School (if those schools still have space) even if other National Schools had space remaining.

Students are notified of their school placement prior to the start of the school year in January. Some students who are unhappy with their placement directly apply to an alternative school and are admitted at the discretion of the head of the school, provided that there are available places. A place in a school is open to a direct applicant only if a student who was admitted to the school does not matriculate at the start of the school year.

⁵After gaining independence from the United Kingdom in 1963, the Kenya Commission on Education promoted the use of secondary schools as vehicles to promote national unity. Instead of adopting the Commission's proposal of a uniform quota system throughout the country, whereby each secondary boarding school would have at least twenty percent of its student body from other regions, the Government instituted the three tiered system with admissions based on merit and region (Gould, 1973).

3 Empirical Strategy

We use a regression discontinuity design (RD) framework to exploit the Ministry of Education’s secondary school admissions policy. If students were placed randomly into schools, then we could estimate the treatment effect of attending a National school as follows:

$$Y = \alpha + \beta T + \varepsilon \tag{1}$$

Where Y is the outcome variable, in this case high school test scores and probability of graduation, T is a binary variable that indicates if the student was subject to the treatment, attending a National School, and ε is the idiosyncratic error. Because students are granted places in National Schools based on their KCPE scores, better students attend better schools. This will cause T and ε to be correlated, and the OLS estimates of Equation (1) will produce biased estimates of $\hat{\beta}$, the treatment effect. However, we can exploit the admissions policy to circumvent this issue. We know that the rule based admission into a particular school conditional on stated preferences is based on the KCPE score. Students are accepted by a National School if the quota of one of a student’s preferred schools has not been filled by students with higher KCPE scores. The score of the lowest scoring student admitted from a district creates the effective KCPE score cutoff for that district-school pair. Students are admitted to a National School if their score is above the cutoff such that

$$N = 1 \text{ if } KCPE > c \tag{2}$$

0 otherwise

Where N is a binary variable indicating receipt of a place in a National school, $KCPE$ is the primary school test score, and c is the cutoff score. Actual attendance at a National school is going to be a function of N such that

$$T = \delta N + f(KCPE - c) + \nu \quad (3)$$

where $f(KCPE - c)$ is a smooth function of the assignment variable, $KCPE$, minus the cutoff score, c . Since National School attendance is partly determined by a discontinuous function of test scores, we can employ a discontinuity design to estimate the treatment effect of attending a National School. In the traditional application of regression discontinuity also known as the sharp RD design, the assignment of treatment status is completely deterministic (Van Der Klaauw, 2001). However, in our application there was not perfect compliance with the treatment rule. Some students whose scores qualify them for a National School chose not to attend. At the start of the school year unclaimed spots were allocated at the discretion of the school to students who directly expressed their interest to the school. Therefore, some students whose scores were below the cutoff attended a National School. Instead of a sharp regression discontinuity of $\Pr(T = 1|KCPE > c) = 1$ we have $\lim_{\eta \downarrow 0} \Pr(T = 1|KCPE = c + \eta) > \lim_{\eta \uparrow 0} \Pr(T = 1|KCPE = c + \eta)$. This design, known as the “fuzzy regression-discontinuity” was explicitly cast into an instrumental variable framework by Van der Klaauw (2001) and implemented by Angrist and Lavy (1999). Following Angrist and Lavy (1999), we can estimate the “fuzzy regression-discontinuity” using the discontinuity in the National School offer as an instrument for attending a National School. We provide a graphical representation of the data and test for the discontinuity at the cutoff by estimating

Equation (3). We define $f(KCPE - c)$ as a piecewise 4th order polynomial that can vary on either side of the discontinuity.⁶

In order to remove concerns of endogeneity inherent in the OLS specification of Equation (1), we use Equation (3) as an instrument for T in Equation (1). The IV estimate of $\hat{\beta}$ is equivalent to the ratio of the effect of being admitted to a National school from the reduced form regression ($\hat{\gamma}$ from $Y = \gamma N + g(KCPE - c) + u$) over $\hat{\delta}$ from Equation (3).

The identification assumption is that as the region around the discontinuity gets smaller the individuals above and below the cutoff are essentially identical at the start of secondary school. Thus we would expect that in the absence of differential treatment, these students would have similar outcomes at the conclusion of secondary school. We do not find any discontinuities in the baseline characteristics that might indicate a violation of our identification assumption.

4 Data

Our data are administrative records provided by the Kenya National Examination Council. For the universe of students who took the KCPE in 2004 we have students' stated school preferences, KCPE scores, sex, district, and primary school type. We link these data at the student level to the universe of students who took the KCSE in 2008. The KCSE records contain each student's composite and subject KCSE scores and school in which the student was enrolled at the time of the exam. We are able to link these data because candidates registering for the KCSE are required to provide prior registration information (candidate

⁶Formally, $f(KCPE - c) = \lambda_0 + \lambda_1(KCPE - c) + \lambda_2(KCPE - c)^2 + \lambda_3(KCPE - c)^3 + \lambda_4(KCPE - c)^4 + N(\lambda_5(KCPE - c) + \lambda_6(KCPE - c)^2 + \lambda_7(KCPE - c)^3 + \lambda_8(KCPE - c)^4)$.

number and year of exam) for the last examination they took (if any).⁷ Table 1 contains summary statistics by school type.

Additionally we have the Ministry of Education district level quotas for each National School and the top Provincial Schools for 2004. From these data, preferences, and test scores, we create the rule based secondary school assignment for each student who took the KCPE. The effective cutoff for each district-school pair is the KCPE score of the student with the lowest KCPE score admitted to a given school from a particular district. Effective cutoffs for National Schools range from 234 to 467 points with a mean of 419 and median of 425.

We want to consider all students whose KCPE scores and preferences place them close to a National or Provincial School cutoff. Since students provide two choices of each school type, a single student could be within a narrow band of two schools. To allow this student to act as a control for both schools, we duplicate observations for each student who is not assigned to the higher tier school, with each observation acting as a control for a separate school-district pair.

As we only observe students in 2004 and 2008, we do not observe the initial school to which students matriculated, only the school from which they graduated (if they graduated). Transferring between schools of the same type will not affect our results. Differential attrition by school type is also a concern (i.e. selection into the test). We provide evidence that this does not appear to be occurring in a differential manner among students around the cutoff for National Schools but does happen for students around the Provincial School cutoff.

⁷Of the students who took the KCSE in 2008 we are able to match 97% to their KCPE scores.

5 Results

5.1 National Schools

Admissions

Figure 1 presents the probability of graduation from a National School as a function of KCPE score minus the effective cutoff ($KCPE - c$). The score threshold faced by each student varies with stated school preferences and home district. The figure shows that students who score exactly at the threshold (i.e. $KCPE - c = 0$) are approximately forty percentage points more likely to graduate from a National School than students whose scores are one point below the threshold (i.e. $KCPE - c = -1$). The data displayed are one point bins (the smallest possible bin size given the integer nature of the KCPE data) with a bandwidth of 34 points, one half of a standard deviation. The curved lines represent the predicted probability of graduation from a National School estimated by specifying $f(KCPE - c)$ in Equation (3) as a piecewise fourth order polynomial with a break at $KCPE = c$.

