School Choice and Educational Mobility: Lessons from Secondary School Applications in Ghana

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Abstract

A large number of school choice systems use merit-based assignment mechanisms in which students have incomplete information and constraints on the number of choices they can list. This paper empirically evaluates the link between school choice mechanisms and educational mobility using detailed administrative data from three cohorts of applicants to secondary school in Ghana, where standardized exams and a nationwide application process are used to allocate 350,000 elementary school students a year to 700 secondary schools. I find that students from lower-performing elementary schools apply and gain admission to less selective secondary schools than students from higher-performing elementary schools with the same exam scores. I demonstrate that this is partly because they are less likely to use sophisticated application strategies but also because of factors independent of the mechanism design. These results imply that mechanism design changes will have limited effects on educational mobility without targeted efforts to address fundamental inequalities in the school choice environment. *JEL*: D84, I21, I24.

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Centralized school choice systems ideally provide an opportunity for educational mobility: a student who begins her education at a low-performing school can choose to complete her education at a higher-performing school with the benefits of access to greater resources. Merit-based systems epitomize this prospect because a student's chances of gaining admission to a more selective school depend on her individual academic performance and not purely on luck or family background. Despite the promise that merit-based assignment holds, there has been limited research to establish what factors determine whether students are willing and able to navigate a school choice system in order to seize the opportunity to attend better schools.

This paper examines the effects of two common features of merit-based assignment mechanisms that potentially limit educational mobility. A large number of school choice systems use mechanisms in which students have incomplete information about their admission chances and constraints on the number of choices they can submit on their list. For example, Ghana has a centralized application system that uses standardized exams and a nationwide application process to allocate 350,000 elementary school students a year to 700 secondary schools based on a deferred acceptance algorithm. Students can only list a limited number of choices (currently six), and they must submit their choices before they know their exam scores. These features of constrained choice and incomplete information are surprisingly common.[1] A set of recent theoretical papers model the problem of constrained choice with incomplete information and show that these features severely complicate the decision facing students.[2] However, there is little understanding of how the effects of these features differ based on students' socio-economic backgrounds and scarce evidence on whether they limit the ability of high-achieving students to attend better schools.

This study extends the existing, largely theoretical, literature by explicitly linking mechanism design features to the issue of educational mobility and by empirically evaluating the consequences of constrained choice under uncertainty. I use detailed administrative data from three cohorts of secondary school applicants in Ghana to analyze application behavior and admission outcomes. I first classify elementary schools based on their median student

[1] Comparable merit-based systems are used for secondary school admission in other countries including Kenya, Romania, Trinidad and Tobago, and the UK, and for college entry in Canada, Mexico, Spain and Hungary. Students often apply to schools before knowing their exam scores or can only submit a fixed number of applications. Additionally, there are strong parallels between these contexts and the context of college choice in the US: students apply to a conservative number of schools because of application costs (both in terms of time and money); and students are relatively uncertain about their admission chances because admission is partly based on measures of students' academic performance which may be known at the time of applying (e.g. SAT/ACT scores and high school GPA), but also on assessments of other background information (such as personal statements, extracurricular activities and recommendation letters).

[2] See Nagypál (2004); Chade and Smith (2006); Chade, Lewis, and Smith (forthcoming); Haeringer and Klijn (2009); and Calsamiglia, Haeringer, and Klijn (2010).

performance on the standardized secondary school entrance exam and then compare the choices and admission outcomes of students with the same individual exam scores. Consistent with findings from several other settings, I observe that students from low-performing elementary schools in Ghana apply to less selective secondary schools than students from high-performing schools with the same exam scores (Figure 1).[3] As a result, students from low-performing elementary schools gain admission to less selective secondary schools, and schools with weaker academic performance. This difference in application behavior and admission outcomes is particularly striking because students from low-performing elementary schools go on to perform better in secondary school than their classmates who had the same entrance exam scores but attended high-performing elementary schools (Ajayi (2013)).[4] This indicates that the standardized entrance exam scores likely understate the true ability of students from low-performing schools and that the observed differences in application behavior would be even more extreme if we could compare students with the same raw ability.

Taking these differences in applications and admission outcomes as a point of departure, I empirically evaluate the possibility that constrained choice under uncertainty disadvantages students from lower performing backgrounds. I do this by first characterizing the optimal application strategy for students facing this school choice problem and then determining what types of students use the optimal strategy. Building on a model of optimal portfolio choice developed by Chade and Smith (2006), I show that the optimal portfolio satisfies three criteria: students should rank their listed choices in order of true preference; they should rank them in decreasing order of selectivity (with the most selective school listed first); and they should apply to a diversified portfolio of schools instead of a set of schools of equal selectivity. The last two criteria allow me to identify students who are well-informed and use sophisticated strategies, without needing to know their true underlying preferences.

Nonetheless, uncovering student preferences is critical to understanding the extent to which educational mobility can be explained by factors that are independent of the design of the assignment mechanism. I therefore formulate an approach for estimating student

[3] This phenomenon that high-achieving students from less privileged backgrounds do not apply to more selective schools is evident across various settings and has been particularly well-established with regard to college applications in the United States (Manski and Wise (1983); Avery and Kane (2004); Bowen, Chingos, and McPherson (2009); and Hoxby and Avery (2012) highlight this issue).

[4] Studies from a host of other contexts suggest that attending a more selective school may improve outcomes for high-achieving students. For examples studying the secondary school context, see: Clark (2010), Jackson (2010), Pop-Eleches and Urquiola (2013), and Lucas and Mbiti (forthcoming) on school quality effects in merit-based systems; Cullen, Jacob, and Levitt (2005), Cullen, Jacob, and Levitt (2006), Hastings, Kane, and Staiger (2008), Lavy (2010), and Deming (2011) on lottery-based systems; and Duflo, Dupas, and Kremer (2011) on the benefits of academic tracking. Recent studies on the effects of attending exam schools in the US have found limited benefits (Abdulkadiroğlu, Angrist, and Pathak (2011) and Dobbie and Fryer (2011)). However, students who apply to elite exam schools in the US likely differ from the broader populations participating in the nation-wide school choice systems evaluated in this paper and earlier studies.

preferences using choice data submitted in the presence of clear incentives for strategic behavior. Estimating preferences in this context is not a trivial exercise because students have strong incentives not to truthfully report their most preferred choices when they can only list a limited number of schools and are uncertain about their admission chances. I address the strategic misreporting of preferences by demonstrating that it is optimal for students to list their most preferred choices out of a set of schools of equal selectivity. Based on this insight, I use a discrete choice framework to estimate the probability that a student chooses a given school out of a set of schools in the same selectivity range and thus recover students' demand for a variety of school characteristics.

My results contribute to the literature on school choice mechanism design and the literature on educational mobility. These two literatures have largely evolved independently but I emphasize the importance of considering their implications jointly. From a mechanism design perspective, I show that constrained choice and incomplete information predominantly disadvantage students from less-privileged backgrounds. Students from lower-performing elementary schools are less likely to use sophisticated strategic behavior when selecting schools and they gain admission to less selective secondary schools than students from higher-performing elementary schools with the same exam scores as a result. Early work in the mechanism design literature argued for changing mechanisms largely based on considerations about efficiency and stability (e.g., Abdulkadiroğlu and Sönmez (2003)). A growing number of more recent studies analyze issues of equity and the distribution of welfare for students in school choice systems which reward strategic behavior (see Abdulkadiroğlu, Pathak, Roth, and Sönmez (2006), Pathak and Sönmez (2008), Lai, Sadoulet, and de Janvry (2009), and Lucas and Mbiti (2012) for example). Examining strategic behavior in the context of other factors in the school choice environment however, I find that strategic sophistication accounts for relatively little (2.5 percent) of the overall differences in application behavior between students from high and low performing elementary schools in Ghana.

From an educational mobility perspective, I show that simplifying the assignment mechanism is not likely to level the playing field on its own because several other factors limit the probability that qualified students from low-performing schools apply to higher-performing ones. My discrete choice model estimates show that educational mobility is also limited by student demand, particularly because of preferences for school proximity. Students from lower-performing elementary schools have a stronger preference for attending schools within close proximity but they are less likely to have a high-performing secondary school located in their home district. This is consistent with findings from Calsamiglia, Haeringer, and Klijn (2010), who use a lab experiment to analyze the effects of constrained choice by comparing the choices submitted by subjects with and without constraints. They note the large extent to which subjects' behavior depends on factors beyond the design of the assignment mechanism, such as asymmetries in school selectivity and underlying preferences for district schools.

As a final source of evidence, I use variation from two policy reforms in Ghana to directly estimate the effects of redesigning the assignment mechanism. The first reform increased the number of choices that each student could list. The second reform assigned secondary schools into four categories based on their available facilities and restricted the number of schools that a student could select from each category. Using a difference-in-differences approach to analyze the effect of each reform, I find that both reforms decreased the difference in selectivity of schools chosen by students from high- and low-performing elementary schools. However, students from high-performing schools continued to gain admission to schools with better academic performance. These findings reiterate the importance of combining mechanism design changes with targeted interventions to improve the scope for educational mobility.

The paper proceeds as follows: Section 1 presents an institutional background on secondary school admissions in Ghana. Section 2 describes the administrative data used in this study. Section 3 formalizes the school choice problem in a theoretical model and motivates my empirical analysis. Section 4 examines potential hypotheses for differences in application behavior and Section 5 estimates the impact of two policy reforms. Section 6 concludes.

1 Institutional Background

Compulsory education in Ghana consists of six years of primary school and three years of junior high school (JHS). Each year, all 350,000 students graduating from the over 9,000 JHSs compete for admission to senior high school (SHS) and may apply to any of the 700 SHSs in the country. This provides an ideal context in which to study educational mobility because there is considerable variation in school quality at both levels of schooling.

In 2005, Ghana introduced a centralized merit-based admission system with the aim of increasing the transparency and equity of the secondary school admission process. The Computerized School Selection and Placement System (CSSPS) allocates JHS students to SHS based on students' ranking of their preferred program choices and their performance on a standardized exam (Box 1 provides more detail). Program choices often result from discussions between students and their parents, teachers or friends. However, I refer to the student as the decision-maker throughout this paper for simplicity. In practice, admission occurs in three stages:

1. Students submit a ranked list of choices, stating a secondary school and a program

track within that school for each choice.[5]

2. Students take the Basic Education Certificate Exam (BECE), which is a nationally administered exam.

3. Students who qualify for admission to SHS are admitted to a school.

On average, less than half of all candidates received a sufficient grade in the BECE to qualify for admission to SHS during the first five years of the CSSPS.[6]

Qualified students are assigned in merit order to the first available school on their list and schools admit students up to their predefined capacity, using a *deferred-acceptance algorithm* (Gale and Shapley (1962), see Appendix A.1 for a more detailed discussion of the matching properties of this algorithm). Under this algorithm, students are placed in schools according to their preferences and priority is determined strictly by academic merit as follows:

- *Step 1*: Each student i proposes to the first school in her ordered list of choices, A_i. Each school s tentatively assigns its seats to proposers one at a time in order of priority determined by students' academic performance (based on BECE scores). Each school rejects any remaining proposers once all of its seats are tentatively assigned.

In general, at

- *Step k*: Each student who was rejected in the previous round proposes to the next choice on her list. Each school compares the set of students it has been holding with the set of new proposers. It tentatively assigns its seats to these students one at a time in order of students' academic performance and rejects remaining proposers once all of its seats are tentatively assigned.

The algorithm terminates when no spaces remain in any of the schools selected by rejected students. Each student is then assigned to his or her final tentative assignment. [7] Rejected students who do not gain admission to any of their chosen schools are administratively assigned to an under-subscribed school with available spaces. Efforts are made to place these students in their preferred district or region wherever possible but there is limited

[5] Available programs include: General Arts, General Science, Agriculture, Business, Home Economics, Visual Arts and Technical Studies.

[6] The requirements for admission to SHS are that students receive a passing grade in the four core subjects (Mathematics, English, Integrated Science and Social Studies) as well as in any two additional subjects. All students who qualify are guaranteed admission to a school.

[7] Note that the deferred acceptance feature of this assignment mechanism means that a student who lists a program as her second choice could displace a student who has a lower score but listed that same option as her first choice and was tentatively assigned to that program in an earlier round.

regard for students' initially ranked choices. As such, there are high stakes involved in the application decision.

Two aspects of the Ghanaian school choice system are especially noteworthy. First, students can only submit a limited number of choices. This is partly a legacy of the manual application system which preceded the CSSPS. Initially, students were allowed to list up to three choices as they had been under the manual system. This increased to four choices in 2007 and to six choices in 2008. Between 94 and 100 percent of students listed the maximum number of choices each year.

Second, the application process is characterized by a substantial amount of uncertainty. Students have to submit their applications before taking the entrance exam;[8] and admission cutoffs are endogenously determined by the quality of applications to a given school each year since schools only define the number of available spaces, but not the explicit exam score required for admission. Therefore, students have incomplete information about their admission chances when they select their choices even though admission is definitively based on exam performance.

