SELF-SELECTION IN SCHOOL CHOICE

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Abstract. We study self-selection in centralized school choice, a strategy that takes place when students submit preferences before knowing their priorities at schools. A student self-selects if she decides not to apply to some schools despite being desirable. We give a theoretical explanation for this behavior: if a student believes her chances of being assigned to some schools are zero, she may not rank them even when the mechanism is strategyproof. Using data from the Mexico City high school match, we find evidence that self-selection exists, and has redistributive consequences. First, given the same past grade, students from low socio-economic backgrounds are more likely to self-select. Second, some students self-select by mistake, and obtain a high priority once the uncertainty is resolved, but nonetheless are not assigned to their most preferred choice exactly because of self-selection. Students from low socio-economic backgrounds are particularly vulnerable to this type of mistake. These findings question the effectiveness of equal access provided by school choice, and we argue it can be improved by changing the timing of submission.

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1. Introduction

School choice is aimed at "leveling the playing field": all students should have equal opportunities to choose the school they like, and whenever the number of applicants exceeds a school's capacity, transparent criteria are employed to decide who will be admitted. To this end, market designers have advocated the use of strategyproof mechanisms, which ensures that students can do no better than submitting preferences truthfully (Abdulkadiroglu and Sönmez, 2003; Roth, 2008). However, strategyproofness does not guarantee that students will submit truthfully. Indeed, strategyproofness only guarantees that truth-telling is a *weakly* dominant strategy, and lab evidence suggests that it may not be focal (Chen and Sönmez, 2006; Pais and Pintér, 2008). Therefore, whether non-truthful behavior occurs in the field and why remains an open question.

In this paper, we investigate the performance of a strategyproof mechanism in a novel situation where students have to submit preferences over schools before knowing their priorities. Using theory and data, we show that uncertainty induces students to skip selective schools despite being their preferred choices. Conditional on the same average grade from secondary school, students from low socio-economic backgrounds are more likely to do so. This behavior jeopardizes their chances of being admitted to schools that would have accepted them. Therefore, the uncertainty caused by the timing of submission, a seemingly innocuous design dimension, can deter students from low socio-economic backgrounds to apply to selective schools.[1]

The introduction of uncertainty about priorities is motivated by the high school match in Mexico City, where students are asked to submit a rank ordered list of high schools before taking a standardized exam. The exam scores then determine a strict and unique priority order, according to which the serial dictatorship mechanism is used to allocate students to schools.[2]

[1]Low application rates to selective schools of students from low socio-economic backgrounds is heatedly debated in many countries, including both centralized or decentralized admissions. See for example Avery, Hoxby, Jackson, Burek, Pope, and Raman (2006) for the case of college admissions in the US. This problem is also present in the UK. As a result, the University of Cambridge has established GEEMA (Group to Encourage Ethnic Minority Applications) that aims at ensuring talented UK black and minority ethnic students are not deterred from applying to Cambridge.

[2]Submitting preferences prior to the knowledge of exam score takes place also in other countries, for example, college admissions in China, Hungary, Ireland, and UK. One difference in the UK is that the clearinghouse Undergraduate Courses At University And College (UCAS) does not employ a matching mechanism to assign students to universities or colleges. Its main task is to collect students' applications, and then send to each university or college to decide. Yet, similarly to the Mexican City case, at the time of applying, students have not obtained their final grades which determine their priorities at each university or college.

We begin by asking: *Does uncertainty about priorities matter even if the mechanism in place is strategyproof?* We approach this question first using theory. We introduce an incomplete information game to study students' equilibrium strategies. In this game, schools are not strategic as priorities are exogenously defined by exam scores, whereas students behave strategically. Their best responses depend crucially on their priors. We show that if the priors are such that **each** profile of other students' preferences and schools' priorities has a positive probability to occur, the **unique** equilibrium in the game induced by the serial dictatorship is to submit preferences truthfully. However, when the priors do not have full support, non-truthful behavior may arise at equilibrium.

The main concept of the paper is *self-selection*, a strategy by which a student does not top rank her most preferred school. Self-selection can be the consequence of equilibrium play as well as strategic mistake.[3] When a student assigns zero probability to be admitted by her most preferred school and therefore self-selects, it may well be that her score is indeed insufficient for this school after the score is revealed. In this case, self-selection is compatible with equilibrium. Alternatively, her score can be sufficient for attending this school, and then self-selection is a strategic mistake that leads to ex-post welfare loss for the student.

In the second step, we ask whether self-selection arises in the data, which cover the allocation of over 300,000 students to public high schools in Mexico City in 2010, as well as a survey conducted by the clearinghouse. To identify the true preferences of students, we utilize the survey information to select a sample of students for whom their most preferred choice belongs to a set of selective high schools affiliated to the *Universidad Nacional Autónoma de México* (UNAM), the most prestigious university in the country. Roughly 43 percent of the students are in our selected sample. When comparing to their actual submitted choices, we find one fifth of them self-select by not top ranking any UNAM high school. In a further analysis, we demonstrate that average grade from secondary school and family income, an indicator for socio-economic backgrounds, are the most important factors contributing to self-selection, after controlling for other variables including distance.

[3]Our concept of self-selection is related to self-selection in labor economics (Roy, 1951) and yet not to be confused with. In our study, students choose not to reveal preferences truthfully even when it is their best interests to do so. This implies that we should be cautious in interpreting the submitted choices as the true preferences. Similarly, in labor economics, as agents choose to participate in job, the observed economic relations are not viewed as the exogenous causal relations. However, self-selection in our case may not be optimal, whereas in labor economics, self-selection is an endogenous outcome of optimizing decisions.

We then go on to disentangle in data the cases where self-selection is consistent with equilibrium strategy from those where it is a consequence of strategic mistake. We say that self-selection is a strategic mistake if a student self-selects and finally obtains a score high enough to enter one of the UNAM high schools. According to this definition, about 23 percent of the self-selected students make a strategic mistake.

In the final step, in order to explore the consequences of self-selection, we correct the submission of those students that self-select by mistake. Compared to the current matching, the number of students from low socio-economic backgrounds rises by 5 percent, increasing social diversity within UNAM high schools.