Columns (1) and (2) of Table 2 provide estimates of Equation (3), confirming the statistical significance of the sharp discontinuity seen in Figure 1. The table provides two alternative estimations. Column (1) has a relatively wide bandwidth (one half of a standard deviation) and uses a piecewise fourth order polynomial as $f(KCPE - c)$. Column (2) uses a narrower bandwidth (one eighth of a standard deviation) with a piecewise linear function as $f(KCPE - c)$. In both cases the effect of qualifying for a National School has a positive and significant effect of about 30 percentage points on the probability that a student graduates from National School.

The sharp discontinuity in Figure 1 and statistically significant results in Table 2 indicate

that the assignment rule for National Schools is followed. However, compliance with the rule is not 100%. Students who qualify for a National School could fail to matriculate or drop out prior to completion. Similarly, some students who did not qualify for a National School based on their scores could have appealed directly to a National School in order to gain admittance. The high degree of compliance allows us to use the assignment rule as an instrument for potentially endogenous National School graduation in the analysis below.

Timely Progression

A student who progresses through secondary school on pace would complete it in four years. In Figure 2 we present the raw data on the probability of graduating from secondary school four years after taking the KCPE as a function of a student's score relative to the score threshold. The figure is weakly suggestive of a discontinuity at the threshold. To test for the statistical significance of a break, we estimate Equation (3) with graduation from any secondary school as the dependent variable. Columns (2) and (3) of Table 2 contain the estimation of this equation, the fitted line in Figure 2, along with further estimations using a narrower bandwidth and fewer polynomial degrees. The estimations provide no evidence of a differential probability of graduation from secondary school in a timely manner for students around the National School cutoffs.

Achievement

At the conclusion of secondary school, all students take the KCSE. Figure 3 presents the relationship between being admitted to a National School and the standardized KCSE score. The point estimates for the fourth order polynomial displayed suggests a small positive effect of National School admission on eventual KCSE score.⁸ Table 3 contains a number of

⁸As discussed above, we found that the probability of graduation from secondary school did not differ

estimations to directly test the significance of this potential effect. Columns (1)-(3) contain an OLS specification of Equation (1), additionally controlling for KCPE score and district, sex, public primary school, and school choice dummy variables. When estimated over the full sample (column (1)), graduating from a National School is associated with an increase in the KCSE score of 30 percent of a standard deviation. Once the sample is limited to more similar students, the point estimates decrease substantially and are no longer statistically significant (columns (2) and (3)). Columns (3) and (4) contain the reduced form estimation of the effect of being admitted to a National School on KCSE score. Even at the relatively wide bandwidth of one half of a standard deviation, 34 points, being admitted to a National School has no statistically significant effect on KCSE score. The effect is similarly insignificant at the eight point bandwidth. Columns (6) and (7) use an instrumental variables approach with the rule based admission to a National School as an instrument for graduating from a National School, equivalent to substituting Equation (3) into Equation (1). Across both bandwidths and polynomial orders National Schools do not have a statistically significant effect on KCSE scores. A similar exercise with individual and composite scores for the core subjects (Math, Swahili, and English) yields similarly insignificant point estimates (results available upon request).

One of the ways in which our paper is unique is that we have multiple effective thresholds within the same school. Students of varied initial ability are combined into the same school based on the different thresholds for each district. Figure 4 displays this heterogeneity. A common critique of other RD papers in education is that the teachers in an elite school are

around the National School cutoff. This alleviates concerns about selection into taking the KCSE exam around the cutoff.

probably not teaching to the student who was barely admitted to the school, but instead to a student whose scores are closer to the median. In our setting we are able to test whether students are differentially effected by the treatment of a National School based on their KCPE scores. The KCPE point range within one school can be as much as 233 points. We provide two tests for a differential effect. First, we interact the dummy variable for being assigned to a National School with a student's standardized KCPE score and use this interaction as an instrument for the interaction of the standardized KCPE score and graduating from a National School. Second we interact a dummy variable for having a KCPE score above the median within a school with being admitted to a National School as an instrument for the same dummy interacted with graduating from a National School. Table 4 columns (1)-(4) presents these results. Across all specifications, the interaction effect is negative and statistically insignificant. A negative point estimate indicates that students with relatively lower KCPE scores (or the lower half of the within school distribution) gain more from being admitted to a National School. Because of the imprecision of the estimates, we cannot reject that the effect is the same for students of all absolute and relative abilities.

Effects may also differ by sex or socioeconomic status. Columns (5)-(8) test for this heterogeneity and find none.

Discussion

One possible reason for the lack of statistically significant outcomes could be that the students who are within one half of a standard deviation of a National School are extremely high achieving and would excel regardless of the schooling environment. Figure 4 displays the raw scores of the students who are within this score range. The average KCPE score is 246 points for all primary school graduates and 288 for all secondary school graduates. The

students within the relevant bandwidth are all above average, and in almost all cases at least one standard deviation above average with many students scoring more than two standard deviations above average.

An alternative explanation is that students who are within 34 points of a national school attend provincial schools that are of similar quality to national schools. Unfortunately, we do not have expenditure or other resource data for each school. Since students with higher KCPE schools are admitted to schools before their lower scoring peers, we can use the average KCPE score of students who attend a given school as a proxy for perceived school quality. Of the 943 provincial schools in the country, 521 of them have at least one student whose KCPE score was within 34 points of a national school. The average KCPE score for students who graduate from a provincial school is 322.5. For students who graduate from a provincial school with at least one graduate within 34 points of the national school regression discontinuity, the overall average KCPE score is 337.3, twenty percent of a standard deviation higher, but still well below the average KCPE score of students who graduate from national schools (414.4). For provincial schools with more than one graduate within 34 points of the national school RD, the average KCPE score was 351.8. Further work will omit the students from both sides of the discontinuity who selected the most elite provincial schools.

5.2 Top Provincial Schools

Provincial Schools admit students based on quotas and the same algorithms as National Schools. Due to limited data on Provincial School quotas, we are only able to analyze a

subset of the Provincial Schools, the 567 out of 943 that have at least some boarding students. These schools represent 78% of all stated provincial school preferences in the country, and in some provinces the coverage is over 90%. When ranked by popularity of stated preferences, we have quotas for 86% of the schools that were ranked by more than 5% of the students in a province and 80% of the top 10 schools in each province. We consider these schools the top provincial schools in the country.

As with the national schools, we implement the assignment algorithm to determine the rule based admission of each student. The score of the last student assigned to a provincial school from a particular district is the effective cutoff for that district-school pair.