These two features of Ghana's CSSPS are remarkably general. Few school choice systems permit an unrestricted number of choices and students must often apply to schools when they have incomplete information about their admission chances (either because they have yet to take an admission exam, or because admission criteria are not fixed but endogenously determined by the school choice mechanism based on the interaction between school capacities and student preferences in a given year). Given the generalizability of the CSSPS setting, the ensuing analysis in this paper provides insights that potentially have wide-reaching implications.

2 Data

I use CSSPS administrative data on secondary school applicants and supplementary data on school characteristics to analyze application behavior and admission outcomes in Ghana.

2.1 Student Applications

CSSPS data cover the universe of students who took the BECE in Ghana between 2005 and 2009 and report their background characteristics, application choices, entrance exam scores, and admission outcomes. Panel A in Appendix Table A.1 presents descriptive statistics by

[8] Timing of the application process is largely determined by logistical concerns – students are dispersed for the end of year vacation by the time their BECE scores are released in August, so it is easier to register their secondary school application choices earlier in the year when they are still enrolled in school.

year. Data on admission outcomes are incomplete for 2006 (administrative assignments are missing), so I use a panel of data from 2007 to 2009 as the core of my analysis.

For each student, I observe the junior high school she attended and the complete ordered list of schools she submitted to the CSSPS – her "application set".[9] I also observe individual exam scores and admission outcomes for students who qualify for admission to secondary school. I convert BECE scores into standardized scores with a mean of zero and standard deviation of one so that they are comparable across years. To examine the extent of educational mobility, I characterize junior high schools based on the average BECE score of students in a given year. In certain specifications, I focus on the 85 percent of students who attended public junior high schools because these students are most likely to comply with their senior high school assignments instead of opting to attend one of the few elite private schools which have independent admission procedures but are substantially more expensive.[10] Table 1 presents a comparison of background characteristics, application choices, and admission outcomes for students in my 2007 to 2009 analysis sample.

2.2 School Characteristics

I supplement the CSSPS student data with information on school characteristics. Ghana Education Service maintains a register of schools which is updated each year to provide information on each school's location and to indicate whether a school is public or private, single sex or coeducational, day or boarding, and technical or academic. The register also lists the types of programs offered and the number of vacancies in each program. Additionally, I obtained school-level distributions of grades in the Secondary School Certificate Examination (SSCE) from the West African Examination Council. The SSCE is taken at the end of secondary school and used for admission to university. It is centrally administered to students at a national level so exam scores are therefore comparable across schools. I use pass rates in the four core subjects (English, Mathematics, Social Studies and Integrated Science) as an index of secondary school performance. I also use the CSSPS data on students' admission outcomes to construct a measure of school selectivity based on the distribution of BECE

[9]The data are especially informative because over 95 percent of students submit a complete list of secondary school choices. This is an extremely high participation rate compared to most school choice programs which have been studied in existing literature. For example, in the US, less than 50 percent of students in Boston Public Schools listed the full number of available choices (Abdulkadiroğlu, Pathak, Roth, and Sönmez (2006)) and 40 to 60 percent did in Charlotte-Mecklenburg Public Schools (Hastings, Kane, and Staiger (2008)). This comprehensive coverage of applications allows me to compare students from a wide range of backgrounds and to examine the general equilibrium effects of Ghana's policy reforms.

[10]The results reported in this paper are robust to alternative sample restrictions and variable definitions, namely: 1) including private school students, 2) including students who do not qualify for admission to senior high school, and 3) using alternative measures of school performance. Additional results are available upon request.

scores of students admitted to a school in a given year. Finally, I use three additional indicators of school selectivity. The first measure captures the 34 "colonial" schools that were constructed before Ghana gained independence in 1957. These pre-independence schools have a historical prestige similar to that of the Ivy League universities in the United States. The second measure captures the 65 top-ranked ("Category A") schools according to a categorization scheme introduced by the government in 2009 to reflect schools' available facilities. The third measure captures the 22 "elite" schools that are both colonial and Category A schools. Panel B in Appendix Table A.1 summarizes the senior high school data.

2.3 Evidence of Systematic Differences in Application Behavior

Figure 1 presents a descriptive illustration of students' application behavior. I plot the average selectivity of schools in a students' application set against students' individual BECE performance. I split the sample into two groups, one comprising students from junior high schools where the average BECE score is above the median average for all schools in the country and the other comprising students from JHSs below the median. The upward slope of both lines in the figure indicates that students with higher BECE scores apply to more selective schools. However, there is a persistent divergence in application behavior based on students' junior high school backgrounds. For a given BECE score, students from high-performing JHSs apply to a more selective set of schools than students from relatively low-performing JHSs.

This divergence in application behavior suggests that qualified students from low-performing backgrounds are not taking full advantage of the opportunity to apply to higher-performing schools. Throughout this study, I interpret BECE scores to be a measure of students' true underlying ability. An alternative interpretation would be to presume that students who received a high BECE score but came from a low performing school were simply lucky. My interpretation of BECE scores is based on empirical analysis in a related paper (Ajayi (2013)), which examines students' performance at the end of secondary school. I find that conditional on a given BECE score, students who attended a less selective elementary school perform better on the SSCE exam at the end of secondary school than their peers who attended a more selective elementary school. This implies that if anything, BECE scores may understate the true ability of students from less selective elementary schools, so the observed differences in application behavior would be even more extreme if we had a more precise measure of innate student ability.

Table 2 evaluates the main predictors of students' application choices and admission outcomes. Each column presents coefficients from a linear regression of the following form:

$$Y_{ijd} = \alpha_0 + \alpha_1 T^*_{ijd} + \alpha_2 \phi_j + \alpha_3 Public_j + \delta_d + \epsilon_{ijd} \tag{1}$$

where Y_{ijd} is some characteristic of the application set or admission outcome of student i from junior high school j in district d, T^*_{ijd} is student i's standardized BECE score, ϕ_j is the median score in student i's junior high school j, and $Public_j$ is an indicator for whether student i attended a public junior high school. I also include district fixed effects, δ_d, for each of Ghana's 138 administrative districts in the study period, to ensure that comparisons focus on students in the same geographical area and to account for any district-specific factors that may influence school choice.

Panel A of Table 2 presents models that take as a dependent variable the average selectivity of schools in student i's application set, where selectivity is measured as the median standardized BECE score of students admitted to a school in the previous year.[11] Column (1) indicates that a 1 standard deviation increase in individual BECE scores is associated with an increase of 0.215σ in the average selectivity of schools to a which a student applies, while a 1 standard deviation increase in JHS median performance accounts for an increase of 0.227σ in the selectivity of choices. Column (2) includes controls for whether a student attended a public JHS, and the coefficient on JHS median performance falls to 0.182. Column (3) adds an indicator for having an elite, colonial, or Category A school in the district, and the coefficient on JHS median performance falls again to 0.159. Column (4) includes district fixed-effects and the coefficient on JHS median performance decreases to 0.082, which suggests that geographical location is an important determinant of differences in school choice, but that application differences by JHS background exist even within districts.

The last two columns look for evidence of school-specific determinants of application choices. Column (5) adds a control for the average number of students in a given JHS who applied to an elite secondary school in the first two years of the CSSPS. The coefficient on JHS median performance decreases to 0.053, suggesting that there is a strong persistence in school choices. Column (6) adds JHS fixed-effects and examines the implications of within-school variation in cohort performance across years. The negative and significant coefficient on JHS median score suggests that students from a given school tend to choose an application set of a fixed selectivity level, regardless of a specific cohort's average performance.

Panel B of Table 2 presents an additional set of results on the selectivity of students'

[11] As a robustness check, Tables A.3 in the Appendix reports the results of replicating this analysis using the 5th percentile exam score of admitted students to measure school selectivity instead of the median exam score of students. This alternative specification of school selectivity yields similar results. I also estimate the results using average school selectivity over the entire period from 2005 to 2009 in order to abstract from year-to-year variation. This again yields similar results as school selectivity is highly correlated across years.

chosen schools and their admission outcomes. Column (1) reports my preferred specification from column (4) of Panel A, using the regression specified in equation (1). Columns (2) and (3) repeat the preceding analysis for students' highest and lowest ranked choices, and columns (4) to (6) focus on admission outcomes: school selectivity, quality of admitted peers, and school performance on the secondary school certification exam. The results consistently indicate that while students' individual ability predicts the selectivity and academic performance of secondary schools where students are admitted, the quality of a student's junior high school is also a significant factor. To more systematically analyze decision-making behavior in Ghana's secondary school application system, I outline a formal model of the school choice problem in the next section.

3 School Choice Model

My primary objective is to evaluate the extent to which constrained choice and incomplete information can explain the observed differences in application choices of students from high and low performing schools. I do this by first establishing what the optimal application behavior is given the school choice mechanism and then determining whether there are significant differences in the likelihood that students adopt the optimal strategy. An ideal alternative approach would be to estimate a fully structural model of students' application behavior and then to simulate the choices that students submit under different school choice mechanisms. However, the complexity of the school choice problem makes it impracticable to adopt a fully structural approach. Students can apply to any of almost 700 schools and their submitted choice lists depend on their idiosyncratic preferences, their subjective beliefs about their admission chances at each school, and their levels of strategic sophistication; none of which are directly observed.[12] The central contribution of the model below is to establish a test for sophisticated strategic behavior and to devise an approach for estimating the parameters of underlying student preferences.

[12] In a recent related paper, Walters (2012) develops a structural model for the case where students know their admission chances and make a binary decision about whether to apply to a charter school or not. The model remains tractable because the number of alternatives is low and students know their admission probabilities. In contrast, the main interest here is in identifying sources of heterogeneity in students' choices in the case where they face a large number of alternatives, are uncertain about their admission chances at individual schools, and have preferences over a range of school characteristics. Chade and Smith (2006) characterize the application decision as: "the maximization of a submodular function of sets of alternatives – to be sure, a complex combinatorial optimization problem" (p. 1293). It would be challenging to estimate a structural model for this problem even if students' admission chances were perfectly known, but it is infeasible to do so when there is incomplete information.

3.1 Setup

Following Chade and Smith (2006), I model the application decision in terms of a portfolio choice problem. Consider a finite set of students $I = \{1, \cdots, K\}$ each with ability T_i^* which is unknown to the student, and a finite set of schools $S = \{1, \cdots, M\}$ each with a known selectivity level q_s. Each student receives some utility U_{is} from attending a school.[13] Given the uncertainty about her actual ability, each student forms a belief about her expected exam performance T_i and associates this belief with some subjective probability of being admitted to a given school, $\Pr(T_i^* > q_s) \equiv \tilde{p}_{is} \in [0, 1)$. Thus, each student has some expected value of applying to a school: $z_{is} = \tilde{p}_{is} U_{is}$.

Students are faced with the task of selecting an application portfolio which is an ordered subset A of schools. Finally, there is an application cost $c(|A|)$ which is associated with selecting a portfolio of size $|A|$ schools. In the CSSPS case, institutional restrictions permit a fixed number of applications n, so $c(|A|) = 0$ if $|A| \leq n$ and $c(|A|) = \infty$ if $|A| > n$.

In the resulting portfolio choice problem, each student chooses an application set $A_i = \{1, \cdots, N\}$ to maximize net expected utility: $\max_{A \subseteq S} f(A) - c(|A|)$. The optimal portfolio (A^*) consists of a ranked set of chosen schools and solves:

$$\max_{A \subseteq S} f(A) = \tilde{p}_1 U_1 + \tilde{\pi}_2 \tilde{p}_2 U_2 + \cdots + \tilde{\pi}_N \tilde{p}_N U_N \tag{2}$$

where the subscript indicates the cth-ranked choice in the application set, and $N \leq n$. Note that $\tilde{p}_c$ denotes the unconditional probability of being admitted to choice c, and $\tilde{\pi}_c \tilde{p}_c$ is the conditional probability of being admitted to school c given that a student is not admitted to any of her more preferred choices.[14]

3.2 Optimal Application Strategy

Chade and Smith (2006) propose an intuitive yet computationally demanding solution concept – a marginal improvement algorithm.[15] To begin, the student identifies the school with the highest expected utility, $z_s = \tilde{p}_{is} U_{is}$. Next, the student considers all the remain-

[13] We can think of this utility as a comprehensive measure of the positive and negative factors associated with attending a school (including the costs of tuition payments and distance traveled as well as the benefits of available facilities, peer quality, and the net present value of expected future income).

[14] This basic notion of conditional probabilities captures the more general observation here – that merit-based assignment implies that a student's admission chances are correlated, so rejection from choice c reduces the expected admission chances at all other chosen schools. For example, a student who receives a negative shock and performs poorly on the BECE will have a lower chance of gaining admission to all schools than if she had performed as well as expected. As such, her realized admission outcome for a given school provides additional information on her admission chances for her lower-ranked choices.