Therefore, uncertainty about priorities indeed matters in practice. Even though the serial dictatorship mechanism is strategyproof, students may adopt non-truthful and potentially harmful behavior when exposed to uncertainty about priorities. A simple way to prevent strategic mistakes and improve the access of disadvantaged students to goods schools is perhaps to change the timing of preferences submission to after knowing priorities. This modification can be difficult due to institutional or logistic constraints. Alternatively, clear advice encouraging truth-telling without considering the chances of admissions, is important for helping low-income students. This recommendation is at odds with the current official advice by the clearinghouse which prompts students to self-select by recommending them to take expected priorities into account:

> *"Which is the best option? . . . In addition to your preferences, interests and circumstances, it is worth considering other factors before choosing your options. ... it turns out evidently that your chances of getting a place in the option you prefer more will depend on the score of your exam. In this sense,* ***you should be very conscious and objective about your likely performance****."*

Our paper offers two main insights beyond the specific matching problem studied here. First, we provide field evidence of a non-truthful behavior when a strategyproof mechanism is in place. We explore theoretically a new channel from which this behavior arises: given the uncertainty about schools' priorities, students form priors to decide about their strategies, which may trigger non-truthful submissions at equilibrium.

Second, the evidence of non-truthful behavior given in this paper, shows that treating submitted preferences as true preferences under strategyproof mechanisms can be problematic. By doing so, if some students of low socio-economic backgrounds do not apply to good schools, one might conclude that they do it simply because they prefer their submitted choices over good schools. However, our findings suggest that this conclusion is hasty if students are facing uncertainty about priorities. In fact, non-truthful behavior, and self-selection in particular, are induced by uncertainty. Therefore, we should expect changes in the application patterns of some students when the timing of preference submission is modified.

The rest of the paper is organized as follows. Section 2 discusses our results in the perspective of the related literature. Section 3 describes organization of the high school match in Mexico City. Section 4 provides a theory of self-selection in the high school match. Section 5 describes our data. Section 6 presents a first piece of evidence of self-selection, and then it gauges mistakes caused by self-selection. Section 7 compares the welfare improvement when all students play equilibrium strategies. Section 8 concludes.

2. Related Literature

Our study is related to several active strands of research. First of all the model of self-selection, is grounded in matching models with incomplete information. The extant literature in school choice mostly assumes complete information, which implies when applying for schools, students know about other students' preferences as well as schools' priorities. Roth (1989) is the first attempt to relax this assumption. His results show, under the strategyproof deferred acceptance mechanism (Gale and Shapley, 1962), even though truth-telling as a (weakly) dominant strategy carries over from complete information to incomplete information, the weaker Nash equilibrium characterization fails to do so. Ehlers and Massó (2007, 2015) further study incomplete information using Bayesian Nash equilibrium concept for stable mechanisms. Additionally, Chakraborty, Citanna, and Ostrovsky (2010), Liu, Mailath, Postlewaite, and Samuelson (2014) both explore a two-sided matching market where one side has incomplete information. The former studies the case where one side of the market has interdependent values, and shows that in general a stable matching mechanism may not exist, whereas the latter focuses on defining stability with respect to the matching. Our theoretical model builds on the incomplete information framework introduced by Ehlers and Massó (2015). Their paper analyzes a two-sided matching model with firms and workers, and shows a connection between Nash equilibrium under complete information and Ordinal Bayesian Nash equilibrium under incomplete information. We show that truth-telling as a unique equilibrium exists when one side of the market, schools, is not strategic (as it is generally the case in school choice) and students' priors have full support.

Second, our finding of self-selection in the Mexico City high school match relates to a few recent studies that aim to investigate whether students indeed behave according to theoretic predictions. Chen and Sönmez (2006) find in an experiment that 28 percent of the subjects do not report their preferences truthfully under the deferred acceptance mechanism, which is equivalent to the serial dictatorship when priorities are identical at every school as in our case. In a different experiment, Pais and Pintér (2008) assess the impact of information on students' strategies. When students have little information about schools' priorities and other students' preferences, students' non-truth-telling behaviors occur with similar percentage under both strategyproof and non-strategyproof mechanisms. As more information becomes available, strategyproof mechanism reduces non-truth-telling strategies significantly as compared to non-strategyproof mechanism. We find in data that under the strategyproof serial dictatorship students in the Mexico City some students choose not to submit preferences truthfully, confirming their results from lab. Of course, a policy change to complete information setting may not necessarily preclude all non-truthfull behaviors, but as we show in this paper, complete information prevents mistakes and gives the same outcome even when some of the students adopt non-truthfull strategy. Unlike experiments, the administrative and survey data allows us to go beyond documenting yet another evidence of non-truthfull behavior under strategyproof mechanism. We show a positive correlation between self-selection and socio-economic backgrounds and quantify the potential improvoment on social mix within the more selective UNAM high schools. Like our paper, Fack, Grenet, and He (2015) use administrative data from school choice in Paris and find students also adopt non-truthful behavior when a strategyproof mechanism is used. They further provide a tractable framework to estimate students' preferences without assuming truth-telling. Their key motivation for potential non-truthful behavior is rooted in the cost of ranking schools, whereas our explaination for self-selection focuses on the information channel. Hassidim, Marciano-Romm, Romm, and Shorrer (2015) look at data from the admission process to graduate studies in psychology in Israel and find preference misrepresentation under the strategyproof deferred acceptance mechanism.

Third, our paper links with an emerging literature on "under-matching" in college admissions in the US. Avery, Hoxby, Jackson, Burek, Pope, and Raman (2006) are among the first to identify the existence of "missing applicants", that is, students with high ability who do not apply to selective colleges. This fact is particularly strong among students from low-income families, known as the "high-achieving low-income' students (see also Dillon and Smith (2017), and Pallais (2015)). Self-selection is similar to under-matching: some students do not apply to good high schools, despite the fact that they are very likely to be admitted by these schools. Nonetheless, self-selection differs from under-matching in terms of the driving force behind. The main explanation for under-matching is difficulty in accessing information.[4] We are however compelled to search for reasons beyond the channel of accessing information due to the features of the Mexico City high school match. First and foremost, the match we study is coordinated through centralized procedures, simpler than the decentralized market for college admissions in the US. This centralized match charges a low application fee that is independent of the number of schools applied to, which was less than 23 USD in 2010. It provides students with equal access to information by publishing every year detailed information of all the available options (and the admission cut-offs of previous years). Second, students in our study are geographically concentrated in Mexico City and its metropolitan area, not in geographically isolated regions.