Admissions

Figure 6 presents the probability of graduating from a top provincial school based on ones KCPE score relative to the cutoff for a particular district-school ($KCPE - c$). Each point is the average of one point score bins. The smoothed lines are fourth order polynomials, allowed to vary discontinuously at $KCPE = c$. At the expected place of the discontinuity ($KCPE - c = 0$), there appears to be a sharp increase in the probability of graduating from a top provincial school. The overall ability of the rule base assignment to correctly predict who will graduate from a top provincial school is quite low. Even on the right side of the discontinuity, at most 35 percent of the students who we think were admitted to top provincial schools actually graduate from top provincial schools. Based on the point estimates of the smoothed lines, the jump in probability of top provincial school graduation is approximately 0.02, or 2 percentage points more likely. Table 5 columns (1) and (2) contain the estimates of the change in probability of graduating from a top provincial school for those students were admitted to a top provincial school. For the 34 point bandwidth

and same polynomial order as in Figure 4, students who should have qualified for a top provincial school have a higher probability of graduating from such a school, confirming the visual discontinuity in Figure 4. Column (2) presents the coefficient from a piecewise linear estimation over a smaller bandwidth. The coefficient is of smaller magnitude, and no longer statistically significant.

The point estimates in columns (1) and (2) are of much smaller magnitude than was the case in the estimation for the National School discontinuity, with an increased probability of graduation from a top provincial school of only 1.59 percentage points in column (1) and 0.91 percentage points in column (2). These small magnitudes could reflect institutional factors or limitations of our current data. First, fewer students at the top provincial school discontinuity graduate from any secondary school (62%) than at the national school discontinuity (93%). Second, because there are 32 times more top provincial schools than national schools, the scope for students being admitted outside the rule based allocation is greater. Third, even though we have excellent data coverage for the top provincial schools that students choose, having a boarding component does not necessarily make a school excellent, and students might switch to a non-boarding provincial school that we do not observe. Fourth, because of the structure of the rule based assignment our not having a quota for a single popular school would offset assignment for the entire district.⁹

Unfortunately, because of the small t-statistics associated with the coefficient of interest, the rule based admissions to a top provincial school is too weak of an instrument to use to estimate the effect of these provincial schools on student achievement.

⁹ The district for which we have the worst coverage of top preference ranked provincial schools in Nairobi. When we re-estimate columns (1) and (2) of Table 5 without Nairobi, the results are similar (available upon request).

Timely Progression

Columns (3) and (4) of Table 5 present the effect of being admitted to a top provincial school on the probability of timely graduation from any secondary school. Top provincial schools seems to exert a negative and statistically significant effect on timely progression, with students admitted to top provincial schools approximately two percentage points less likely to graduate secondary school in four years. A number of factors could contribute to this negative result. First, students with scores near the top provincial school thresholds might find such schools too challenging and either drop out or take an additional year to complete while similar students in lower quality schools (where expectations are lower) might have no trouble. Second, lower quality schools might have easier standards for passing each grade. Third, higher quality schools might discourage unprepared students from taking the KCSE in order to retain their status as more desirable schools.

6 Robustness Checks

One potential concern with any regression discontinuity is manipulation of the assignment around the threshold. We think this is unlikely to have occurred in our setting for a number of reasons. First, all exams are graded centrally and the graders do not know the students. Second, the graders do not have access to the student preferences about schools. Finally, each threshold is district and school specific and dependent on all other scores in the district in a given year. Figure 7 provides additional evidence about the validity of our regression discontinuity design. The first frame provides the number of students who score in each one point score bin. As expected there is no break as the threshold is approached from above

or below. The number of students who score exactly at the threshold ($KCPE - c = 0$) is substantially larger than those who score one point below and above. This spike is due to the design of the threshold. By assigning the lowest student score in each district-school pair to serve as the threshold, there are at least 1,260 students who score exactly at the threshold (18 schools times 70 districts). The next higher (or lower) student in a district could have a score that is only one point different or the next score might be many points away from the threshold, thus the number of students in each point above and below the threshold is smaller than 1,260.

Unfortunately, we only have limited demographic data on students. Frame 2 displays the percent of students who are male. Frame 3 shows the percent of students who graduated from a public primary school, an approximation of socioeconomic status since richer students are more likely to attend private primary schools. Neither variable display a discontinuity around the threshold. Both measures become noisier for the scores that are more than 25 points above the threshold because of the small sample size for those scores.

Even though our empirical strategy passes the typical concerns about a regression discontinuity, one still might be concerned that students who are better informed or are more adept at gaming the system, while unable to exactly manipulate their admission to a national school, might be better at getting themselves “close” to a school. For example, a better informed student might be able to choose schools to list as preferences to maximize the chance of national school admission. We cannot perfectly observe such behavior. Instead, we can approximate who was admitted to a national school because they choose well by comparing students admitted to National Schools under the preference based rules to those who would

have been admitted based on the KCPE score alone.¹⁰ Twenty-three percent of girls and 25 percent of the boys who were admitted to National Schools based on the rules based assignment would not have admitted under a score-only system. These students (and others who were not admitted but were able to get themselves within a small point range of the effective point of discontinuity) could be better informed than other students. Therefore, while internally valid, our estimates might be on a selected, “well informed” sample. To address this concern, we use an alternative instrumental variables approach that does not rely on stated preferences.

An alternative way to solve the endogeneity problem in Equation (1) is to instrument for T with the inverse of a student’s rank. After controlling for KCPE score and district fixed effects, a student’s rank should not affect his KCSE score, except through selection into a National School. Formally, the in the first stage we estimate

$$T = \phi_0 + \phi_1 \frac{1}{rank} + \phi_2 KCPE + X'\Phi + \mu \quad (4)$$

as a linear probability model where $rank$ is an individual’s within district-gender rank for district and X includes dummy variables for gender, public primary school, district, and stated preferences, with other notation as above. The second stage is then

$$Y = \theta_0 + \theta_1 \hat{T} + \theta_2 KCPE + X'\Theta + \varpi \quad (5)$$

¹⁰For example, 10 girls are admitted to National Schools from Busia district, but because of stated student preferences for schools and school specific quotas, the top 10 girls from the district are not necessarily the ones admitted. In our sample, girls ranked 1-9 and 15 were admitted to National Schools based on the admissions rule.

using the predicted value of T , \widehat{T} from the preceding equation. This methodology alleviates concerns of students being able to select into the regression sample by being “well informed.”

If the regression discontinuity samples were selected on some margin, then one might see different results with this strategy in which the sample is determined exclusively by district-gender rank. For each of the outcomes of interest we estimate the model over four different samples. The full sample estimations provide the global estimates, but include many students who are very different than the students considered in the regression discontinuity estimations and whose scores are much lower than those required to gain admittance to a National School. For each district we calculate the total district-gender quota as the sum of the National School quotas for each district-gender pair and limit the sample to students whose ranks are within two and three times this district-gender quota to estimate the model over more similar students, all of whom were relatively close to gaining admission to a National School. The fourth sample is over the same students who appear in the 34 point bandwidth in the regression discontinuity estimates to provide an exact comparison to the above estimates.

Table 6 contains the point estimates from this exercise on the three outcomes of interest. The findings are similar to the regression discontinuity design. Columns (1) - (4) show that $\frac{1}{rank}$ does predict the probability of graduation from National School for all samples considered. From columns (5) - (8) there does not appear to be an effect on timely graduation. And finally, this alternative estimation does not provide evidence that there is a statistically significant effect of graduating from a National School on ones KCSE score.