[15] See Appendix A.2 for an analysis of the equilibrium solutions in the cases of perfect information and unconstrained choice.

ing choices and identifies the school and rank ordering with the largest marginal benefit to the existing choice set, where the expected utility of the new choice set is given by $\max_{A \subseteq S} f(A) = \tilde{p}_1 U_1 + \tilde{\pi}_2 \tilde{p}_2 U_2$. In general, the algorithm stops when the net marginal benefit becomes negative. In the case of restricted number of choices (as in Ghana's case), this happens when the student chooses up to the maximum number of permitted choices, if not earlier.

The resulting optimal portfolio satisfies the following three criteria:

1. Rank order of chosen schools is increasing in utility: $U_{i1} > U_{i2} > \cdots > U_{iN}$. So, students should rank schools in true preference order within their set of listed choices.[16]

2. Rank order of chosen schools is decreasing in expected admission chances, such that the first ranked choice is most selective and subsequently ranked choices are decreasingly selective: $\tilde{p}_{i1} < \tilde{p}_{i2} < \cdots < \tilde{p}_{iN}$.[17]

3. The optimal portfolio is upwardly diverse and more agressive than the single choice with the highest expected utility (i.e., there are incentives to include a selective, high utility school instead of only choosing schools with moderate selectivity and desirability).

These criteria hold regardless of students' levels of risk aversion. They therefore provide an objective measure of students' sophistication in strategic behavior. (Chade and Smith (2006) present additional discussions of the more general portfolio choice problem and formal proofs of these results.)

A notable implication of the optimal application strategy is that a student does not necessarily apply to her most preferred school overall (the school that satisfies $\max(U_{is})$), because admission chances are uncertain and students are constrained in the number of schools they can apply to. Instead, students pick schools based on their expected utility, $z_{is} = \tilde{p}_{is} U_{is}$. This implies that any school in the application portfolio is preferred to all other schools which are equally selective (i.e., all other schools to which a student believes

[16] Notably, the CSSPS guidelines explicitly instruct students that "choices must be listed in order of preference" (MOES (2005), p.5).

[17] This criterion implies that schools are ranked in order of selectivity: $q_{i1} > q_{i2} > \cdots > q_{iN}$, because of the earlier modeling assumption that students' *subjective* rankings of school selectivity have the same ordering as the *actual* rankings of schools selectivity. For the intuition behind this result, consider a student i who applies to two schools with admission chances $p_{i1} < p_{i2}$. Suppose the student ranks school 1 below school 2. If she is rejected from school 2, then this implies that $T_i^* < q_2$ and she has scored below the necessary admission threshold. This in turn implies that $T_i^* < q_1$, so she will not gain admission to the more selective school and she effectively wastes a spot by listing school 1 as a lower ranked choice. Alternatively, if she lists school 1 above school 2, then rejection from school 1 still means that she has a chance of gaining admission at school 2, so she will have a higher expected utility. (Note that admission chances are correlated because of the fact that all schools use the same exam score to determine merit.)

she has equal admission chances). This key insight provides the foundation for my empirical estimation of external factors responsible for application differences.

3.3 Parameter Estimates

It would be necessary to know students' expected admission chances at each school in order to implement the marginal improvement algorithm. In the absence of this information, I focus on estimating the demand parameters that characterize student preferences. Recall that students pick schools based on $z_s = \tilde{p}_{is}U_{is}$. This implies that any school in the application portfolio is preferred to all other schools which are equally selective, and allows us to estimate students' revealed preferences for schools selected from alternatives in a restricted choice set.

Taking the highest-ranked choice, for example, student i's expected utility satisfies the following statement:

$$\tilde{p}_{i1}U_{i1} > \tilde{p}_{it}U_{it} \quad \forall \ t \ \text{ s.t. } \tilde{p}_{it} = \tilde{p_{i1}} \tag{3}$$

$$\frac{\tilde{p}_{i1}}{\tilde{p}_{it}}U_{i1} > U_{it} \tag{4}$$

$$U_{i1} > U_{it} \tag{5}$$

We can specify a discrete choice estimation framework for the selection of a first choice school based on the fact that student i chooses the most preferred school s out of the set of all schools with equal selectivity as her first choice school (S_i^1). The dependent variable of interest is defined by:

$$y_{is} = \begin{cases} 1 & \text{iff } U_{is} > U_{it} \quad \forall \ t \in \ S_i^1 \\ 0 & otherwise \end{cases}$$

Thus, the probability that student i lists school s as a first choice is:

$$P_i\left(s\right) = Pr\left(U_{is} > U_{it} \quad \forall \ t \in \ S_i^1\right).$$

If we assume that $U_{is} = \boldsymbol{X}_{is}\boldsymbol{\beta} + \epsilon_{is}$, where $\boldsymbol{X}_{is}$ is a vector of observable school characteristics and the idiosyncratic component ϵ_{is} of student utility is independently and identically distributed (i.i.d.) extreme value, then the probability that student i chooses school s as a first choice can be written as:

$$P_i(s) = Pr\left(U_{is} > U_{it}\ \forall\, t\ \in\ S_i^1\right) \tag{6}$$

$$= \frac{e^{\boldsymbol{X}_{is}\boldsymbol{\beta}}}{\sum_{t\epsilon S_i^1} e^{\boldsymbol{X}_{is}\boldsymbol{\beta}}} \tag{7}$$

This yields the log-likelihood function:

$$LL(\boldsymbol{X}, \boldsymbol{\beta}) = \sum_{i=1}^{N} \sum_{s=1}^{S_i^1} y_{is} ln \frac{e^{\boldsymbol{X}_{is}\boldsymbol{\beta}}}{\sum_{t\epsilon S} e^{\boldsymbol{X}_{is}\boldsymbol{\beta}}} \tag{8}$$

which we can estimate using maximum likelihood. The independence from irrelevant alternatives property of the multinomial logit model implies that focusing on the subset of alternatives in this restricted choice set (S_i^1) still provides a valid estimate of the parameters determining student preferences.[18]

3.4 Student Beliefs

A core component of linking the theory to data is to specify students' formulation of beliefs about their admission chances in the absence of complete information. Note that the model's setup implies that uncertainty about $\Pr(T_i^* > q_s) \equiv \tilde{p}_{is} \in [0, 1)$ stems from uncertainty about individual ability and assumes that admission cutoffs are known. This setup abstracts from year-to-year variation in school selectivity (taking admission cutoffs q_s as fixed) and models uncertainty as coming entirely from students' incomplete information about their exam performance. In essence, this simplification requires that students' subjective expectations of their admission chances are a rank-preserving transformation of their actual admission chances, so that $\tilde{p}_{is} = g(q_s)$ where the function $g(\cdot)$ is a rank-preserving transformation which ensures that $\tilde{p}_{is} = \tilde{p}_{it} \iff q_s = q_t$.[19] Empirically, I assume that students' expectations about their admission chances are based on the selectivity of schools in the previous year. School selectivity in Ghana is indeed relatively stable over the period studied, the

[18]The theoretical foundations of this discrete choice estimation approach are reviewed in Train (2003). Several recent empirical studies have used application data to analyze revealed preferences in school choice settings, including: Griffith and Rask (2007); Hastings, Kane, and Staiger (2008); and Avery, Glickman, Hoxby, and Metrick (2013).

[19]The key requirement of this assumption is that students should be able to accurately gauge which set of schools are equally as selective as their preferred choice. Although this assumption is somewhat restrictive, it allows for students to have different beliefs about their absolute admission chances and only imposes that students have correct beliefs about their *relative* chances of gaining admission into various schools (i.e., certain students may be more or less confident than others, but they must be uniformly biased about their chances of gaining admission to all schools.)

correlation in selectivity levels is above 0.90 for all years.

3.5 Student Utility

My empirical approach also relies on standard assumptions about students' utility functions. I assume that student i's utility from attending school s depends on a set of observed and unobserved factors, where the observable component is a linear function of school selectivity q_s and a vector of student-specific school characteristics $\boldsymbol{X}_{is}$. Thus, demand for school selectivity is additively separable from demand for other school characteristics:

$$U_{is} = \alpha q_s + \boldsymbol{X}_{is}\boldsymbol{\beta} + \epsilon_{is} \tag{9}$$

The error term in this utility function denotes students' valuation of school characteristics which are unobserved by the researcher. The subscript is indicates that school characteristics result from an interaction between school attributes and student characteristics. For example, proximity to a given school varies across students.

4 Empirical Estimation

The theoretical model presented in the preceding section suggests a two-stage approach for estimating the determinants of differences in students' application behavior in the face of constrained choice under uncertainty. First, we can construct an objective measure of sophisticated strategic behavior based on the defining characteristics of an optimal choice set, and can then examine what types of students are likely to use sophisticated choice strategies. Second, we can estimate the parameters of student preferences by restricting their choice sets to schools of equal selectivity. In the remainder of this section, I therefore consider the relative importance of mechanism design features and external factors in explaining observed differences in application choices. I begin by looking for differences in students' understanding of the school choice problem and ability to adopt the optimal application strategy. I then look for differences in student preferences for school characteristics.

4.1 Heterogeneity in Sophistication

I identify strategic sophistication using the fact that it is optimal for applicants to rank their chosen schools in reverse order of their expected admission chances. I do not observe students' expectations in the data, but I do observe the actual selectivity of schools, given by the performance distribution of students admitted to a school in previous years. I construct six measures to evaluate the level of students' sophistication in strategic behavior by noting that admission chances p_{is} are inversely correlated with school selectivity q_s. Essentially, I measure the extent to which students rank a selective school lower than a less selective school on their submitted list. This is a dominated application strategy because admission chances are correlated across schools, so students are guaranteed to be rejected from the higher performing school conditional on rejection from a lower-performing school that was ranked higher on their list. They effectively waste a space on their choice list. (See Appendix A.3 for more detail on the specific measures of sophistication that I use.)

Overall, students from low-performing schools are less likely to use sophisticated application strategies as demonstrated by the fact that they are more likely to rank a more selective school lower than a less selective school, even though the dominant strategy is to rank more selective schools higher in the list. As Table 3 shows, less than 8 percent of students in the full sample ranked their choices strictly in order of selectivity, although 82.3 percent of students ranked their selected schools such that their first-choice school was equally or more selective than their lowest-ranked school. Notably, however, only 82.6 percent of students who qualified from low-performing public schools did, compared to 89.1 percent of students who qualified from high-performing public schools and 94.5 percent of students from private junior high schools. This suggests that students from low-performing schools may not fully understand the assignment mechanism or may lack guidance about the optimal application strategy to adopt when faced with constrained choice and uncertainty.

Table 4 estimates the importance of strategic sophistication in explaining differences in application choices and admission outcomes, using coefficients from a linear regression of the following form:

$$Y_{ijd} = \alpha_0 + \alpha_1 T^*_{ijd} + \alpha_2 \phi_j + \alpha_3 Public_j + \alpha_4 DMQ_{ijd} + \delta_d + \epsilon_{ijd} \tag{10}$$

where Y_{ijd} is some characteristic of the application set or admission outcome of student i from junior high school j in district d as before, T^*_{ijd} is student i's standardized BECE score, ϕ_j is the median score in student i's junior high school j, $Public_j$ is an indicator for whether students attended a public junior high school, and the decision-making quality index (DMQ_{ijd}) is a measure of whether students rank their choices in order of selectivity. I retain the district fixed-effects, δ_d.

Each column in Table 4 reports the coefficients from a separate regression estimating the correlates of various outcomes. I use the decision-making quality index to summarize the alternative definitions of sophisticated strategic behavior. To begin, column (1) takes the decision-making index as the outcome of interest and indicates that students from higher performing JHSs, students with higher individual BECE scores, and students from private schools have higher levels of strategic sophistication (these students are more likely to use the optimal strategy). I then include the decision-making quality index as a control variable in the remaining regressions. The coefficients on the decision-making quality index in columns (2) to (4) indicate that students who use the optimal strategy apply to a more selective first choice school, a less selective last choice school, and a more selective application set on average. Columns (5) to (7) look at admission outcomes and indicate that strategically sophisticated students are admitted to a more selective and higher performing set of senior high schools.

These results suggest that constrained choice under uncertainty does indeed disadvantage students from less privileged backgrounds. Nonetheless, it is worth noting that differences in students' levels of sophistication do not appear to explain much of the difference in application choices of students from high and low performing elementary schools. Looking at estimates of the average selectivity of choices in students' application sets in column (1) of Table 2 and the comparable estimates in column (2) of Table 4, for example, demonstrates that adding controls for decision-making quality reduces the coefficient on JHS median BECE score by only 2.5 percent (it drops from 0.082 to 0.080). This suggests that features of the school choice mechanism design alone cannot explain a significant part of why there are differences in application decisions and admission outcomes for students from different junior high school backgrounds.