Finally, there are a few papers that study the high school match in Mexico City from different perspectives. In line with our finding, Ortega Hesles (2015) documents a static effect of socio-economic background on application patterns, and Estrada (2016) finds that the differences in application patters persist throughout time. Bobba and Frisancho (2016) is perhaps the closest to our paper as they also look at the role of beliefs on students' high-school choices. They run a mock exam and communicate individual scores to a randomly chosen subset of students. This feedback convinces those who have a higher score from the mock to apply more often to academically-oriented high school programs, whereas those with a lower score to apply less often to these programs. The main difference with our paper is that they consider the case where students have uncertainty about their preferences, and the mock allows them to better access their fit with the programs. In our paper, we consider students know their true preferences, but have uncertainty about their future exam performance.

3. The Mexico City high school match

This section summarizes the key elements in the organization of the Mexico City High School Match, which provide motivation for our modeling choices and the way we interpret our data.

[4]The high-achieving low-income students who do not apply to selective institutions often come from small districts that are geographically isolated, supporting the argument of difficulty in accessing valuable information (Hoxby and Avery, 2013). Hoxby and Turner (2015) demonstrate that after receiving information about the cost of college and financing options, the availability of the curricula and peers, and the different types of colleges available to them, students have a higher probability of applying to selective colleges.

The current match has been administrated by the *Comisión Metropolitana de Instituciones Públicas de Educación Media Superior* (COMIPEMS) since 1996. It handles applications from students who are leaving secondary schools to public high schools. Most students in Mexico City go to free public high schools, which cover roughly 81 percent of the total school-age students in 2011 (INEE, 2011).[5] There are three types of public high schools that students can choose from: academic schools (Bachillerato General), technical schools (Bachillerato Tecnológico), and vocational schools (Carrera Técnica). Only the first two types of schools prepare students for higher education. Each high school is managed by a public institution, and there are 9 such public institutions. We focus in this paper on high schools that offer academic courses, and in particular, those that are managed by the UNAM which are generally viewed as selective high schools.[6]

One feature of the match is that students are asked to submit their preferences before knowing their exam scores (see Figure 1). Prior to this, in *late January*, students receive brochures from the clearinghouse, which explain application instructions, and contain information about available options as well as admission cut-offs of previous years.

In *March*, students submit an application form where they can rank up to 20 school options.[7] In addition, students are asked to fill out a survey questionnaire. The response is voluntary, however strongly recommended by the clearinghouse.

In *June*, all students simultaneously take a standardized exam.[8] The exam score is used to determine student's priority in the subsequent match. To be eligible for the match, a minimum score of 31 out of a total score of 128 is required, as well as proof of finishing secondary school.[9] The latter certificate has to be presented by *mid July*.

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[5]Education in Mexico is compulsory from the age of 6 to 17. Elementary school provides education from the of age 6 to 11, secondary school from the age 12 to 14, and high school from the age 15 to 17. Private schools exist especially at high school level where students have to pay a significant amount for tuition fees. Most private schools offer international curriculum that aim to prepare students for studying in universities aboard. Nevertheless, private schools remain a relatively small share as compared to public high schools.

[6]In addition, *Instituto Politécnico Nacional* (IPN) is the other institution that operates technically-oriented selective high schools.

[7]As we argue in Section 6.1, this restriction is not binding for almost all students as only 3 percent of them use the full list.

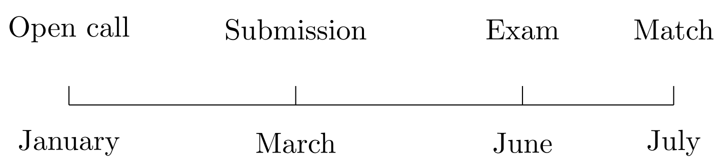
[8]There are two versions of the exam. Applicants who listed a UNAM-affiliated school as their first choice must take UNAM's version of the exam, while the rest take the version of the National Center of Evaluation for Higher Education (CENEVAL). These exams are supposed to be "technically equivalent" in content and difficulty, and to have a high degree of reliability, validity, lack of bias, and equity (COMIPEMS, 2012).

[9]This minimum score requirement was abolished as of 2013 as an endeavor to extend compulsory education to high school level.

If a student wants to apply to UNAM high schools, a minimum average grade of 7 in the secondary school (from a scale of 10) is also required.

In *late July*, the match takes place in two phases. In the *first phase*, the clearinghouse uses the *serial dictatorship* (SD) mechanism. The mechanism takes priorities, submitted preferences, and capacities as the main inputs. It assigns the student with the highest priority her most favorite choice, then proceeds to the student with the next highest priority and assigns her the most favorite choice that is still available, and so forth. When more than one student has the same score, the clearinghouse assigns them together to their most favorite choice which is still available. If there are more students with the same score than the remaining seats, the clearinghouse consults the school either to take all or reject all tied students.[10] The *second phase* is decentralized, and is meant for students who remain unassigned because all of their submitted options are full.

FIGURE 1. The timing of the Mexico City high school match



4. Theoretical Framework

In the Mexico City high school match, students do not observe their priorities when submitting preferences. This clearly departs from the standard school choice model of complete information where students are assumed to know the priorities. In this section, we develop a school choice model with incomplete information that captures this salient feature. Moreover, our model also allows for the case that students do not observe other students' preferences.

We introduce first the main ingredients of the model. Let $S = \{s_1, \dots, s_m\}$ denote the set of schools, and I the finite set of students. We use the term school as in the literature, this is essentially the same as option. The capacity of school s_j is q_j, and $q = (q_1, \dots, q_m)$ is the vector with each school's capacity. The overall capacity does not exceed the total number of students, that is, $\sum_{j=1}^{m} q_j \leq |I|$. Consider a null

[10]This way of breaking ties makes the mechanism manipulable in theory. However, the manipulation is extremely difficult in practice as it requires complete knowledge of future priorities and other students' preferences.

school, denoted by s_0, which is used to accept unassigned students. Without loss of generality we suppose that s_0 is not scarce.