7 Conclusions

This paper exploits the centralized system of placing students into public secondary schools to estimate the effect of school type on student academic achievement. The institutional features are such that school type and school quality are invariably linked. This enables us to estimate the effect of a broad measure of school quality on student outcomes. Using a regression discontinuity design we find that students who are admitted to National Schools (the most elite in Kenya) are no more likely to graduate from secondary school than their peers who are not admitted. Further, we find no statistically significant difference between student scores on the secondary school exit exam for students in National versus other schools. Using the same design for Provincial Schools, we find students are less likely to graduate from secondary school in four years.

Parents and students in Kenya highly value graduating from National Schools as evidenced by the prices they are willing to pay and prestige associated with the graduates, and yet we found no measurable effect of these higher quality schools on achievement. A possible explanation is that the better inputs found in National Schools are not being utilized efficiently, for example if teacher absence was high across all school types. These results could also indicate that inputs such as better teachers and peers have no impact on test scores. However, it should be noted that the majority of the students at the margin of National School thresholds have primary school test scores that are two standard deviations above the mean. Thus, these results are limited to the impacts of school quality on high ability students, which are likely different than the impacts of school quality on students who are closer to the nationwide average. Moreover, a secondary school test score is only one outcome

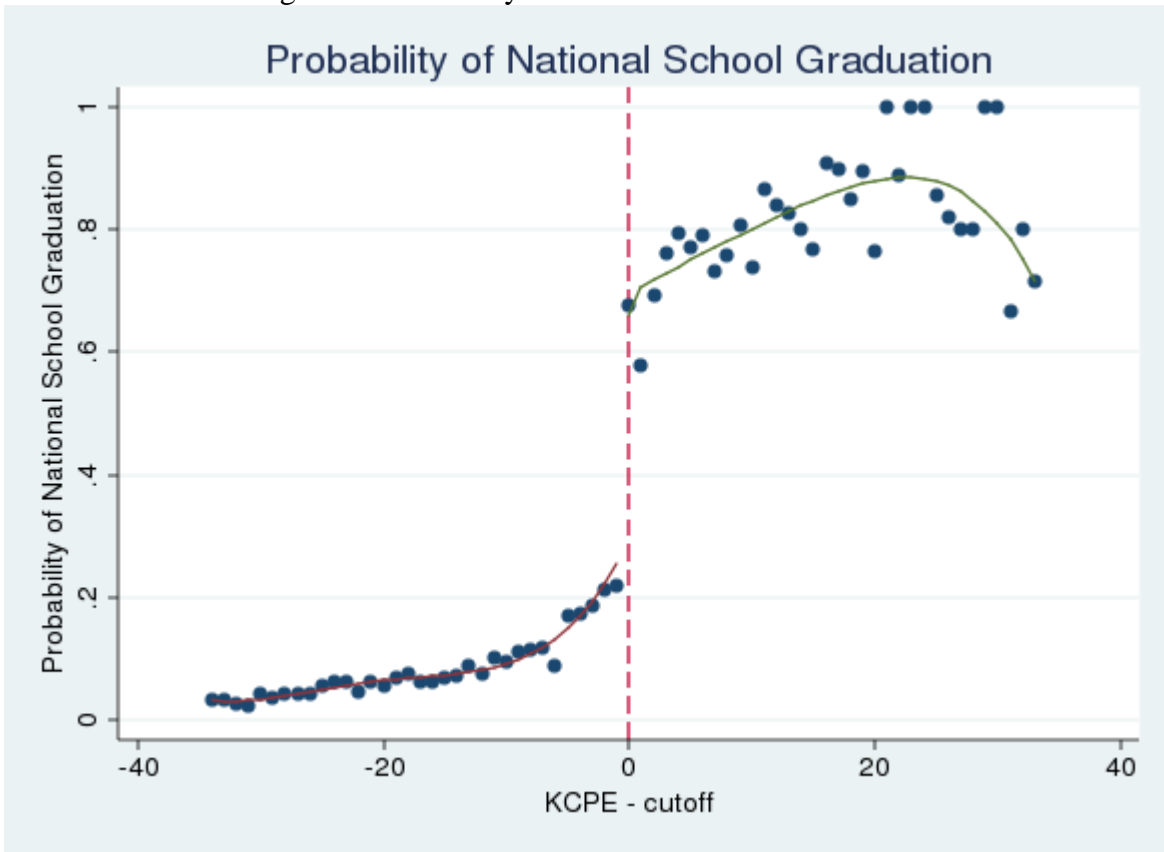
that could be valued. We are unable to measure the effect of a National School education on labor market outcomes such as career and income, nor can we measure the importance of signaling and networking that come with graduation from an elite school. These could be important factors that drive the demand for elite schools in Kenya.

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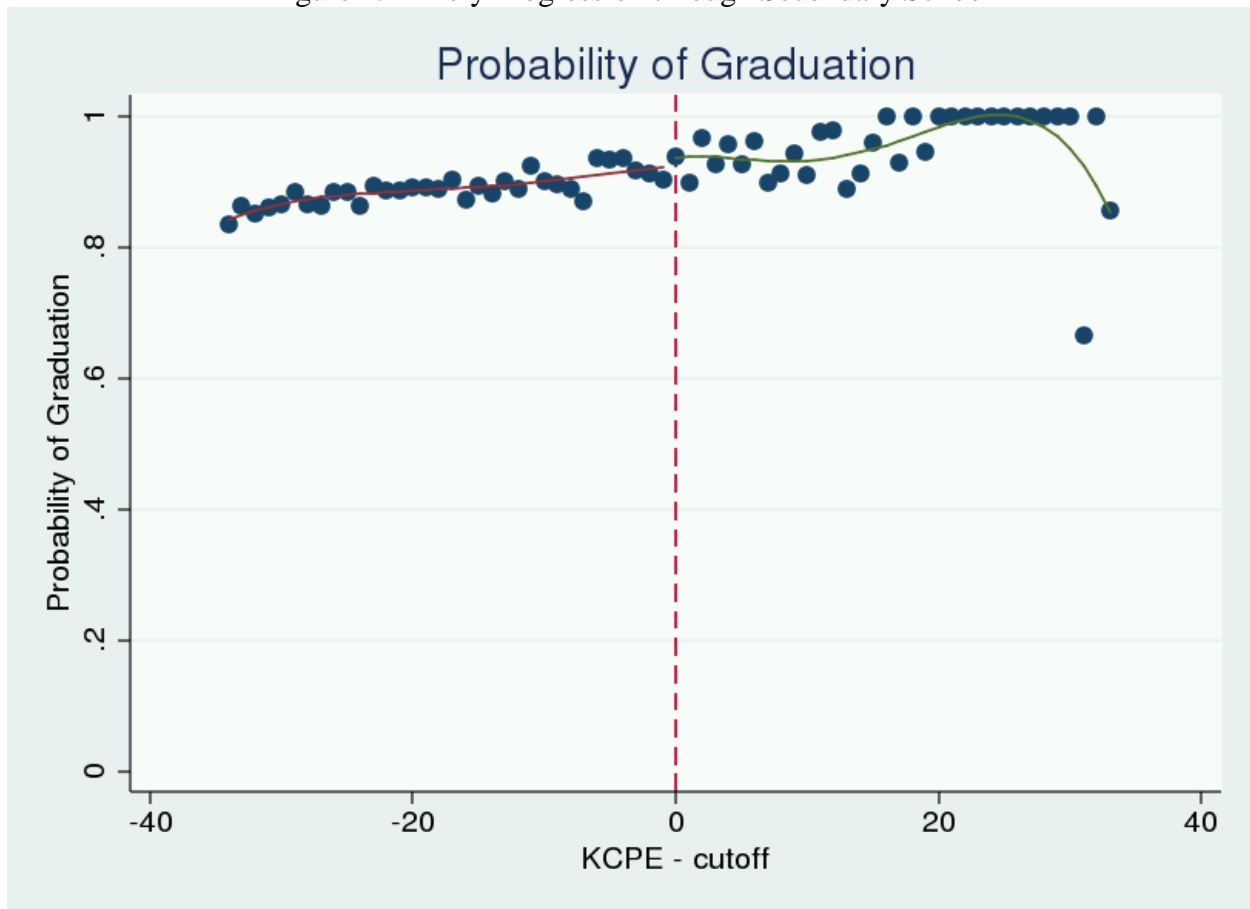
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Figure 1: Probability of National School Graduation