4.2 Heterogeneity in Student Preferences

Having evaluated differences in students' levels of strategic sophistication, I now turn to look at factors that are independent of the mechanism design, captured by students' underlying demand for schools. To examine heterogeneity in preferences, I estimate the discrete choice model outlined in Section 3.5 and allow demand for a vector of school characteristics $\boldsymbol{X_{is}}$ to vary by student performance, T_i^*, and the median performance in a student's junior high school, ϕ_j. I therefore parameterize students' utility function in the following way:

$$U_{ijs} = \boldsymbol{X}_{is}\boldsymbol{\beta}_1 + (\boldsymbol{X}_{is} \times T_i^*)\boldsymbol{\beta}_2 + (\boldsymbol{X}_{is} \times \phi_j)\boldsymbol{\beta}_3 + \epsilon_{ijs} \quad (11)$$

The key objective is to evaluate whether $\boldsymbol{\beta}_3 \neq 0$. I cluster standard errors at the junior high school level to allow for correlation in the preferences of students in a given school.

My estimation strategy relies on the assumption that sophisticated students apply to schools based on their relative selectivity. I therefore restrict the sample to focus on students who demonstrate an understanding of the optimal school choice strategy by ensuring that their first choice school is more selective than their lowest-ranked school (condition (6) in Appendix A.3).[20] Additionally, I split the sample by gender to account for the presence of single-sex schools.

Tables 5 and 6 report estimates from the multinomial logit regressions. Columns (1) to (3) include all sophisticated students who qualified for admission to SHS. On average, students prefer schools that were established before Ghana gained independence (a signal of historical prestige) and those with higher SSCE pass rates. Column (3) includes interactions between SHS characteristics and students' JHS performance. The coefficients on the public school indicator and school distance measure are statistically significant for both male and female students. The respective coefficient signs imply that students from lower-performing schools have a stronger preference for attending senior high schools that are nearby and for attending public schools (presumably because of the lower costs).

With regard to secondary school quality, students from lower-performing JHSs are no more likely to apply to historically prestigious schools. However, both male and female students from lower-performing schools are significantly less likely to apply to secondary schools with high SSCE performance. This, in contrast to the insignificant differences in demand for colonial schools, suggests that students from lower-performing junior high schools may have less information about school performance beyond the broad signals they can infer from the fact that schools were constructed before Ghana gained independence.

Altogether, this analysis suggests that distance and costs of attending a higher-quality school may be more important determinants of application behavior than preferences for school quality per se.[21] These results are consistent with findings from Burgess, Greaves, Vignoles, and Wilson (2009) who study school choice in England. They find that preferences for academic performance do not substantially vary across different socio-economic groups and largely attribute educational inequality to differences in access to high quality schools.

To provide a more conservative estimate of heterogeneity in preferences for secondary school characteristics, I limit my analysis to public school students in column (4). Public JHS students are more likely to comply with their admission outcomes instead of opting

[20] This restriction still retains over 82 percent of students in the sample. My results are robust to estimating the discrete choice model on the full sample of students or to defining sophisticated students using more restrictive measures of whether they are using the optimal application strategy.

[21] Cost and distance are key considerations for families because basic education in public schools is tuition free but secondary education is not. Junior high schools often still charge various fees but secondary school is substantially more expensive. In 2007, for example, fees for day students in public SHSs were c33,000 ($30) per term and boarding fees were c784,700 ($75) per term. The feeding fee was c746,700 ($72) and the approved list of total fees payable on admission (covering admission, school uniform, house attire, and physical education kits) was c442,000 ($42). (Ghanaian Times (2007)) A boarding student therefore had to pay up to $190 per term or $570 per year. Annual GDP per capita was $1,100 and minimum wage was approximately $650 per year.

out into the set of elite private schools which have independent admissions procedures. Additionally, private JHS students may have stronger preferences for attending private senior high schools even within the centralized application system. As expected, I find smaller differences in preferences between students from high and low performing public schools. Yet, the differences remain statistically significant and reflect the same patterns as within the full sample. Finally, I limit the sample to the 30 percent of students who have an elite public SHS in their district in column (5). If differential proximity to high-performing schools partly explains differences in application behavior, then one would expect to see less heterogeneity in preferences for school distance for students who have a high-performing SHS in their home district. Indeed, the magnitude of the coefficient on school distance interacted with JHS median performance decreases in this restricted sample, which is consistent with the hypothesis that having a high quality school in one's district dampens the heterogeneity in preferences for applying outside of the district. However, the coefficient is not significantly different from that in column (4).

4.3 Robustness Checks

Both the results on heterogeneity in strategic sophistication and heterogeneity in preferences are based on specifications that measure school selectivity using the median BECE scores of students admitted to a school in the previous year. As a robustness check, I estimate these same models using the 5th percentile BECE score of students admitted to a school in the previous year as an alternative measure of school selectivity. The idea here is that if students are primarily concerned about their admission chances, they might be focused on the lower tail of the exam score distribution for admitted students instead of focusing on the median. The results estimated using this alternative measure of school selectivity are qualitatively similar and are reported in the Appendix. I also examine whether the estimates are robust to including students who do not qualify for secondary school admission. Finally, I use alternative measures of decision-making quality to identify whether students are using the optimal application strategy. My results are robust to these alternative specifications (additional estimates are available on request).

5 Effect of School Choice Reforms

The empirical analysis in the preceding section provides suggestive evidence that constrained choice under uncertainty is one of several potential barriers to educational mobility. I now turn to the task of directly estimating whether redesigning Ghana's school choice system could increase the likelihood that students from poorer educational backgrounds apply to more selective schools. I evaluate the effects of two mechanism design changes that altered the school choice problem facing students in Ghana: 1) increasing the number of choices that students could rank on their lists, and 2) providing information and a restrictive set of guidelines on permissible school choice strategies.

5.1 School Choice Reforms in Ghana

The design of the CSSPS has changed several times since the system was introduced in 2005, I use two successive school choice reforms to identify the effects of redesigning the system. First, the number of permitted choices has increased over time. Students were allowed to list up to three choices when the CSSPS began in 2005, this increased to four choices in 2007 and to six choices in 2008. I focus on this last increase. Second, Ghana Education Service introduced a categorization scheme in 2009 and restricted the number of schools that a student could list from each category (Box 2 details these changes and Appendix A.4 provides the full set of CSSPS guidelines). Notably, public secondary schools were assigned into four categories based on their "available facilities" and students were restricted in their selection of schools from each category; they could only pick: up to one Category A school, up to two Category B schools, and up to five Category C or D schools. Students were still allowed to list a maximum of six program choices as they had been in the previous year, but they could no longer pick more than one program from any given school.[22]

Figure 2 provides some descriptive statistics and illustrates the distribution of selectivity for schools in each category. The categorization of schools under this new scheme is positively correlated with school age (historical prestige) and academic performance. On average, the median standardized BECE score of students admitted to Category A schools in the year preceding the reform was 1.04 but -0.97 for Category D schools, reflecting a difference of two standard deviations in median student performance. However, the correlation between school quality and categorization is not perfect. In particular, some schools which were assigned to Category A were obviously elite but others were not of high quality by any observable measures. Discussions with Ghana Education Service revealed that schools were categorized based on their capacity to admit students, their historical selectivity, as well as a concern for spatial variation by ensuring that each region contains at least one school from each category.

[22]This categorization scheme only affected choices in 2009 since it was not available in earlier years. Students in the 2008 cohort submitted their lists of choices in September 2007 and the categories were not publicized until February 2009 when students in the 2009 cohort were submitting their choices, so there is no possibility that the categorization had a causal effect on choices prior to this.

Note that neither the increased number of choices nor the categorization reform forced students to apply to a more selective set of schools. Under both reforms, students could avoid applying to selective schools if they were explicitly averse to doing so. In the first case, an expansion of choices could merely allow students to list an additional set of non-selective schools if they were genuinely interested in attending a non-selective school. In the second case, students could apply to one of the non-selective A or B schools, or they could list five non-selective category C and D schools at the top of their list and a selective A or B school as their sixth choice, which would preclude them from gaining admission. Thus, it is not inevitable that the introduction of the categorization scheme would lead students from lower-performing schools to apply to more selective secondary schools. Conversely, the categorization reform imposes additional constraints on choices and forces high-achieving students to apply to at most three selective schools. It is therefore unambiguously welfare-reducing for students and, even if effective, would be an inefficient mechanism for increasing educational mobility.

5.2 Difference-in-Differences Estimation

I use a difference-in-differences framework to compare the change in application behavior and admission outcomes for students from lower-performing schools relative to the change for students from higher-performing schools following each of the reforms. I estimate the impact of the first policy by observing changes following the increase from four choices in 2007 to six choices in 2008. I estimate the impact of the second policy by observing the changes following the categorization reform in 2009. In each case, I pool two successive years of CSSPS data and estimate the following regression:

$$Y_{ijdt} = \pi_0 + \pi_1 T_i^* + \pi_2 \phi_{jt} + \pi_3 After_t + \pi_4 (After_t \times \phi_{jt}) + \delta_d + \epsilon_{ijdt} \qquad (12)$$

As in my earlier regressions, Y_{ijdt} is some characteristic of the application set or admission outcome of student i from junior high school j in district d and year t, T_i^* is student i's standardized BECE score, ϕ_{jt} is the median score in student i's junior high school in year t, and δ_d is a district fixed-effect. $After_t$ denotes the period after a reform and $After_t \times \phi_j$ is the interaction between this post-reform indicator and the JHS median score. The coefficient on this last variable is the main estimate of interest and indicates the extent to which a given school choice reform is able to narrow the gap between students from different JHS backgrounds. The identifying assumption underlying this analysis is that the differences between students from high- and low-performing schools would have stayed constant in the absence of Ghana's school choice reforms.

5.3 Results

Table 7 illustrates the results from estimating the regression specified in equation (12). Panel A reports effects of the first reform (expanding number of choices from four to six) and Panel B reports effects of the categorization reform. Column (1) indicates that there were no relative changes in students' decision making quality following the first reform; however, students from higher performing schools improved their decision making quality following the second reform. Columns (2) to (4) examine changes in application choices. Overall, I find a decrease in the difference in average selectivity of schools to which students from high-performing and low-performing schools applied following the reforms. Both groups of students applied to more selective first choices and less selective last choices, but the difference in the average selectivity of their choices decreased.[23]

With regard to admission outcomes, I find that the difference in selectivity of schools to which students were admitted increased following the first reform but then decreased significantly following the second (column (5)). These changes in admission outcomes capture two opposing forces: on one hand, the changes in application behavior implied a decrease in the application advantage for students from higher-performing schools; on the other hand, there was a dramatic decrease in administrative assignments after the first reform because students' lowest ranked choices became less selective. The decline in administrative assignments led to an increase in the selectivity of schools to which low-performing students from high-performing schools were admitted (results not shown). Overall, the effect of decreased administrative assignments outweighed the changes in application choices so the net impact of these two factors was that students from high-performing schools ended up gaining admission to more selective schools on average following the first reform. Column (6) indicates that the reforms also led to similar changes in peer quality in senior high schools. Finally, column (7) demonstrates that the gap in the quality of schools where students gained admission (measured by schools' performance on the secondary school certification exam) increased in both cases.[24]

Overall, this analysis indicates that the application choices of students from high- and low-performing schools became increasingly similar following each reform. However, students

[23] Pallais (2013) finds a similar result in her analysis of the effect of increasing the number of free score reports provided for ACT-takers applying to colleges in the US. This suggests that my findings on the changes in application behavior likely generalize to other settings.

[24] As an alternative measure of the impact of the school choice reforms, Table 8 repeats the analysis in Table 7 but uses the likelihood that students apply to an elite school, a colonial school, and a Category A school (in columns (2) to (4)), and the probability that they are admitted to these schools (columns (5) to (7)). I find similarly to the earlier estimates that increasing the number of choices widened the gaps between students from high and low performing schools, but that the introduction of the categorization scheme decreased the gaps in outcomes.

from high-performing schools continued to apply to more selective schools even after the restrictive categorization reform. Additionally, students from high-performing schools ended up gaining admission to more selective schools than students from low-performing schools in the wake of the first policy change although the difference declined following the categorization reform. These results highlight the potential and limitations of mechanism design changes – student behavior does respond to constraints imposed by the mechanism design; however, relaxing constraints on choices will not necessarily improve educational mobility, nor will imposing additional constraints on choices.

6 Conclusions

This paper empirically examines the implications of two common features of merit-based school choice systems: constrained choice and incomplete information. I show that these features predominantly disadvantage students from less privileged educational backgrounds because these students are less likely to use sophisticated school choice strategies to optimize their admission outcomes. I additionally provide evidence of heterogeneity in students' preferences for school characteristics and show that this limits the extent to which mechanism design changes can level the playing field. These results provide a clear explanation for the finding that qualified students from low performing schools do not take full advantage of the opportunity to apply to better schools. In order to do so, they must use the optimal application strategy; but they must also be willing and able to travel increased distances or incur any additional costs required to attend a higher performing school.

This study has broader implications for other contexts in which policy makers seek to encourage high-performing students from underprivileged backgrounds to apply to more selective schools. Ultimately, the theoretical model and empirical evidence presented here demonstrate that merit-based school choice systems are more likely promote educational mobility if there is perfect information, unconstrained choice, and an institutional environment that facilitates equality in access to higher performing schools by addressing practical concerns about geographic location and financial cost.