Students have strict preferences over the set of schools. Let P_i denote student i's preferences over $S \cup \{s_0\}$, and $\mathcal{P}_i$ the set of all possible preferences of student i. The notation sP_is' means that student i prefers school s over s', and when $s \equiv s_0$, then school s' is not acceptable for student i. Let R_i be the weak preferences associated with P_i. A preference profile is a vector in $\times_{i\in I}\mathcal{P}_i$. The exam scores form a common priority ranking of all students, and high scores are preferred over low scores. We assume that the priority order over students, P_s, is strict, and let $\mathcal{P}_s$ denote the set of all possible priority orders.

Apart from the uncertainty about priorities created in the match, each student's preferences over schools are private information. Let $\mathcal{P} = (\times_{i\in I}\mathcal{P}_i) \times \mathcal{P}_s$ denote the set of all preference profiles and priorities, and $\mathcal{P}_{-i} = (\times_{j\in I\setminus\{i\}}\mathcal{P}_j) \times \mathcal{P}_s$. Student i has a private prior $\tilde{P}^i$, which is a probability distribution over $\mathcal{P}$. Then, given the private prior $\tilde{P}^i$ and a preference P_i, student i updates her prior using a conditional probability $\tilde{P}^i_{-i}|P_i$. More precisely, let $\tilde{P}^i_{-i}|P_i$ denote the probability distribution which $\tilde{P}^i$ induces over $\mathcal{P}_{-i}$ conditionally on P_i. This conditional probability describes the uncertainty that she faces about the priority order as well as the other students' preferences. A profile of priors is a vector $\tilde{P} = (\tilde{P}^i)_{i\in I}$ specifying a private prior for each student.

When there is no uncertainty, a matching is a function $\mu : I \to S \cup \{s_0\}$, satisfying $|\mu^{-1}(s_j)| \leq q_j$ for every $j \in \{1, \ldots, m\}$. The set of all matchings is $\mathcal{M}$. Because in the match we study students face uncertainty, it is convenient to consider random matchings. A random matching $\tilde{\eta}$ is a probability distribution over the set of all matchings $\mathcal{M}$. Given $\mu \in \mathcal{M}$, let $\Pr\{\tilde{\eta} = \mu\}$ be the probability that $\tilde{\eta}$ assigns to μ. The random matching $\tilde{\eta}$ induces for each student i a probability distribution over schools that represents the probability with which the student is assigned to each school:

$$\Pr\{\tilde{\eta}(i) = s\} = \sum_{\mu\in\mathcal{M} \text{ s.t. } \mu(i)=s} \Pr\{\tilde{\eta} = \mu\}, \text{ for each } s \in S \cup \{s_0\}.$$

We fix throughout this paper the set of students I, the set of schools S and the capacity vector q. Thus, a mechanism is a function that maps the set of all preference profiles and priorities to the set of all possible matchings: $\phi : \mathcal{P} \to \mathcal{M}$. For each student i, and every possible preference profile and priority $P \in \mathcal{P}$, let $\phi_i[P]$ denote the school assigned to student i by the mechanism ϕ when preferences and priority order are P. A mechanism ϕ is **strategyproof** if truth-telling is a weakly dominant strategy for all students. Strategyproofness is desirable because it can reduce costly and risky non-truth-telling behavior by rewarding the truth-telling students with a no-worse outcome than if they had adopted any other strategy. The SD mechanism that we study is strategyproof. In addition, since schools have strict and identical priorities over students, the SD mechanism is also outcome equivalent to another strategyproof mechanism, the deferred acceptance mechanism.

A strategy of student i defines a rank order list of schools for each possible preference she may have, that is, a strategy is a function that maps the set of preferences into itself, $r_i : \mathcal{P}_i \to \mathcal{P}_i$. A strategy profile is a vector $r = (r_i)_{i \in I}$ that specifies for each preference profile in $\times_{i \in I} \mathcal{P}_i$ a profile of preferences to be submitted. We denote as r_{-i} a vector of strategies for all students different from i.

Given a mechanism ϕ and a prior $\tilde{P}^i$, a strategy profile r induces a random matching $\phi[r(\tilde{P}^i)]$ in the following way: for each $\mu \in \mathcal{M}$,

$$\Pr\{\phi[r(\tilde{P}^i)] = \mu\} = \sum_{P \in \mathcal{P}: \phi[r(P)] = \mu} \Pr\{\tilde{P}^i = P\}.$$

For student i the relevant random matching using Bayesian updating, given her type P_i and a strategy profile r, is $\phi[r_i(P_i), r_{-i}(\tilde{P}^i_{-i}|P_i)]$, where $r_{-i}(\tilde{P}^i_{-i}|P_i)$ is the probability distribution over the possible rank order lists other students submit.

We use an ordinal equilibrium concept as students are required to submit rank order lists over schools and not specific utility representations of their preferences. To introduce the equilibrium concept we first need to define how we compare two random matchings. Given two random matchings $\tilde{\eta}$ and $\tilde{\eta}'$, for each student i and $P_i \in \mathcal{P}_i$ we say that $\tilde{\eta}(i)$ *first-order stochastically* P_i *dominates* $\tilde{\eta}'(i)$, denoted by $\tilde{\eta}(i) \gtrdot \tilde{\eta}'(i)$, if for all $s \in S \cup \{s_0\}$,

$$\sum_{s' \in S \cup \{s_0\}: s' R_i s} Pr\{\tilde{\eta}(i) = s'\} \quad \geq \sum_{s' \in S \cup \{s_0\}: s' R_i s} Pr\{\tilde{\eta}'(i) = s'\}.$$

Finally, let $\tilde{P}^i_i$ be the marginal distribution of $\tilde{P}^i$ over the set of all her possible preferences $\mathcal{P}_i$.

Definition 1 (**Equilibrium Concept**)**.** Let $\tilde{P}$ be a profile of priors. A strategy profile r is an *ordinal Bayesian Nash equilibrium* (OBNE) in the revelation game induced by a mechanism ϕ under $\tilde{P}$, if for all $i \in I$ and all $P_i \in \mathcal{P}_i$ such that $\Pr\{\tilde{P}^i_i = P_i\} > 0$,

$$\phi_i[r_i(P_i), r_{-i}(\tilde{P}^i_{-i}|P_i)] \gtrdot \phi_i[P'_i, r_{-i}(\tilde{P}^i_{-i}|P_i)], \quad \text{for all } P'_i \in \mathcal{P}_i.$$

It is worth noting that the equilibrium concept is not restrictive. In fact, as Ehlers and Massó (2007) point out, an OBNE is equivalent to a Bayesian Nash equilibrium for every von Neumann–Morgenstern utility representation of the preference order.