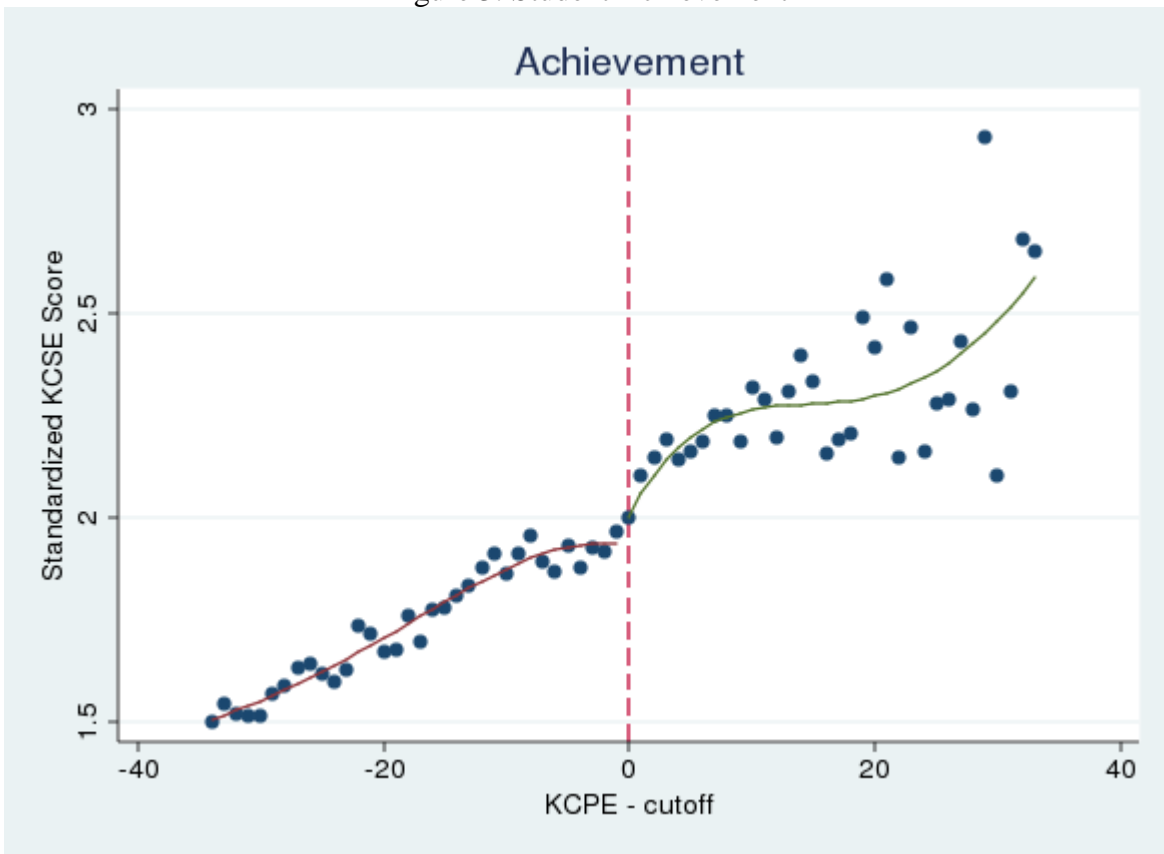
Note: “KCPE-cutoff” is the KCPE score minus the effective National School cutoff score. See text for details on the calculation of the cutoff. Each point is the mean of the probability of graduation from a National School within non-overlapping 1 point bins. The lines are fitted values from a fourth order polynomial, separately estimated on each side of the cutoff.

Figure 2: Timely Progression through Secondary School



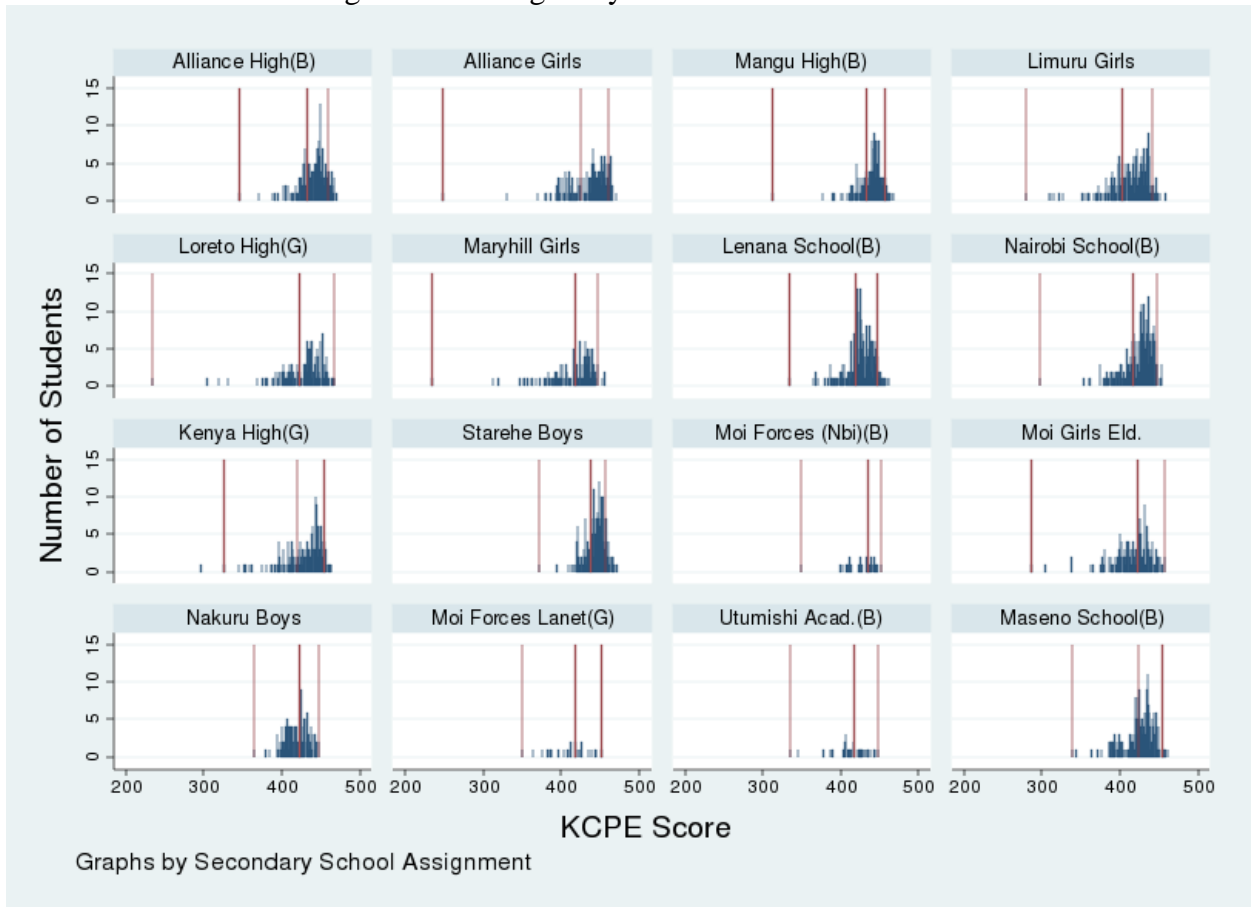
Note: "KCPE-cutoff" is the KCPE score minus the effective National School cutoff score. See text for details on the calculation of the cutoff. Each point is the mean of the probability of graduation from secondary school within four years of taking the KCPE within non-overlapping 1 point bins. The lines are fitted values from a fourth order polynomial, separately estimated on each side of the cutoff.