Given that it is often infeasible to provide full information and completely eliminate constraints on choice, it may be useful to outline the relative advantages of alternative policy reforms. Firstly, this paper raises an important caveat about the effectiveness of relaxing school choice constraints as a means to increase equity in merit-based assignment systems. Specific examples of reforms in this direction include: the introduction of the common application for college admissions in the US, increases in the number of free score reports for standardized tests, and expanding the numbers of applications that students can submit in centralized choice systems. Reforms such as these are likely to bridge the gap in application differences. However, these interventions may not necessarily decrease admission advantages for students from high-performing schools. A critical consideration is that overall changes in admission outcomes depend on the general equilibrium effects of market-wide changes in application behavior. As demonstrated in my analysis of Ghana's reforms, students who had previously been overconfident may also benefit from these relaxed constraints on their choices. Importantly, these mechanisms remain vulnerable to manipulation (Pathak and Sönmez (2013)), so asymmetries in information and sophistication can still benefit certain students at the expense of others.

Secondly, students' application behavior relies on the ability to understand a school assignment mechanism and to implement an effective school choice strategy. Therefore, reforms will likely have only a limited impact on expanding students' educational opportunities unless they are accompanied by targeted efforts to improve the level of guidance and information available to historically disadvantaged students. Both of these two factors reinforce the case for developing programs and policies specifically focused on high-achieving, underprivileged students (such as the college choice intervention evaluated by Hoxby and Turner (2013)).

Lastly, schooling choices are undoubtedly driven by considerations about non-academic factors (especially cost and proximity). As such, socio-economic differences in application behavior will likely persist unless there are complementary efforts to increase affordability and geographical access. Thus, the emphasis on information and choice constraints in this paper and the mechanism design literature on school choice should not obscure the importance of addressing financial and structural barriers to educational mobility.

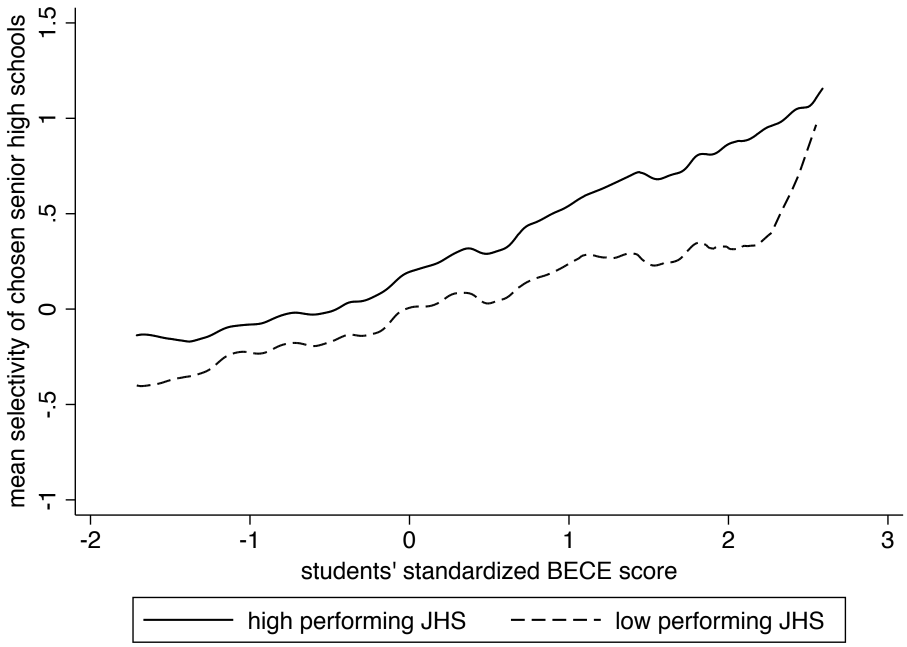

Figure 1: Exam Performance and Application Choices

Notes: Figure illustrates differences in selectivity of application choices for students with the same exam scores but from low and high-performing junior high schools (JHSs). School selectivity is measured by the median BECE score of students admitted to a school in the previous year. High-performing JHSs are those where the average BECE score of students is above the median average for all schools in the country; low-performing JHSs are those with below-median performance.

	School Quality			
	Selectivity[a]	Pass Rate[b]	Colonial[c]	Total
Available Facilities				
Category A	1.039	88.535	22	65
Category B	0.601	84.927	10	72
Category C	-0.400	70.194	2	178
Category D	-0.968	59.525	0	178
Mean (Total)	-0.266	71.008	(34)	(493)

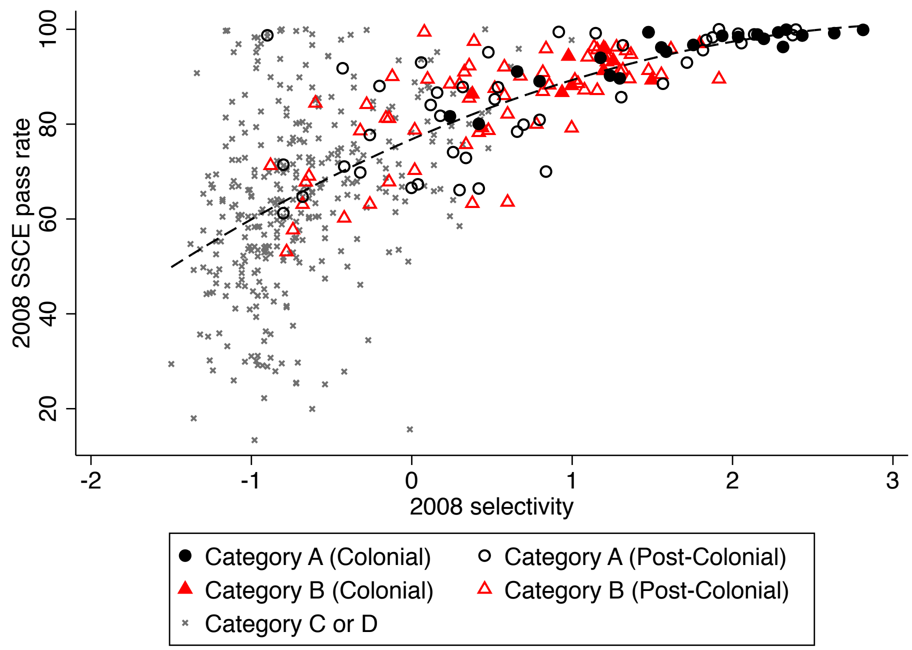

FIGURE 2: CATEGORIZATION AND QUALITY OF PUBLIC SENIOR HIGH SCHOOLS

Notes: [a]School selectivity indicates the median BECE score of students admitted to a school in 2008. [b]Pass rate is the average percentage of students who scored between A and E in the SSCE core exams in 2008. [c]Colonial schools are those which were constructed before Ghana gained independence in 1957.

Table 1: Summary Statistics by JHS Performance

	Full sample	Qualified students	Qualified, low-perf. public JHS	Qualified, high-perf. public JHS	Qualified, private JHS
	(1)	(2)	(3)	(4)	(5)
Panel A: Student characteristics					
Age	17.164	16.701	17.265	16.682	16.119
Male	0.547	0.582	0.653	0.566	0.530
Attended high-performing JHS	0.495	0.675	0.000	1.000	0.871
JHS Public	0.823	0.732	1.000	1.000	0.000
JHS pass rate	0.497	0.692	0.444	0.760	0.851
JHS median BECE score	-0.369	-0.046	-0.842	0.138	0.517
Number of JHS classmates	65.847	67.642	60.431	75.576	62.376
JHS applicants to elite school 2005/6	14.967	20.774	7.792	22.222	31.620
JHS admits to elite school 2005/6	2.975	5.176	0.483	4.691	10.661
Elite SHS in district	0.270	0.312	0.175	0.324	0.442
Colonial SHS in district	0.319	0.355	0.215	0.360	0.498
Category A SHS in district	0.426	0.465	0.351	0.472	0.577
Listed maximum no. of choices	0.995	0.995	0.996	0.995	0.995
Panel B: First choice school					
SSCE pass rate	80.518	84.790	78.913	85.322	90.307
SHS median BECE score	0.403	0.786	0.225	0.805	1.363
Colonial	0.183	0.266	0.143	0.248	0.428
Public	1.000	1.000	1.000	1.000	1.000
Mixed sex	0.832	0.738	0.889	0.758	0.541
Boarding facilities	0.815	0.885	0.836	0.884	0.942
Located in JHS district	0.404	0.337	0.390	0.344	0.265
Located in JHS region	0.795	0.728	0.832	0.742	0.594
Distance from JHS (miles)	29.231	34.926	30.850	34.222	40.480
Number of programs offered	5.152	5.177	5.142	5.239	5.111
Number of vacancies	457.641	462.613	457.954	469.320	456.600
Panel C: Admission outcomes					
Qualified for admission to SHS	0.499	1.000	1.000	1.000	1.000
Student's BECE score		0.003	-0.741	0.172	0.531
Admitted to first choice		0.273	0.231	0.315	0.250
Administratively assigned		0.005	0.007	0.004	0.006
Admitted to school in JHS district		0.365	0.444	0.357	0.294
Admitted to school in JHS region		0.757	0.862	0.763	0.632
Distance from JHS to SHS (miles)		32.112	26.896	32.503	37.100
Admitted as boarding student		0.650	0.535	0.677	0.730
SSCE pass rate		74.578	67.288	76.259	79.600
SHS median BECE score		-0.030	-0.604	0.062	0.442
N	970592	484248	140720	213911	129617

Table 2: Differences in Application Choices and Admission Outcomes

Panel A: Selectivity of choices	Portfolio Average (1)	Portfolio Average (2)	Portfolio Average (3)	Portfolio Average (4)	Portfolio Average (5)	Portfolio Average (6)
Student's BECE	0.215***	0.215***	0.215***	0.214***	0.214***	0.203***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
JHS median BECE	0.227***	0.182***	0.159***	0.082***	0.053***	-0.107***
	(0.005)	(0.006)	(0.005)	(0.005)	(0.005)	(0.007)
JHS public		-0.202***	-0.183***	-0.155***	-0.152***	
		(0.009)	(0.008)	(0.008)	(0.007)	
Elite SHS in district			0.074***			
			(0.011)			
Colonial SHS in district			0.131***			
			(0.011)			
Category A SHS in district			-0.008			
			(0.009)			
JHS applicants to elite SHSs					0.002***	
					(0.000)	
District FEs	No	No	No	Yes	Yes	No
School FEs	No	No	No	No	No	Yes
R^2	0.444	0.464	0.488	0.569	0.580	0.668
N	484248	484248	484248	484248	484248	484248

	Selectivity of Choices			Admission Outcomes		
Panel B: Additional outcomes	Portfolio Average (1)	First Choice (2)	Last Choice (3)	Selectivity of SHS (4)	Peer Quality in SHS (5)	SSCE Pass Rate in SHS (6)
Student's BECE	0.214***	0.385***	0.060***	0.628***	0.658***	8.036***
	(0.001)	(0.002)	(0.002)	(0.004)	(0.003)	(0.053)
JHS median BECE	0.082***	0.063***	0.053***	0.107***	0.105***	0.484***
	(0.005)	(0.007)	(0.006)	(0.004)	(0.004)	(0.078)
JHS public	-0.155***	-0.308***	-0.004	-0.043***	-0.047***	-0.177
	(0.008)	(0.011)	(0.009)	(0.005)	(0.005)	(0.111)
District FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.569	0.445	0.135	0.703	0.746	0.325
N	484248	484248	484248	483643	484248	432383

Notes: Table reports coefficients from a set of linear regressions. Outcome of interest is indicated at the top of each column. School selectivity measures the median exam score of students admitted in the previous year. Peer quality measures the median exam score of students admitted in the current year. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Table 3: Differences in Strategic Behavior

	Full sample (1)	Qualified students (2)	Qualified, low-performing public JHS (3)	Qualified, high-performing public JHS (4)	Qualified, private JHS (5)
$q_{i1} > q_{i2} > \ldots > q_{iN}$	0.078	0.115	0.065	0.110	0.178
$q_{i1} \geq q_{i2} \geq \ldots \geq q_{iN}$	0.106	0.150	0.091	0.144	0.223
$q_{i1} + 10 \geq q_{i2},\ q_{i2} + 10 \geq q_{i3}, \ldots \geq q_{iN}$	0.159	0.207	0.142	0.200	0.289
$q_{i1} + 20 \geq q_{i2},\ q_{i2} + 20 \geq q_{i3} \ldots \geq q_{iN}$	0.228	0.277	0.207	0.267	0.370
$q_{i1} = \max(q_i)$ and $q_{iN} = \min(q_i)$	0.241	0.317	0.211	0.309	0.446
$q_{i1} \geq q_{iN}$	0.827	0.887	0.826	0.891	0.945
Mean index of decision-making quality	1.720	2.038	1.628	2.005	2.539
Std. deviation of school selectivity	0.635	0.705	0.612	0.700	0.814
N	970592	484248	140720	213913	129615

Notes: Table indicates the share of students whose ranking of application choices satisfies a given measure of decision-making quality, for example: choices are strictly ranked in order of selectivity (row (1)) or choices are weakly ranked in order of selectivity (row (2)). The index of decision-making quality in row (7) assigns a value of 6 to students whose choices satisfy the condition in row (1), a value of 5 to those who satisfy the condition in row (2), and so on, assigning a value of 0 to those who fail to satisfy any of the six conditions. School selectivity is measured by the median exam score of students admitted in the previous year.