A truth-telling OBNE is an OBNE strategy profile such that for every $i \in I$, $r_i(P_i) = P_i$ at every $P_i \in \mathcal{P}_i$ such that $\Pr\{\tilde{P}_i^i = P_i\} > 0$. To show truth-telling is indeed an OBNE in our setting, we need the following result that connects Nash equilibrium under complete information and OBNE under incomplete information.

Proposition 1 (**Equilibrium Strategy**). *A strategy profile r is an OBNE in the SD mechanism under incomplete information $\tilde{P}$ if and only if for all $i \in I$ and any $P \in \mathcal{P}$ in the support of $\tilde{P}^i$, $r_i(P_i)$ is a best response to $r_{-i}(P_{-i})$ in the revelation game induced by the SD under complete information P.*

Proposition 1 is implied by Theorem 1 of Ehlers and Massó (2015). Their result relates the concept of OBNE in an incomplete information setting to Nash equilibrium under complete information for any stable mechanism, and we consider the SD mechanism, which is stable under complete information. Thus, by this proposition, truth-telling is indeed an OBNE, because truth-telling is a weakly dominant strategy under complete information.

4.1. **The full-support case.** In this subsection we investigate under which condition truth-telling is the unique equilibrium. The support of a prior is the set of all elements of $\mathcal{P}$ on which the prior puts positive probability. This prior may vary across students, and it can have different supports. When $\tilde{P}^i$ is such that $\Pr\{\tilde{P}^i = P\} > 0$ for every possible preference profile and priority $P \in \mathcal{P}$, we say that $\tilde{P}^i$ has *full support*.

Theorem 1 (**Uniqueness**). *Let $\tilde{P}$ be a profile of priors such that $\tilde{P}^i_{-i}\,|P_i$ has full support for each $i \in I$ and $P_i \in \mathcal{P}_i$ with $\Pr\{\tilde{P}^i_i = P_i\} > 0$. Then, there exists a unique OBNE, which is the truth-telling OBNE.*

Theorem 1 says when each student's prior about other students' preferences and schools priority has full support, there exists a unique OBNE at which students submit truthfully. The proof (see Appendix A) is by contradiction, if the strategy of a student i is such that $r_i(P_i) \neq P_i$, we can construct some preferences for the other students and a priority order such that if i submits P_i she is assigned to a school which is preferred to her assignment under $r_i(P_i)$. The assumption of full support is crucial in this argument because once we construct the preferences and the priority, we know that every student plays, at any OBNE, a best response to the strategy of other students.

However, the converse part of Theorem 1 does not hold. Indeed, even if submitting truthfully is the unique OBNE, the priors of some students may not have full support. The following example demonstrates this.

Example 1. Consider a market with two schools $S = \{s_1, s_2\}$, each with a capacity of one seat, and two students $I = \{i_1, i_2\}$. Student i_2's prior has full support, so she submits truthfully at every OBNE. Student i_1 prefers s_1 over s_2, and she believes that for each possible priority order, the probability i_2 prefers s_2 over s_1 is zero. Thus, her prior does not have full support. However, submitting any other list other than her true preference is not an equilibrium strategy. Indeed, suppose $P_2 = (s_2, s_1)$ (which implies that $r_2((s_2, s_1)) = (s_2, s_1))$ and that $P_s = (i_1, i_2)$. In this case, the unique best response of i_1 is to submit truthfully. Therefore, the unique OBNE is the truth-telling OBNE but student i_1's prior does not have full support.

4.2. **The non-full-support case.** Truth-telling is the unique equilibrium when priors have full support. This assumption may sound strong, we relax it now by focusing on the top choice of each student. Our result examines under which condition students will list truthfully their top school at every OBNE. The reasons why we focus on each student's top choice are, first, the top choice is without doubt the most important choice of all. Second, the survey information collected by the clearinghouse allows us to cleanly identify in Section 6 the top choice for a subset of students without imposing further assumptions.

Crucial to our result is the assumption that priors have rich-support. For each student i, let $\tilde{P}^i_s$ denote the marginal distribution of $\tilde{P}^i$ over the set $\mathcal{P}_s$, and $P_s(i)$ the position of student i at P_s. Moreover, let $\pi_j(P_i)$ be the school in position j at P_i.

Definition 2 (**Rich-Support**). A prior $\tilde{P}^i$ has rich-support if for every P_i such that $Pr\{\tilde{P}^i_i = P_i\} > 0$ there exists P_s with $Pr\{\tilde{P}^i_s = P_s\} > 0$ and $P_s(i) \leq q_{\pi_1(P_i)}$.

Rich-support of the prior requires, for every possible preference, there exists a priority order such that when it is the turn for student i to choose, her top choice still has available seats **independently** of other students' strategies. When a student's prior has rich-support, the following result shows that she submits truthfully her top choice at every OBNE.

Proposition 2. *Consider a student i with rich-support prior $\tilde{P}^i$. Then, at every OBNE, and for every $P_i \in \mathcal{P}_i$ such that $Pr\{\tilde{P}^i_i = P_i\} > 0$,*

$$\pi_1(P_i) = \pi_1(r_i(P_i)).$$

The intuition behind Proposition 2 is clear. Consider a student whose prior has rich-support, she will not be better by not listing her top choice truthfully, instead she will be strictly worse off. This is because, for each preference that she may have, there is a priority order such that when it is her turn to choose, her top choice has free seats. This is true for every possible strategy of the other students. Thus, at any OBNE, a best response of this student implies that she top ranks truthfully.

When a student's prior does not have rich-support, then both top ranking and not top ranking her top choice may emerge at equilibrium.

Corollary 1 (**Skipping Top Choice Strategically**)**.** *Consider student i who does not top rank her most preferred school at an OBNE. Then, her prior does not have rich-support.*

Now we are ready to introduce the definition of self-selection.

Definition 3 (**Self-selection**)**.** A student *self-selects* if she does not top rank her most preferred school.

Self-selection is the phenomenon in which some students self-select. It is worth mentioning that although self-selection is possible at equilibrium, it is not restricted to be just an equilibrium strategy. In fact, self-selection can also be due to strategic mistakes and it is easy to show that these have welfare consequence ex post. We will explore empirically the consequences of strategic mistakes in Section 7.