Figure 3: Student Achievement



Note: "KCPE-cutoff" is the KCPE score minus the effective National School cutoff score. See text for details on the calculation of the cutoff. Each point is the mean of the standardized KCSE score within non-overlapping 1 point bins. The lines are fitted values from a fourth order polynomial, separately estimated on each side of the cutoff.

Figure 4: Heterogeneity within National Schools



Notes: Each figure is the plot of the number of students admitted to each National School on the vertical axis and raw KCPE score on the horizontal axis. Within each school plot the left most vertical line is the minimum cutoff for the school (the score of the lowest student admitted to the school), the middle vertical line is the median district cutoff for the school, and the right vertical line is the maximum district cutoff for the school. Boys' schools are indicated as (B) and girls' schools are indicated by (G) if the gender of the school is not obvious from the name.

Figure 5: Raw KCPE Scores of Students near National School Threshold

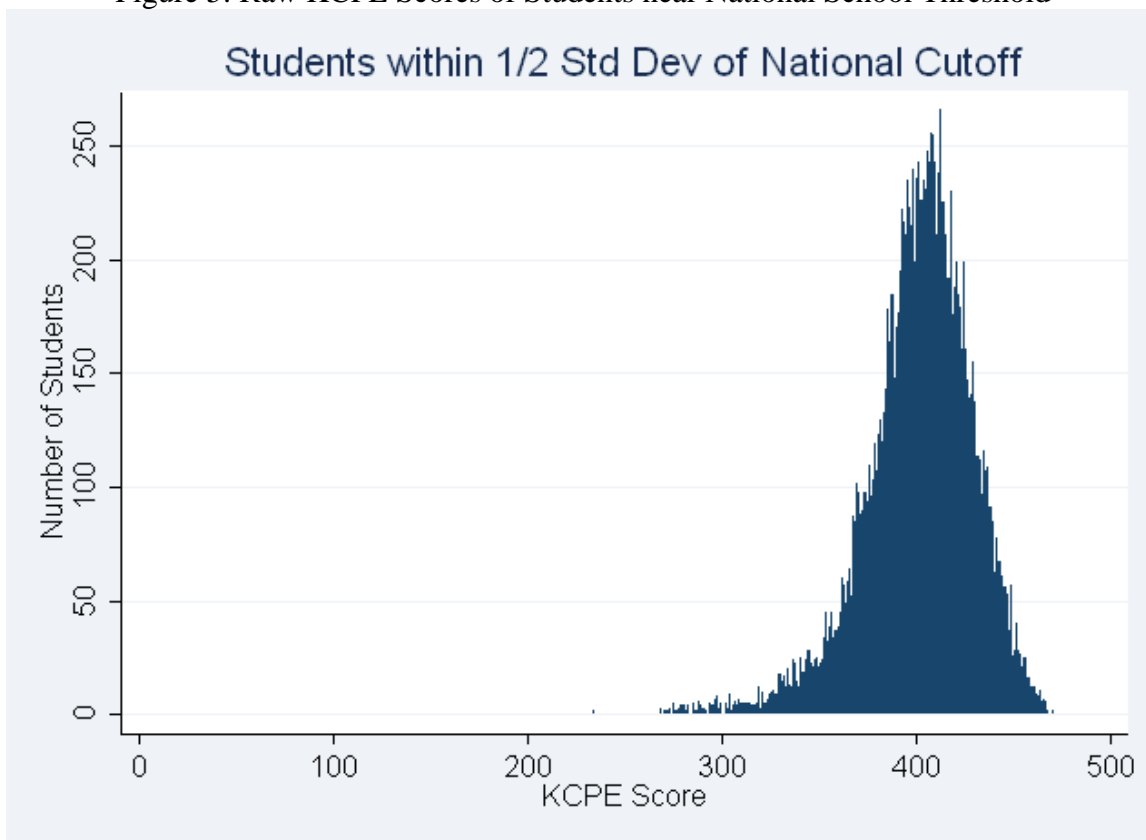
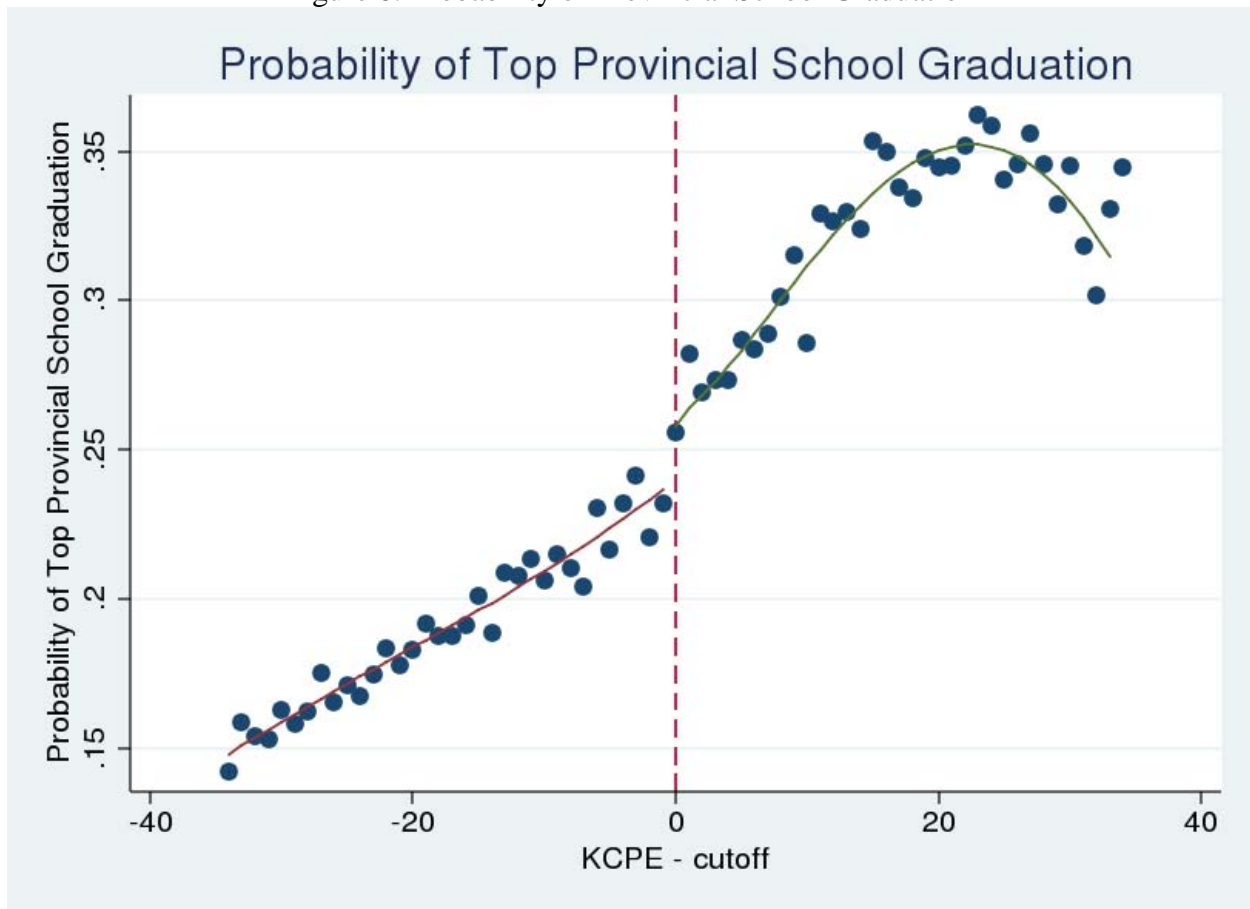
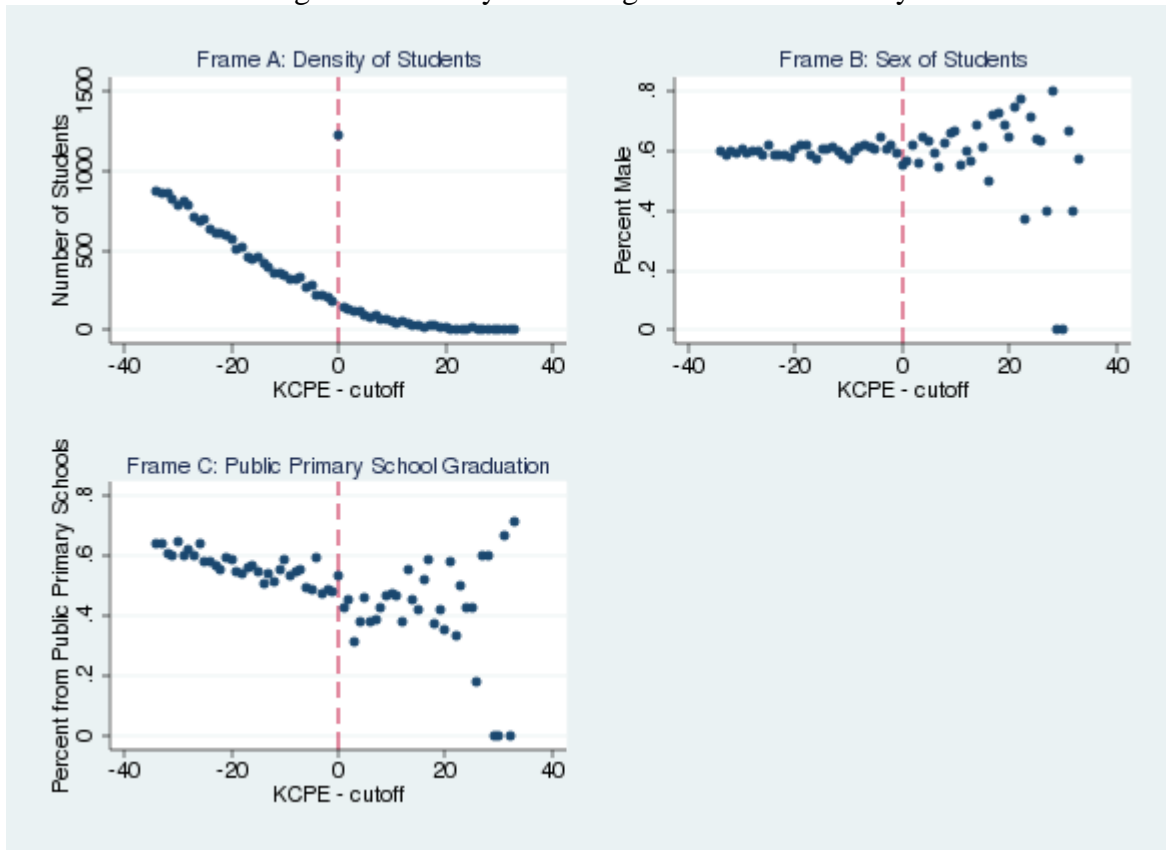


Figure 6: Probability of Provincial School Graduation



Note: “KCPE-cutoff” is the KCPE score minus the effective Provincial School cutoff score. See text for details on the calculation of the cutoff. Each point is the mean of the probability of graduation from a Provincial School within four years of taking the KCPE within non-overlapping 1 point bins. The lines are fitted values from a fourth order polynomial, separately estimated on each side of the cutoff.

Figure 7: Validity of the Regression Discontinuity



Note: “KCPE-cutoff” is the KCPE score minus the effective National School cutoff score. See text for details on the calculation of the cutoff. Frame B and C: Each point is the mean of y-axis variable within non-overlapping 1 point bins.