Table 4: Implications of Strategic Behavior

		Selectivity of Choices			Admission Outcomes		
	DMQ Index (1)	Portfolio Average (2)	First Choice (3)	Last Choice (4)	Selectivity of SHS (5)	Peer Quality in SHS (6)	SSCE Pass Rate in SHS (7)
Student's BECE	0.376***	0.203***	0.331***	0.090***	0.617***	0.647***	7.961***
	(0.005)	(0.001)	(0.002)	(0.002)	(0.004)	(0.003)	(0.053)
JHS median BECE	0.076***	0.080***	0.052***	0.059***	0.105***	0.103***	0.469***
	(0.011)	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)	(0.078)
JHS public	-0.303***	-0.146***	-0.264***	-0.028***	-0.035***	-0.038***	-0.113
	(0.017)	(0.008)	(0.009)	(0.010)	(0.005)	(0.004)	(0.111)
DMQ index		0.031***	0.144***	-0.081***	0.029***	0.031***	0.203***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.016)
District FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.099	0.578	0.513	0.189	0.707	0.750	0.325
N	484248	484248	484248	484248	483643	484248	432383

Notes: Table reports coefficients from a set of linear regressions. Outcome of interest is indicated at the top of each column. School selectivity measures the median exam score of students admitted in the previous year. Peer quality measures the median exam score of students admitted in the current year. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Table 5: Discrete Choice Model Estimates (Males)

	All Qualified Students			Public JHS Students	
				All	Elite SHS in District
Choice characteristic	(1)	(2)	(3)	(4)	(5)
Colonial	0.449***	0.479***	0.468***	0.448***	0.625***
	(0.016)	(0.016)	(0.016)	(0.022)	(0.032)
SSCE pass rate	0.008***	0.012***	0.014***	0.011***	0.012***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Public	3.882***	3.704***	3.928***	3.803***	3.260***
	(0.324)	(0.319)	(0.406)	(0.415)	(0.679)
Single sex	1.594***	1.222***	1.203***	1.135***	1.137***
	(0.023)	(0.023)	(0.023)	(0.031)	(0.051)
Boarding facilities	0.928***	1.028***	1.035***	0.990***	1.010***
	(0.019)	(0.021)	(0.023)	(0.029)	(0.047)
Distance	-0.045***	-0.049***	-0.048***	-0.052***	-0.044***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Number of vacancies	0.002***	0.003***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Student's BECE score					
× Colonial		-0.078***	-0.065***	-0.074***	-0.087**
		(0.015)	(0.017)	(0.022)	(0.035)
× SSCE pass rate		0.011***	0.004***	0.001	0.005**
		(0.001)	(0.001)	(0.001)	(0.002)
× Public		-1.310***	-0.124	-0.781**	-1.493**
		(0.382)	(0.496)	(0.319)	(0.659)
× Single sex		0.381***	0.500***	0.586***	0.599***
		(0.020)	(0.024)	(0.031)	(0.055)
× Boarding facilities		0.186***	0.135***	0.151***	0.185***
		(0.022)	(0.023)	(0.025)	(0.045)
× Distance		0.010***	0.004***	0.005***	0.003***
		(0.000)	(0.000)	(0.000)	(0.000)
× Number of vacancies		0.000***	-0.000***	-0.000**	-0.000**
		(0.000)	(0.000)	(0.000)	(0.000)
JHS median BECE score					
× Colonial			-0.027	-0.007	0.046
			(0.025)	(0.036)	(0.054)
× SSCE pass rate			0.013***	0.010***	0.006*
			(0.001)	(0.002)	(0.003)
× Public			-2.012***	-1.416	-1.289
			(0.753)	(0.863)	(1.439)
× Single sex			-0.192***	-0.189***	-0.216***
			(0.031)	(0.045)	(0.078)
× Boarding facilities			0.114***	0.058	0.289***
			(0.036)	(0.046)	(0.080)
× Distance			0.008***	0.006***	0.005***
			(0.000)	(0.001)	(0.001)
× Number of vacancies			0.001***	0.001***	0.001***
			(0.000)	(0.000)	(0.000)

Notes: Dependent variable is an indicator for the student's first choice school. Alternatives consist of five next most selective schools relative to the student's first choice (measured by median exam score of students admitted to school in previous year). Regressions also include distance squared and number of programs offered. Standard errors are clustered at the junior high school level, *p<0.1, **p<0.05, ***p<0.01.

Table 6: Discrete Choice Model Estimates (Females)

	All Qualified Students			Public JHS Students	
				All	Elite SHS in District
Choice characteristic	(1)	(2)	(3)	(4)	(5)
Colonial	0.564***	0.530***	0.524***	0.489***	0.478***
	(0.014)	(0.015)	(0.015)	(0.020)	(0.033)
SSCE pass rate	0.002***	0.007***	0.007***	0.005***	0.004
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)
Public	1.989***	2.031***	2.190***	2.205***	3.317***
	(0.467)	(0.397)	(0.407)	(0.439)	(1.274)
Single sex	1.600***	1.445***	1.438***	1.386***	1.341***
	(0.019)	(0.019)	(0.019)	(0.026)	(0.043)
Boarding facilities	1.098***	1.206***	1.200***	1.184***	1.301***
	(0.021)	(0.026)	(0.026)	(0.032)	(0.052)
Distance	-0.042***	-0.045***	-0.046***	-0.049***	-0.041***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Number of vacancies	-0.000***	-0.000	-0.000	0.000***	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Student's BECE score					
× Colonial		0.010	0.015	0.027	-0.020
		(0.013)	(0.018)	(0.024)	(0.037)
× SSCE pass rate		0.011***	0.008***	0.003***	0.010***
		(0.001)	(0.001)	(0.001)	(0.003)
× Public		-1.738***	-0.879*	-1.380***	-0.102
		(0.457)	(0.488)	(0.508)	(0.501)
× Single sex		0.370***	0.335***	0.305***	0.276***
		(0.018)	(0.022)	(0.027)	(0.041)
× Boarding facilities		0.083***	-0.033	-0.016	0.143***
		(0.025)	(0.029)	(0.033)	(0.055)
× Distance		0.012***	0.007***	0.007***	0.005***
		(0.000)	(0.000)	(0.000)	(0.000)
× Number of vacancies		-0.000**	-0.000	-0.000***	-0.000**
		(0.000)	(0.000)	(0.000)	(0.000)
JHS median BECE score					
× Colonial			-0.005	-0.021	0.056
			(0.023)	(0.032)	(0.050)
× SSCE pass rate			0.006***	0.004**	0.010**
			(0.001)	(0.002)	(0.004)
× Public			-1.272*	-1.424*	-4.432***
			(0.771)	(0.821)	(0.955)
× Single sex			0.055**	-0.003	0.054
			(0.028)	(0.040)	(0.072)
× Boarding facilities			0.215***	0.217***	0.331***
			(0.041)	(0.049)	(0.085)
× Distance			0.007***	0.006***	0.005***
			(0.000)	(0.001)	(0.001)
× Number of vacancies			-0.000	0.000	0.000
			(0.000)	(0.000)	(0.000)

Notes: Dependent variable is an indicator for the student's first choice school. Alternatives consist of five next most selective schools relative to the student's first choice (measured by median exam score of students admitted to school in previous year). Regressions also include distance squared and number of programs offered. Standard errors are clustered at the junior high school level, *p<0.1, **p<0.05, ***p<0.01.

Table 7: Changes in Application Choices and Admission Outcomes

		Selectivity of Choices			Admission Outcomes		
	DMQ Index (1)	Portfolio Average (2)	First Choice (3)	Last Choice (4)	Selectivity of SHS (5)	Peer Quality in SHS (6)	SSCE Pass Rate (7)
Panel A. 2007-2008 Reform: Increase from 4 to 6 choices							
JHS median BECE	0.107***	0.137***	0.050***	0.212***	0.082***	0.114***	0.012
	(0.016)	(0.007)	(0.008)	(0.007)	(0.006)	(0.005)	(0.114)
After reform	-0.834***	-0.117***	0.173***	-0.328***	0.151***	-0.006**	1.709***
	(0.012)	(0.004)	(0.005)	(0.005)	(0.003)	(0.003)	(0.110)
After reform × JHS median BECE	0.007	-0.074***	0.074***	-0.283***	0.096***	0.023***	1.506***
	(0.014)	(0.004)	(0.006)	(0.007)	(0.004)	(0.003)	(0.108)
R^2	0.135	0.586	0.458	0.308	0.717	0.752	0.355
N	315372	315372	315372	315372	315372	315372	267949
Panel B. 2008-2009 Reform: Categorization and restrictions							
JHS median BECE	0.077***	0.105***	0.080***	0.064***	0.123***	0.120***	0.332***
	(0.012)	(0.005)	(0.009)	(0.004)	(0.005)	(0.004)	(0.112)
After reform	0.375***	-0.040***	0.035***	-0.264***	-0.023***	0.008***	-1.436***
	(0.011)	(0.004)	(0.006)	(0.005)	(0.003)	(0.003)	(0.137)
After reform × JHS median BECE	0.063***	-0.065***	-0.027***	-0.098***	-0.035***	-0.044***	0.363***
	(0.015)	(0.004)	(0.008)	(0.006)	(0.005)	(0.004)	(0.133)
R^2	0.146	0.618	0.466	0.185	0.720	0.753	0.340
N	325113	325113	325113	325113	325113	325113	312856

Notes: Table reports coefficients from a set of difference-in-differences regressions. The top panel analyzes the 2008 reform which increased the maximum number of applications from four to six choices. The bottom panel analyzes the 2009 reform which imposed a shift from six unrestricted choices to six restricted choices under the new categorization system. The period "before" a reform is the preceding year, the period "after" is the year of the reform. Outcome of interest is indicated at the top of each column. DMQ Index is an index of students' decision-making quality, as outlined in Appendix A.3. School selectivity measures the median exam score of students admitted in the previous year. Peer quality measures the median exam score of students admitted in the current year. Regressions include controls for individual BECE score, an indicator for attending a public JHS, and district fixed effects. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Table 8: Changes in Application Choices and Admission Outcomes

	DMQ Index (1)	Selectivity of Choices: Elite SHS (2)	Selectivity of Choices: Colonial SHS (3)	Selectivity of Choices: Category A SHS (4)	Admission Outcomes: Elite SHS (5)	Admission Outcomes: Colonial SHS (6)	Admission Outcomes: Category A SHS (7)
Panel A. 2007-2008 Reform: Increase from 4 to 6 choices							
JHS median BECE	0.107***	0.031***	0.020***	0.028***	0.028***	0.023***	0.027***
	(0.016)	(0.005)	(0.005)	(0.004)	(0.003)	(0.003)	(0.004)
After reform	-0.834***	0.001	-0.002	0.068***	-0.000	-0.001	-0.013***
	(0.012)	(0.003)	(0.003)	(0.003)	(0.001)	(0.001)	(0.002)
After reform × JHS median BECE	0.007	0.011***	0.015***	0.003	0.004	0.004*	0.016***
	(0.014)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
R^2	0.135	0.234	0.247	0.231	0.197	0.230	0.236
N	315372	315372	315370	315372	315372	314559	315372
Panel B. 2008-2009 Reform: Categorization and restrictions							
JHS median BECE	0.077***	0.040***	0.035***	0.018***	0.036***	0.035***	0.038***
	(0.012)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.003)
After reform	0.375***	-0.029***	-0.013***	0.025***	-0.005***	-0.007***	-0.011***
	(0.011)	(0.003)	(0.004)	(0.004)	(0.002)	(0.002)	(0.003)
After reform × JHS median BECE	0.063***	-0.025***	-0.027***	-0.014***	-0.011***	-0.014***	-0.015***
	(0.015)	(0.004)	(0.004)	(0.004)	(0.003)	(0.003)	(0.004)
R^2	0.146	0.212	0.249	0.217	0.186	0.216	0.248
N	325113	325113	325113	325113	325113	325113	325113

Notes: Table reports coefficients from a set of difference-in-differences regressions. The top panel analyzes the 2008 reform which increased the maximum number of applications from four to six choices. The bottom panel analyzes the 2009 reform which imposed a shift from six unrestricted choices to six restricted choices under the new categorization system. The period "before" a reform is the preceding year, the period "after" is the year of the reform. Outcome of interest is indicated at the top of each column. DMQ Index is an index of students' decision-making quality, as outlined in Appendix A.3. Elite SHS is an indicator for applying (Column 2) or being admitted (Column 5) to an elite senior high school, similarly for colonial schools (in Columns 3 and 6) and Category A schools (in Columns 4 and 7). All regressions include controls for individual BECE score, an indicator for attending a public JHS, and district fixed effects. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Box 1: Timeline for School Selection and Placement in Ghana (2005-2008)