5. Description of Data

Our data set covers the assignment information about the Mexico City high school match in 2010, and includes both the match information and the survey responses (see Appendix B for details on data construction). In addition, to control for quality of secondary schools, the data is merged with the official secondary school quality index.[11] In the remainder of the section, we first describe the full sample, then we explain how, by leveraging the survey information, we select a sub-sample of students whose top choices can be identified as one of the UNAM high schools.

Options Characteristics. Our full sample contains in total 536 options. Schools report their capacities to the clearinghouse before the start of the match, however capacity constraints may not be binding in situations where there are multiple students with equal score competing for the last seat of an option (see Section 3 for more

[11] The school quality index uses the score from National Assessment of Academic Achievement in Schools (ENLACE), which runs a standardized test for primary and secondary schools in Mexico.

details on ties). The capacities for each option range from 16 to 3,976. The 14 high schools managed by UNAM have large capacities, offering on average 2,446 seats.

Students characteristics. A total number of 315,848 students submitted their applications. In the main phase of the match, 230,074 eligible students were assigned, of whom 37 percent were assigned to their first option, close to 78 percent were assigned to one of their top 5 options, and 12 percent remained unassigned. Table 1 summarizes the main characteristics for the full sample. The first group of our variables are continuous variables. In terms of distance, we compare both the distance to the submitted first choice as well as the nearest UNAM high school. We use the distance to the nearest UNAM high school as a proxy to measure the travel cost to these selective schools. The 14 UNAM high schools spread over the city (see map C.1 in appendix), close to 14 percent of the students have at least one UNAM high schools within walking distance (a radius of 3 km), and 57 percent of students have at least one UNAM high school within a radius of 10 km, that is approximately half an hour travel by public transport.

TABLE 1. Descriptive statistics: full and selected samples

	Full sample		Selected sample	
Panel A:	Mean	Std.Dev.	Mean	Std.Dev.
Number of submitted options	9.87	3.80	10.00	3.86
Age	15.25	1.16	15.24	1.10
Average grade	8.11	0.86	8.22	0.86
Exam score	65.42	19.82	68.01	19.32
Distance to nearest UNAM HS	11.10	8.76	9.90	8.30
Distance to submitted 1st choice	11.06	9.27	10.81	8.64
Panel B:	Freq	Col %	Freq	Col %
Family income				
- Low	82,613	41.57	39,431	36.98
- Middle	101,320	50.99	57,177	53.63
- High	14,785	7.44	10,015	9.39
Parental education				
- $\leq$ Primary	49,863	25.09	22,521	21.12
- Secondary	104,704	52.69	55,450	52.01
- $\geq$ HS	44,151	22.22	28,652	26.87
N	198,718		106,623	

Note: The full sample removes missing observations in line with probit regression (see Appendix D).

The second group includes socio-economic variables reported by students in the survey. The response rate is high: 81 percent of students reported their family income, 78 percent responded to the type of university they wish to attend, about 81 percent to both the parent education level and their expected education level. The application brochure informs students explicitly that their responses to the survey have no impact on their assignment outcome. Therefore, we have no compelling reason to think that the survey information does not reflect the real decision environment faced by the students.

Sample selection. By utilizing the survey, we are able to identify 134,706 students (43 percent of full sample) whose most preferred school is one of the UNAM high schools. The following question serves our purpose:

"*Which type of university would you like to attend after high school?*"

Students are asked to choose one from a list of answers including: UNAM, *Instituto Politécnico Nacional* (IPN), which is another high-quality university with technical orientation, private universities, technology universities or colleges, and other type of universities. If the student chooses UNAM, then we consider her top choice should be one of the UNAM high schools.

There are two main reasons that motivate us to use this question about preference for university to infer preference for high school. First of all, given that UNAM is the most competitive and recognized public university in Mexico, its affiliated high schools also provide the best education quality (see Table C.1 in Appendix C). Second, these high schools offer the easiest access to UNAM. A quick look at the UNAM admission statistics in the year 2009-2010, a year before students in our data were making decisions, reveals that 87 percent of the students from UNAM high schools were admitted in comparison to under 15 percent of students from other types of high schools (DGP, 2010). Similar pattern persists when we trace the 2010 cohort in our data to university application, and students from UNAM high schools have the highest admission rate (see Table C.2 in Appendix C).[12] One main cause behind this situation is that students from UNAM high schools have priority to get a seat in UNAM over other students.[13] Thus, attending a UNAM high school maximizes the probability of being admitted to UNAM. New survey questions also lend support for these two points.[14]

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[12]A student can also apply to UNAM after attending a private high school. However, the admission rate of these students has little difference from those who attended a non-UNAM public high school, and significantly lower than those from a UNAM high school.

[13]Similar privilege does not exist for students applying to IPN from IPN high schools. Thus, we cannot use this survey question to identify students whose most preferred high school is one of the IPN high schools.

[14]As of 2013, the clearinghouse started to ask students in the survey if quality and easy access to universities are their main concerns among others when choosing their top choice. In 2014, for

The selected sample resembles the full sample (see Table 1). For instance, in terms of average grade, for students in the selected sample it is slightly higher by 0.11 point on a scale of maximum 10. Similarly, they perform slightly better in the final exam (under 3 points on a scale of maximum 128). In addition, they live 1 km closer to the nearest UNAM high school, 2 percent more students come from households with higher income, and 4 percent more students have parents with high school diploma. Both the selected and the full samples have more girls than boys, and there is 4 percent more girls in our selected sample compared to the full sample.

There are two remarks worth discussing about our identification approach. First, our approach is cautious, and possibly neglecting students who prefer other type of universities but nevertheless prefer UNAM high schools as well. Second, our strategy refrains from the potential heterogeneous preferences students may have within the group of UNAM high schools, and the only criterion we impose for truth-telling is just to top rank one of them. This is because, given that all UNAM high schools have the same priority to be admitted to UNAM at the university level, there is no clear rule to distinguish between them. Thus, we adopt a coarse criterion, under which, we may overlook non-truthful behavior within the set of UNAM high schools.