Table 1: Summary Statistics

	Primary School Graduates	Secondary School Graduates						
		All	National School	Provincial School	District School	Private School	Disability School	Unknown Type
Number of Students	651,647	229,503	3,100	79,394	115,435	28,578	309	2,687
Number of Schools		5,158	18	943	3,190	859	6	142
Average KCPE Score (out of 500)	246.0 (67.8)	288.4 (60.6)	414.4 (33.2)	322.5 (49.8)	266.0 (50.5)	273.7 (66.9)	331.7 (85.0)	251.1 (58.9)
Average KCSE Score (out of 12)		4.92 (2.4)	9.58 (1.79)	6.23 (2.3)	4.05 (1.9)	4.38 (2.6)	6.97 (3.1)	3.19 (1.9)
Average Number of Subject Tests Offered		11.0 (1.3)	16.4 (2.7)	12.2 (1.3)	10.8 (1.0)	10.9 (1.4)	12.5 (1.8)	10.1 (1.4)
Percent Male	51.7	52.6	56.0	53.7	53.0	48.2	49.5	48.6
Percent Graduating from Public Primary Schools	92.6	87.1	49.2	81.6	93.7	80.4	57.6	89.2

Notes: Standard deviations appear in parenthesis. Source: Calculations based on data provided by Kenya National Examination Council.

Table 2: Graduate from Secondary School Around the National Regression Discontinuity

Dependent Variable:	Graduate from National Secondary School		Graduate from Any Secondary School	
	(1)	(2)	(3)	(4)
Qualify for National School	0.336*** (0.0282)	0.294*** (0.0317)	0.0039 (0.0093)	-0.0021 (0.0208)
KCPE Score	0.00849*** (0.0009)	0.0044 (0.0031)	0.0005 (0.0010)	0.0036 (0.0023)
Bandwidth	34	8	34	8
Order of Polynomial	4	1	1	1
Observations	20,021	4,090	20,021	4,090
Rsquared	0.47	0.55	0.09	0.25

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors clustered at the district level appear in parentheses. Piecewise polynomial of KCPE score minus cutoff of order indicated also included. Sample limited to students within indicated bandwidth of cutoff. Additional controls: district, male, national school preferences, and public primary school dummy variables and interactions between school preference and district dummy variables.

Table 3: Achievement

	Dependent Variable: Standardized KCSE Score						
	OLS			Reduced Form		IV Estimation	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Graduate From National School	0.306*** (0.0244)	0.020 (0.0263)	0.0303 (0.0280)			0.0874 (0.1290)	0.1440 (0.1470)
Qualify for a National School				0.0300 (0.0442)	0.0439 (0.0449)		
KCPE Score	0.0131*** (0.0001)	0.0163*** (0.0006)	0.0145*** (0.0007)	0.0179*** (0.0057)	0.0072 (0.0121)	0.0171*** (0.0055)	0.0070 (0.0121)
Bandwidth	all	34	8	34	8	34	8
Order of Polynomial	0	0	0	4	1	4	1
Observations	213,267	12,668	3,509	17,704	3,757	17,704	3,757
Rsquared	0.64	0.30	0.28	0.32	0.46	0.32	0.46

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors clustered at the district level appear in parentheses. Additional controls: district, male, national school preferences, and public primary school dummy variables and interactions between school preference and district dummy variables. Columns (4) - (7): piecewise polynomial of KCPE score minus cutoff of order indicated also included, sample limited to students within indicated bandwidth of cutoff. Columns (6) and (7): instrument is being admitted to a National School.

Table 4: Heterogeneous Effects

	Dependent Variable: Standardized KCSE Score							
	Heterogeneous Effects							
	By Ability			By Sex		By SES		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Graduate From National School	0.408 (0.260)	0.707 (0.463)	0.195 (0.188)	0.258 (0.346)	0.129 (0.141)	0.185 (0.174)	0.101 (0.136)	0.119 (0.157)
Graduate From National School X Standardized KCPE Score	-0.126 (0.081)	-0.221 (0.168)						
Graduate From National School X High KCPE Score			-0.114 (0.139)	-0.121 (0.314)				
Graduate From National School X Female					-0.076 (0.053)	-0.0845 (0.104)		
Graduate From National School X Lower Socioeconomic Status							-0.0243 (0.046)	0.0471 (0.104)
Bandwidth	34	8	34	8	34	8	34	8
Order of Polynomial	4	1	4	1	4	1	4	1
Observations	17,704	3,757	17,704	3,757	17,704	3,757	17,704	3,757
Rsquared	0.32	0.46	0.322	0.46	0.321	0.458	0.322	0.459

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors clustered at the district level appear in parentheses. Additional controls as in columns (6) and (7) of Table 3. Columns (7) and (8): graduation from public primary school used as a proxy for lower socioeconomic status.

Table 5: Graduate from Secondary School Around the Provincial Regression Discontinuity

Dependent Variable:	Graduate from Top Provincial Secondary School		Graduate from Any Secondary School	
	(1)	(2)	(3)	(4)
Qualify for Top Provincial School	0.0159* (0.0095)	0.0091 (0.0068)	-0.0204* (0.0109)	-0.0156* (0.0086)
KCPE Score	0.00277*** (0.0001)	0.00259*** (0.0001)	0.00377*** (0.0001)	0.00369*** (0.0001)
Bandwidth	34	8	34	8
Order of Polynomial	4	1	4	1
Observations	134,505	36,442	134,505	36,442
Rsquared	0.22	0.24	0.20	0.21

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors clustered at the district level appear in parentheses. Piecewise polynomial of KCPE score minus cutoff of order indicated also included. Sample limited to students within indicated bandwidth of cutoff. Additional controls: district, male, school preferences, and public primary school dummy variables and interactions between school preference and district dummy variables.

Table 6: Rank as an Instrument for National School Graduation

Dependent Variable:	Graduate from National School				Graduate from Any Secondary School				Standardized KCSE Score			
	Sample:	National School Quota		34 Point Bandwidth	Full Sample	National School Quota		34 Point Bandwidth	Full Sample	National School Quota		34 Point Bandwidth
		Times Two	Times Three			Times Two	Times Three			Times Two	Times Three	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
One over within district rank	1.607*** (0.0401)	0.218*** (0.0775)	0.373*** (0.0678)	0.626*** (0.0388)	0.035 (0.044)	0.0164 (0.0213)	0.0109 (0.0223)	0.00792 (0.0210)				
Graduate From National School									0.605*** (0.0394)	-0.093 (0.3840)	0.00638 (0.2050)	-0.0335 (0.0943)
KCPE Score	0.0000833*** (0.00001)	0.0162*** (0.00161)	0.0137*** (0.00116)	0.00983*** (0.00045)	0.00338*** (0.0001)	0.00146*** (0.00031)	0.00165*** (0.00031)	0.00223*** (0.00023)	0.0130*** (0.0001)	0.0173** (0.0075)	0.0153*** (0.0038)	0.0170*** (0.0014)
Observations	601,903	5,323	7,977	14,137	601,903	5,323	7,977	14,137	214,879	4,899	7,255	12,454
Rsquared	0.24	0.28	0.31	0.34	0.25	0.04	0.03	0.04	0.637	0.264	0.275	0.291

Notes: * significant at 10%; ** significant at 5%; *** significant at 1%. Standard errors clustered at the district level appear in parentheses. Piecewise polynomial of KCPE score minus cutoff of order indicated also included. Sample limited to students within indicated bandwidth of cutoff. Additional controls: district, male, national school preferences, and public primary school dummy variables and interactions between school preference and district dummy variables. Columns (9) - (12): instrument for graduation with 1/rank.