1. **Students Submit Choices**
   - **October**: West Africa Exam Council (WAEC) registers students for Basic Education Certification Exam (BECE)
     - Collects students' lists of program choices
     - Provides CSSPS Secretariat with data on student backgrounds and choices
2. **Schools Declare Vacancies**
   - **January**: Ministry of Education supplies CSSPS Secretariat with
     - register of all JHSs
     - register of all SHSs (with numbers of program vacancies)
3. **Student Quality Revealed**
   - **April**: Students take the BECE exams
4. **Students Admitted to Schools**
   - **July/August**: WAEC sends scores to CSSPS Secretariat which then
     - Assigns each student an aggregate score based on performance in 4 core and 2 best subjects
     - Places qualified students in schools according to ranked choices and deferred acceptance algorithm, with priority determined by aggregate BECE scores
   - **A few weeks** after CSSPS Secretariat receives BECE results:
     - Placement results released and displayed in junior and senior high schools or retrieved by text messaging candidate IDs to the CSSPS Secretariat

Box 2: History of School Choice Reforms in Ghana

- 2005: Computerization
  - shift from a manual admission system
  - students can apply to 3 choices anywhere in the country
  - schools have limited input in admission process
- 2007: Increase in number of permitted choices, from 3 to 4
- 2008: Increase in number of permitted choices, from 4 to 6
- 2009: School categorization reform (guidelines quoted from MOES (2005))
  1. All second cycle institutions have been grouped into categories as follow:
     - Senior High Schools: four (4) categories namely A, B, C, and D depending on available facilities (e.g. single sex, boarding and day, geographical location).
     - Technical Institutes (T).
     - Private Schools (P).
  2. Before making any selection of schools and programmes offered in these schools, parents are advised to note the following:
     - All schools selected (1st to 6th) are considered in the placement of candidates
     - Placement in schools is based on scores obtained by candidates (Merit)
  3. Conditions for Selection of Schools
     - Candidates must choose six schools (1st - 6th choice).
     - Candidates must select a programme and accommodation for each choice.
     - Candidates must not choose one school twice.
     - Candidates cannot choose more than one (1) school in category A.
     - Candidates cannot choose more than two (2) schools in category B.
     - Candidates may choose a maximum of 5 schools from category C or D.
  4. Note: Regardless of the categories, candidates must arrange their choices in order of preference.

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A Appendix

A.1 Student Optimal Stable Matching Mechanism

Note that academic performance is the ultimate determinant of school assignment in the CSSPS and no preferential treatment is given to students for listing a school as a first choice. Thus, there is no penalty for ranking schools in true preference order within the set of listed choices. This contrasts with the *Boston mechanism* (formerly used by Boston public schools and several other school districts in the United States) which assigns students based on their first choices in the same way but then keeps these initial assignments for all subsequent rounds and does not allow higher priority students to displace students already assigned to a school in a preceding round. There are clear incentives for making a strategic first choice under the *Boston mechanism* which do not apply under the *deferred-acceptance algorithm*. The CSSPS technical working committee produced a handbook outlining a set of "Guidelines for Selection and Admission into Senior Secondary Schools and Technical/Vocational Institutes" (MOES (2005)). The publication highlights the issue of "Displacement of 1st choice candidates and 2nd choice candidates as a matter of merit or better performance" and emphasizes the notion that placement priority is based on "merit not choice". (p.4)

The *deferred-acceptance algorithm* has several desirable properties when students are allowed to rank all schools - it is student optimal, strategy proof and eliminates "justified envy"[25] (Gale and Shapley (1962); and Abdulkadiroğlu and Sönmez (2003)). The attractiveness of this mechanism decreases only slightly when students are forced to make a constrained choice with an opportunity to rank only a limited number of schools (Abdulkadiroğlu, Pathak, and Roth (2009), p.30). However, the CSSPS's merit-based priority may create incentives for strategic behavior because students are encouraged to select schools according to their anticipated BECE scores and expected admission chances. The mechanism has been shown to be stable and strategy proof. It is not Pareto efficient, however, it is Pareto optimal relative to all other stable matching algorithms (Haeringer and Klijn (2009)).

A.2 Equilibrium Solutions to School Choice Problem

This section demonstrates the implications that constrained choice and imperfect information have for the complexity of the school choice problem. Denote the optimal application set for a student with beliefs $B(\tilde{p}_1, \cdots, \tilde{p}_M)$ by $A^*(\tilde{P})$ and its s^{th} element by $s^*(\tilde{P})$. We can

[25] This requires that there should be no unmatched student-school pair (i, s) where student i prefers school s to her final assignment and has higher priority than another student who is assigned to school s.

then consider three cases: 1) perfect information, 2) unconstrained choice, and 3) imperfect information with constrained choice. Examining all three cases in turn illustrates how institutional features alter the school choice problem.

Case 1: Perfect Information In the case of perfect information, there is no uncertainty about admission prospects so students know that they are either guaranteed admission to a school or certain to be rejected. We can summarize the information set as follows: $\tilde{p}_{is} = p_{is} \in \{0, 1\}$. In this case, the student solves:

$$A^* \left(\tilde{P}\right) = \max_{A \subseteq S} f\left(A\right) = \max\left(U_{is} \mid p_{is} = 1,\ U_{is} > 0\right) \tag{13}$$

The optimal solution is to apply to the most preferred choice in the set of schools to which admission is guaranteed. Thus, the application set consists of only one school - that which gives the student the highest payoff for attending.

Case 2: Unconstrained Choice In the absence of constraints on the number of applications one can submit, the maximum application set is equivalent to the full set of available choices, $n = M$. Thus, the student chooses:

$$A^* \left(\tilde{P}\right) = \left(1, 2, \ldots, N^*\right), \, where \, \left(U_{i1} > \ldots > U_{iN^*} > 0\right) \tag{14}$$

The solution is to apply to all schools in the choice set which yield positive utility. In practice, this case is evident in school choice programs which have no limit on the number of schools that students can list. Even with uncertainty about admission prospects, students can avoid the complex optimization problem because there is no cost to listing the full set of schools.

Case 3: Imperfect information with constrained choice In this case, there is uncertainty about admission prospects so that $\tilde{p}_s \in [0, 1)$. Additionally, there are some constraints on the number of schools to which students can apply, which means that $n < M$. Under these conditions, there is no simplification so the student must solve the full optimization problem outlined in Section 3:

$$A^* \left(\tilde{P}\right) = \max_{A \subseteq S} f\left(A\right) - c\left(|A|\right) \tag{15}$$

A.3 Measures of Decision-Making Quality

I do not observe students' expected admission chances in the data, but I do observe school selectivity, given by the performance distribution of students admitted to the school in previous years. Noting that admission chances (p_{is}) are inversely correlated with school selectivity (q_s), I use six measures to evaluate the quality of students' decision making:

1. $q_{i1} > q_{i2} > \ldots > q_{iN}$: choices are strictly ranked in order of selectivity.

2. $q_{i1} \geq q_{i2} \geq \ldots \geq q_{iN}$: choices are weakly ranked in order of selectivity.

3. $q_{i1} + 0.1 \geq q_{i2}, \;\; q_{i2} + 0.1 \geq q_{i3}, \ldots \geq q_{iN}$: choices are weakly ranked in order of selectivity, allowing for a band of 0.1 standard deviations around the selectivity level of each school.

4. $q_{i1} + 0.2 \geq q_{i2}, \;\; q_{i2} + 0.2 \geq q_{i3} \ldots \geq q_{iN}$: choices are weakly ranked in order of selectivity, allowing for a band of 0.2 standard deviations around the selectivity level of each school.

5. $q_{i1} = \max(q_i)$ and $q_{iN} = \min(q_i)$: the highest-ranked choice is the most selective school in a student's portfolio and the lowest-ranked choice is the least selective school.

6. $q_{i1} \geq q_{iN}$: the highest-ranked choice is weakly more selective than the lowest-ranked choice.

Finally, I also construct a decision-making index which assigns a value of 6 to students who satisfy condition (1), a value of 5 to those who satisfy condition (2), and so on, assigning a value of 1 to students who satisfy condition (6) and a value of 0 to those who fail to satisfy any of the six conditions. The final row in each panel of Table 4 indicates the share of students who satisfy each condition in a given year. For the most part of my analysis, I use condition (6) as my preferred measure of decision-making quality since it predicts the largest change in the selectivity of senior high schools to which students gain admission.

A.4 CSSPS Guidelines

Students applying to secondary schools in Ghana do not receive much guidance. The CSSPS issues a handbook which provides limited advice to students about their selection of schools MOES (2005). First, the guidelines specifically instruct students to be truthful about their *ordering* of choices, urging that "choices must be listed in order of preference" (p.5). However, the handbook also emphasizes that applicants should make a calculated application decision because they are only allowed to list a limited number of choices and are not guaranteed admission to any particular default school:

> Parents should take the registration exercise seriously and select schools where their wards chances of admission are brightest. Over-estimation and under-estimation of candidates' academic capabilities should be avoided. (p.9)

In outlining the Roles and Responsibilities of Candidates, the document states that "[c]andidates must assess their chances of gaining admission into very competitive Senior Secondary schools" and concludes that "[it] is therefore important to make realistic choices in order to make the new system effective" (p.10-11). The CSSPS handbook therefore emphasizes that certain students could benefit from choosing their *set* of listed schools carefully. Thus, students receive two primary instructions: to carefully consider their admission prospects when selecting schools and to rank selected choices truthfully.

The complexity of the choice problem and features of the optimal portfolio naturally suggest the use of a rule of thumb as an alternative to explicitly solving the optimization problem. Although this may not always be optimal, a rule of thumb provides an easy means to approximate the optimal portfolio choice when agents are hampered by decision-making costs or limitations. In particular, suppose that schools lie on a continuum of desirability and selectivity. On one end of this spectrum, a *reach* school represents a highly preferred school which is highly selective. The *safety* school is at the other end of the spectrum and reflects a less preferred option but one which has lower admission standards and so ensures a successful application. In the middle lie a set of *match* schools where admission chances are favorable and there is strong appeal. Students can approximate the best portfolio by applying to at least one reach, one match, and one safety school.[26] Additionally, it is optimal to rank schools based on payoffs and admission standards.

The new conditions imposed by the Ghanaian categorization reform are similar in spirit to the reach, match and safety school rule of thumb. Category A primarily consists of more selective "reach" schools, Category B of less selective schools and Categories C and D consist of the least selective schools. The key restriction in the program, however, is that these categorizations are specified in absolute terms and not in relation to an individual student's expected admission chances.

[26] This rule of thumb is a commonly accepted guideline for college choice in the US. The website www.go4ivy.com define the following thresholds for school types: Reach/Stretch: 1 to 49 percent admission chance, Match/Likely: 50 to 85 percent, Safety: 86 to 99 percent. "We recommend that you choose at least two colleges in each category (stretch, likely, safety) to help maximize your chances of getting in. Try to minimize the number of schools in the outer ranges. For example, consider applying to no more than one single-digit stretch school (i.e. 7%) because such schools do not match your background well. You can probably find an equally prestigious school where you have a better chance of getting in." (Go4ivy (2010))

Table A.1: Summary Statistics by Year

	2005	2006	2007	2008	2009
Panel A: Student Characteristics					
Age	17.014	17.100	17.168	17.133	17.251
Male	0.554	0.548	0.546	0.549	0.543
Attended a public JHS	0.837	0.822	0.838	0.847	0.798
Number of classmates	77.431	63.857	63.443	62.879	66.738
Application Choices					
Number of choices permitted	3	3	4	6	6
Listed maximum number of choices	0.983	0.981	0.993	0.938	1.000
Admission Outcomes					
Qualified for admission	0.555		0.520	0.472	0.462
Number of qualified students	162,077		167,279	160,936	183,484
Admitted to first choice	0.270		0.254	0.282	0.287
Administratively assigned	0.195		0.010	0.000	0.006
Admitted to school in JHS district	0.412		0.393	0.390	0.334
Admitted to school in JHS region	0.761		0.765	0.756	0.747
Distance to admitted school (miles)	28.346		31.209	32.099	33.463
Admitted to boarding school	0.563		0.672	0.657	0.617
Observations	292,070	309,911	321,891	340,823	379,279
Panel B: School Characteristics					
Public	0.939	0.817	0.813	0.786	0.806
Mixed	0.917	0.916	0.915	0.916	0.905
Males only	0.037	0.037	0.037	0.035	0.037
Females only	0.046	0.047	0.048	0.049	0.057
Technical or vocational institute	0.123	0.123	0.123	0.123	0.121
Has boarding facilities	0.442	0.504	0.513	0.514	0.538
Programs per school (mean)	2.624	3.624	4.040	4.012	4.306
Vacancies Reported					
Vacancies per program (mean)	66.481	63.859	75.572	65.012	88.068
Vacancies per school (mean)	246.682	242.248	313.886	260.807	366.225
Total number of vacancies	160,590	159,157	204,340	176,566	235,849
Academic Performance					
SSCE pass rate in core subjects	53.395	63.369	68.917	71.119	70.609
SSCE pass rate in mathematics	45.171	66.806	54.027	60.477	50.898
Observations	651	657	649	677	644

Notes: Data on admission outcomes for 2006 are incomplete.