6. Self-selection in data

In this section, we present evidence that although the mechanism is strategyproof, students in the Mexico City high school match self-select in a way consistent with our theory in Section 4. The analysis supports our empirical strategy to verify non-truth-telling behavior by focusing on the top choice.

6.1. **Evidence.** Out of the 134,706 students who prefer UNAM high schools the most, we find 30,308 (22 percent) do not list any of the UNAM high schools as their first choice, while the rest 104,398 (78 percent) do so. Thus, over one fifth of the students do not submit their true first option, even though the mechanism in place is strategyproof. This is our first piece of evidence of *self-selection.*[15]

This evidence is not undermined by the maximal number of 20 options allowed on the rank order list. Indeed, students in the selected sample submit on average 10 options, and under 4 percent submit a list of 20 schools. Moreover, the self-selected

example, 91 percent students consider quality being one of the main concerns when select top choice, and 66 percent of the students declare easy access to universities as one of the main reasons.

[15]UNAM high schools require a minimum average grade of 7 in secondary school for admission. Thus, some students may self-select anticipating that they will not fulfill this minimum grade. As a robustness check of our evidence, we consider only those students with a secondary grade higher than or equal to 7. Under this criterion, 20 percent of students self-select.

students submit on average 9 options, and less than 3 percent of them use the full list, a smaller percentage comparing to the selected sample. Therefore, it is reasonable to think students' submitted preferences are unconstrained.

Next, we compare the characteristics of the self-selected students with those who rank a UNAM high school first. After removing missing observations, the sample reduces to 106,623 students, with 21 percent self-selected students. Panel A of Table 2 shows that self-selected students have a mean average grade of close to 8 from a scale of 10, about half point lower than the truth-telling students. The final exam score is also lower among the self-selected students, by about 9 points out of a scale of 128. In terms of geographic distance, the self-selected students live about 1.6 times further from the nearest UNAM high school in comparison to the truth-telling ones. Panel B summarizes variables related to socio-economic backgrounds that are reported by students. Family income is divided into three levels: low, middle and high income. Low-income students account for 47 percent of the self-selected, up by about 12 percent compared to truth-telling students. Another important variable often received attention in empirical analysis is parent's education. Following the literature, we take into account mother's education level, and only use father's education level when the former is not available. The data show that students whose parents have an education level lower than or equal to primary education, accounting for about 30 percent of the self-selected population, is higher than the share among those non-self-selected ones by about 11 percent.

We further find, using a probit regression, that average grade and family income are the most important driving factors behind self-selection (see Appendix D for more details). The results suggest that if a student increases her average grade by 1 point, all else being equal, then the probability of self-selection drops by nearly 9 percentage points. The average marginal effects of income evaluate the differences in probabilities of self-selection when varying a student's family income level. A student coming from a low-income family, is almost 8 percentage points more likely to self-select with respect to someone from a high-income family. The interaction between grades and income is also significant, and shows that, conditionally on the same grade, low-income students are more likely to self-select than those from high-income families. Finally, it is worth noting that, although significant, distance has a small influence on the probability of self-selection.

6.2. **Strategic mistake and equilibrium strategy.** As we mentioned previously, students may self-select as a strategic mistake. In this subsection, we identify, using

Table 2. Descriptive statistics: self-selected and truth-telling students

	Self-selected		Truth-telling	
Panel A:	Mean	Std.Dev.	Mean	Std.Dev.
Average grade	7.90	0.86	8.30	0.84
Exam score	60.89	18.00	69.86	19.23
Distance to nearest UNAM HS	14.28	9.42	8.73	7.56
Distance to submitted 1st choice	9.56	9.39	11.15	8.44
Panel B:	Freq	Col %	Freq	Col %
Family income				
- Low income	10,392	46.58	29,039	34.44
- Middle income	10,905	48.88	46,272	54.88
- High income	1,012	4.54	9,003	10.68
Parent education				
- $\leq$ Primary	6,713	30.09	15,808	18.75
- Secondary	12,149	54.46	43,301	51.36
- $\geq$ HS	3,447	15.45	25,205	29.89
N	22,309		84,314	

the final exam scores, those cases where self-selection is *not* compatible with equilibrium strategy. Consider a student who self-selects and once the uncertainty is resolved, her position in the priority ranking allows her to be admitted to her most preferred school. If her prior was correct, given that we observe a realization of schools' priorities that meets the condition of Proposition 2, she should top rank her most preferred school at any OBNE. Thus, self-selection is a strategic mistake for this student. Another option is that student's prior was not correct. Since we do not directly observe priors in data, we cannot distinguish between these two explanations, and in either case we say that the student self-selects as a strategic mistake. The direct implication is that when all self-selected students play equilibrium strategies, the outcome coincides with the matching under complete information. Therefore, uncertainty about priorities may hurt only those self-selected students due to strategic mistakes.

When students self-select, we do not know which of the UNAM high schools is their most preferred one. We overcome this issue by treating all UNAM high schools as a single high school and the lowest of the cutoff scores of all UNAM high schools as the acceptance cutoff of the new single school.[16] This gives us the following definition.

[16]We have experimented with other criteria including the mean and maximum of all UNAM high schools' thresholds. When taking the mean score 88 as benchmark, more than 7 percent of the self-selected students make strategic mistakes. The maximum score is 101, given this criterion, close to

Table 3. Disentangling self-selection

	Cutoff 2009				Cutoff 2010			
	Strategic mistake		Equilibrium strategy		Strategic mistake		Equilibrium strategy	
	Freq	Row %	Freq	Row %	Freq	Row %	Freq	Row %
Low-income	3,556	25.10	10,613	74.90	2,261	16.83	11,170	83.17
Middle-income	4,916	34.74	9,235	65.26	3,592	26.66	9,883	69.84
High-income	679	51.99	627	48.01	500	41.95	692	52.99
N	9,151	30.89	20,475	69.11	6,353	22.61	21,745	77.39

Definition 4 (Strategic mistake). For a self-selected student, if her final exam score is higher than or equal to the lowest minimum threshold of all UNAM high schools, then self-selection is said to be a strategic mistake.

Otherwise, we say that self-selection is an equilibrium strategy. Because when submitting preferences, students only observe the cutoffs from past years, we first use the lowest cutoff from 2009, equal to 71, to differentiate strategic mistake and equilibrium strategy. Table 3 shows nearly 31 percent of self-selected students make strategic mistakes, whereas 69 percent of the students are playing equilibrium strategies. We also consider the 2010 observed cutoffs. The lowest cutoff from 2010 is 74, higher than 2009, therefore it is not surprising to see the share of students making strategic mistakes drops to 23 percent under this criterion.