Table A.2: Differences in Application Choices and Admission Outcomes

	Selectivity of Choices			Admission Outcomes	
	Portfolio Average (1)	First Choice (2)	Last Choice (3)	Selectivity of SHS (4)	Peer Quality in SHS (5)
Student's BECE	0.218***	0.410***	0.055***	0.592***	0.633***
	(0.001)	(0.003)	(0.002)	(0.004)	(0.004)
JHS median BECE	0.084***	0.079***	0.048***	0.131***	0.120***
	(0.004)	(0.007)	(0.007)	(0.005)	(0.004)
JHS public	-0.164***	-0.329***	-0.009	-0.046***	-0.037***
	(0.007)	(0.011)	(0.012)	(0.006)	(0.005)
District FEs	Yes	Yes	Yes	Yes	Yes
R^2	0.542	0.436	0.090	0.653	0.706
N	484248	484248	484248	483643	484248

Notes: Table reports coefficients from a set of linear regressions. Outcome of interest is indicated at the top of each column. School selectivity measures the 5th percentile exam score of students admitted in the previous year. Peer quality measures the 5th percentile exam score of students admitted in the current year. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Table A.3: Differences in Decision-Making Quality

	Full sample (1)	Qualified students (2)	Qualified, low-performing public JHS (3)	Qualified, high-performing public JHS (4)	Qualified, private JHS (5)
$q_{i1} > q_{i2} > \ldots > q_{iN}$	0.063	0.090	0.053	0.088	0.134
$q_{i1} \geq q_{i2} \geq \ldots \geq q_{iN}$	0.090	0.123	0.082	0.120	0.171
$q_{i1} + 10 \geq q_{i2},\ q_{i2} + 10 \geq q_{i3}, \ldots \geq q_{iN}$	0.176	0.202	0.169	0.196	0.246
$q_{i1} + 20 \geq q_{i2},\ q_{i2} + 20 \geq q_{i3} \ldots \geq q_{iN}$	0.275	0.294	0.270	0.284	0.336
$q_{i1} = \max(q_i)$ and $q_{iN} = \min(q_i)$	0.214	0.280	0.183	0.274	0.395
$q_{i1} \geq q_{iN}$	0.816	0.874	0.814	0.877	0.934
Mean index of decision-making quality	1.753	1.981	1.705	1.953	2.326
Std. deviation of school selectivity	0.611	0.706	0.553	0.711	0.866
N	970592	484248	140720	213913	129615

Notes: Table indicates the share of students whose ranking of application choices satisfies a given measure of decision-making quality, for example: choices are strictly ranked in order of selectivity (row (1)) or choices are weakly ranked in order of selectivity (row (2)). The index of decision-making quality in row (7) assigns a value of 6 to students whose choices satisfy the condition in row (1), a value of 5 to those who satisfy the condition in row (2), and so on, assigning a value of 0 to those who fail to satisfy any of the six conditions. School selectivity is measured by the 5th percentile exam score of students admitted in the previous year.

Table A.4: Importance of Decision-Making Quality

		Selectivity of Choices			Admission Outcomes	
	DMQ Index (1)	Portfolio Average (2)	First Choice (3)	Last Choice (4)	Selectivity of SHS (5)	Peer Quality in SHS (6)
Student's BECE	0.297***	0.212***	0.363***	0.081***	0.582***	0.625***
	(0.005)	(0.001)	(0.002)	(0.002)	(0.004)	(0.004)
JHS median BECE	0.012	0.084***	0.077***	0.049***	0.130***	0.119***
	(0.010)	(0.004)	(0.007)	(0.008)	(0.005)	(0.004)
JHS public	-0.227***	-0.159***	-0.292***	-0.029**	-0.038***	-0.031***
	(0.015)	(0.007)	(0.010)	(0.012)	(0.006)	(0.005)
DMQ index		0.021***	0.160***	-0.086***	0.033***	0.025***
		(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
District FEs	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.059	0.546	0.503	0.157	0.657	0.709
N	484248	484248	484248	484248	483643	484248

Notes: Table reports coefficients from a set of linear regressions. Outcome of interest is indicated at the top of each column. School selectivity measures the 5th percentile exam score of students admitted in the previous year. Peer quality measures the 5th percentile exam score of students admitted in the current year. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.

Table A.5: Discrete Choice Model Estimates (Males)

	All Qualified Students			Public JHS Students	
				All	Elite SHS in District
Choice characteristic	(1)	(2)	(3)	(4)	(5)
Colonial	0.614***	0.604***	0.605***	0.578***	0.865***
	(0.018)	(0.017)	(0.017)	(0.023)	(0.033)
SSCE pass rate	0.012***	0.018***	0.020***	0.016***	0.015***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Public	3.677***	3.653***	3.924***	3.871***	3.996***
	(0.330)	(0.327)	(0.412)	(0.486)	(0.802)
Single sex	1.137***	0.683***	0.664***	0.528***	0.462***
	(0.024)	(0.023)	(0.023)	(0.029)	(0.047)
Boarding facilities	1.104***	1.167***	1.161***	1.176***	1.086***
	(0.019)	(0.020)	(0.022)	(0.026)	(0.042)
Distance	-0.044***	-0.048***	-0.047***	-0.051***	-0.043***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Number of vacancies	0.002***	0.002***	0.003***	0.003***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Student's BECE score					
× Colonial		0.071***	0.009	0.012	-0.020
		(0.018)	(0.018)	(0.023)	(0.036)
× SSCE pass rate		0.012***	0.007***	0.006***	0.011***
		(0.001)	(0.001)	(0.001)	(0.002)
× Public		-1.287***	-0.369	-1.092***	-1.618
		(0.362)	(0.525)	(0.415)	(1.007)
× Single sex		0.493***	0.599***	0.660***	0.693***
		(0.018)	(0.022)	(0.026)	(0.045)
× Boarding facilities		0.007	0.009	0.037	0.087*
		(0.020)	(0.023)	(0.026)	(0.044)
× Distance		0.010***	0.004***	0.005***	0.003***
		(0.000)	(0.000)	(0.000)	(0.000)
× Number of vacancies		-0.000	-0.001***	-0.001***	-0.000***
		(0.000)	(0.000)	(0.000)	(0.000)
JHS median BECE score					
× Colonial			0.087***	0.109***	0.113*
			(0.028)	(0.039)	(0.060)
× SSCE pass rate			0.008***	0.004***	-0.001
			(0.001)	(0.002)	(0.003)
× Public			-1.459*	-0.304	-0.633
			(0.783)	(1.170)	(2.270)
× Single sex			-0.176***	-0.233***	-0.205***
			(0.030)	(0.040)	(0.066)
× Boarding facilities			0.017	0.017	0.186**
			(0.035)	(0.044)	(0.079)
× Distance			0.009***	0.006***	0.006***
			(0.000)	(0.001)	(0.001)
× Number of vacancies			0.001***	0.001***	0.001***
			(0.000)	(0.000)	(0.000)

Notes: Dependent variable is an indicator for the student's first choice school. Alternatives consist of five next most selective schools relative to the student's first choice (measured by 5th percentile exam score of students admitted to school in previous year). Regressions also include distance squared and number of programs offered. Standard errors are clustered at the junior high school level, *p<0.1, **p<0.05, ***p<0.01.

Table A.6: Discrete Choice Model Estimates (Females)

	All Qualified Students			Public JHS Students	
				All	Elite SHS in District
Choice characteristic	(1)	(2)	(3)	(4)	(5)
Colonial	0.560***	0.601***	0.600***	0.546***	0.577***
	(0.017)	(0.017)	(0.017)	(0.023)	(0.039)
SSCE pass rate	0.006***	0.011***	0.011***	0.009***	0.009***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Public	1.973***	2.013***	2.116***	2.200***	3.215***
	(0.436)	(0.359)	(0.359)	(0.394)	(0.753)
Single sex	1.221***	1.108***	1.099***	1.039***	0.902***
	(0.019)	(0.020)	(0.020)	(0.026)	(0.042)
Boarding facilities	1.230***	1.335***	1.334***	1.343***	1.366***
	(0.023)	(0.028)	(0.028)	(0.034)	(0.056)
Distance	-0.038***	-0.042***	-0.043***	-0.047***	-0.038***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)
Number of vacancies	-0.001***	-0.000***	-0.000**	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Student's BECE score					
× Colonial		0.076***	0.081***	0.069**	0.063
		(0.016)	(0.021)	(0.028)	(0.045)
× SSCE pass rate		0.009***	0.008***	0.006***	0.013***
		(0.001)	(0.001)	(0.001)	(0.002)
× Public		-1.537***	-0.896**	-1.034**	-0.046
		(0.292)	(0.389)	(0.405)	(0.186)
× Single sex		0.397***	0.327***	0.292***	0.361***
		(0.019)	(0.023)	(0.028)	(0.044)
× Boarding facilities		0.008	-0.078***	-0.076**	0.005
		(0.028)	(0.030)	(0.034)	(0.056)
× Distance		0.013***	0.008***	0.007***	0.006***
		(0.000)	(0.000)	(0.000)	(0.001)
× Number of vacancies		-0.001***	-0.001***	-0.001***	-0.001***
		(0.000)	(0.000)	(0.000)	(0.000)
JHS median BECE score					
× Colonial			0.001	-0.025	0.027
			(0.027)	(0.037)	(0.061)
× SSCE pass rate			0.003**	0.001	-0.001
			(0.001)	(0.002)	(0.003)
× Public			-1.005*	-1.319*	-3.387***
			(0.602)	(0.742)	(0.705)
× Single sex			0.106***	0.026	0.103
			(0.030)	(0.040)	(0.072)
× Boarding facilities			0.172***	0.189***	0.123
			(0.044)	(0.054)	(0.098)
× Distance			0.007***	0.006***	0.006***
			(0.000)	(0.001)	(0.001)
× Number of vacancies			-0.000	0.000	-0.000
			(0.000)	(0.000)	(0.000)

Notes: Dependent variable is an indicator for the student's first choice school. Alternatives consist of five next most selective schools relative to the student's first choice (measured by 5th percentile exam score of students admitted to school in previous year). Regressions also include distance squared and number of programs offered. Standard errors are clustered at the junior high school level, *p<0.1, **p<0.05, ***p<0.01.

Table A.7: Changes in Application Choices and Admission Outcomes

		Selectivity of Choices			Admission Outcomes	
	DMQ Index (1)	Portfolio Average (2)	First Choice (3)	Last Choice (4)	Selectivity of SHS (5)	Peer Quality in SHS (6)
Panel A. 2007-2008 Reform: Increase from 4 to 6 choices						
JHS median BECE	0.019	0.152***	0.063***	0.223***	0.128***	0.105***
	(0.015)	(0.006)	(0.009)	(0.007)	(0.007)	(0.007)
After reform	-0.657***	-0.156***	0.097***	-0.318***	0.145***	0.081***
	(0.012)	(0.005)	(0.008)	(0.005)	(0.005)	(0.004)
After reform × JHS median BECE	0.002	-0.105***	0.075***	-0.319***	0.040***	0.077***
	(0.014)	(0.007)	(0.009)	(0.007)	(0.008)	(0.007)
R^2	0.079	0.560	0.445	0.265	0.668	0.710
N	315372	315372	315372	315372	315372	315372
Panel B. 2008-2009 Reform: Categorization and restrictions						
JHS median BECE	-0.029***	0.088***	0.088***	0.040***	0.111***	0.134***
	(0.011)	(0.005)	(0.010)	(0.003)	(0.006)	(0.005)
After reform	0.262***	0.082***	0.184***	-0.162***	0.062***	-0.074***
	(0.010)	(0.004)	(0.007)	(0.004)	(0.004)	(0.003)
After reform × JHS median BECE	0.153***	-0.033***	-0.005	-0.064***	0.031***	-0.049***
	(0.014)	(0.005)	(0.008)	(0.005)	(0.006)	(0.005)
R^2	0.097	0.597	0.464	0.103	0.665	0.720
N	325113	325113	325113	325113	325113	325113

Notes: Table reports coefficients from a set of difference-in-differences regressions. The top panel analyzes the 2008 reform which increased the maximum number of applications from four to six choices. The bottom panel analyzes the 2009 reform which imposed a shift from six unrestricted choices to six restricted choices under the new categorization system. The period "before" a reform is the preceding year, the period "after" is the year of the reform. Outcome of interest is indicated at the top of each column. Regressions include controls for individual BECE score, an indicator for attending a public JHS, and district fixed effects. School selectivity measures the 5th percentile exam score of students admitted in the previous year. Peer quality measures the 5th percentile exam score of students admitted in the current year. Standard errors are clustered at the junior high school level and reported in parentheses, *p<0.1, **p<0.05, ***p<0.01.