The share of self-selection due to strategic mistakes increases as we move from low-income to high-income using both criteria of cutoffs. This can be explained by the fact that students from better socio-economic backgrounds obtain better scores, and as a result self-selection is more likely due to strategic mistake.[17]

7. Consequences of self-selection

Among the students currently admitted to all UNAM high schools, only 24 percent are from low-income backgrounds. Comparing to the population who regard UNAM high schools as their most desirable choices, the low-income students are under-represented by 15 percentage points. Given this discrepancy, we are intrigued

2 percent of the students self-select as a consequence of strategic mistakes. This last ratio provides a very conservative lower-bound for scope of strategic mistakes.

[17] Students from low-income group achieve a mean exam score of 61 with a standard deviation of 18, students from middle-income group obtain a mean exam score of 69 and a standard deviation of 19, and finally students from high-income group have a mean exam score of 78 with a standard deviation of 20.

to ask: if there are no strategic mistakes, will social diversity within UNAM high schools become more representative of the given population?

To address this concern of low participation from low-income students, we simulate a new matching with no strategic mistakes assuming all students play truthfully (which we call equilibrium matching). Because the outcome under this hypothesis coincides with the one under complete information, the scenario without mistakes may be also viewed as a situation where students have complete information about schools' priorities.

Why do we expect a change of social mix within UNAM high schools after correcting strategic mistakes? First, within all self-selected students making strategic mistakes, high scored students from low-income backgrounds do not perform much differently with respect to those from the other income groups (see Figure E.1 in Appendix E). Second, low-income students constitute a sizable share, representing almost 36 percent of all students who make strategic mistakes (compared to 8 percent high-income).

Table 4 confirms such a change in the distribution of students by income, between the current and the equilibrium matching. In the equilibrium matching the participation of students from low-income families increases. In particular, by comparing the change in the number of students that are assigned to a UNAM high school in the equilibrium matching for each income group, low-income students are the most impacted. In the new matching, the number of admitted students from low-income families increases by 5 percent, and close to 2 percent for those from the middle-income group. Whereas the number for high-income students is reduced by half percent. In terms of the social diversity within UNAM high schools, this means that the share of students from low-income families increases now by about 1 percentage point comparing to the current matching. Based on the counterfactual exercise, a change in the timing of preference submission after students learn their scores (as a way to eliminate strategic mistakes due to incomplete information on priorities) will benefit those from low socio-economic backgrounds.

8. Discussion

Economic theory has played an increasingly important role in designing real life matching markets such as school choice. The standard literature in school choice assumes complete information: students know each others' preferences and their priorities at schools. However, complete information may not always happen in practice, and yet practitioners have to design the market through trial and error, and often on *ad hoc* basis.

Table 4. Social composition within UNAM high schools

	Current matching	Equilibrium matching	Δ %	Assigned at both matchings	Rejected at new matching*	Newly assigned
Low-income	6,902	7,259	5.2	6,020	882	1,239
Middle-income	17,532	17,804	1.6	15,595	1,937	2,209
High-income	4,897	4,873	-0.5	4,515	382	357
Missing obs	4,919	4,314		4,253	666	61
N	34,250	34,250		30,653	3,267	3,867

**Rejected at new matching* measures the number of students who were assigned in the current matching but not in the new matching. As there are 666 rejected students for whom we do not observe their family income, we assign these students with missing information to each income by assuming the income distribution in the whole population. The ratios are taken from the year book of UNAM high schools (DGP, 2011). This adjustment results the net change at low, middle and high income level to be 248, −194, −104, with a percentage net change of 3.6, −1.1, −2.1 respectively. Through different measurements, the access for low-income students always improves.

In this paper, we explore the effects of uncertainty about priorities on students' welfare. It is motivated by the high school match in Mexico City, where students have to submit their preferences before priorities are known. Our theory suggests that even when the mechanism in place is strategyproof, non-truthful behavior may happen at equilibrium which, in turn, may create a loss of information preventing us from treating submitted preferences as true preferences. We give *field* evidence on the existence of one important non-truthful behavior, self-selection. Given the same past grade, we found that students from low socio-economic backgrounds are more likely to self-select. This raises further concerns about high-achieving students from low socio-economic families, as they are more likely not to be assigned to their most preferred choice because of self-selection. Therefore, changing the timing of submission after knowing priorities, as a way to eliminate strategic mistakes, can improve the access of these students.

By studying in details the Mexico City high school match, we found an alerting phenomenon of self-selection which is so far neglected in designing school choice. Centralized school choice using strategyproof mechanism is designed to provide students from all socio-economic backgrounds with equal opportunities to attend good schools, contrary to the widely debated school choice programs based on catchment areas. However, the evidence of self-selection makes us to ponder if this goal is fulfilled, and suggests the importance of some details such as timing of submission in school choice design.

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Appendix A. Proof of Theorem 1

Consider an OBNE r. The proof is by induction. We show first that in any OBNE students should submit truthfully their first and second options, and then we finish the proof using induction on the number of options. In fact, we only need to prove the statement for the first option, including the second option is to illustrate the construction of the general argument.

Claim 1: At any OBNE, each student submits truthfully the first option of each preference profile: $\pi_1(P_i) = \pi_1(r_i(P_i))$ for every $i \in I$.

Suppose this is not the case, and consider a student i and preferences $P_i = (s_l, \ldots)$ such that $r_i(P_i) = (s_{j \neq l}, \ldots)$. Given that $\tilde{P}^i$ has full support, we can consider an order of students P_s where i is ranked the first, and for any $r_{-i}(P_{-i})$, student i will not be assigned to s_l, her true first choice under $r_i(P_i)$, because she will be assigned to s_j. This contradicts that $(r_i(P_i), r_{-i}(P_{-i}))$ is a Nash equilibrium under complete information, and then r is not an OBNE. Thus, we should have every student submitting truthfully the first option at any OBNE.

Claim 2: At any OBNE, each student submits truthfully the first two schools: $\pi_j(P_i) = \pi_j(r_i(P_i))$ for every $i \in I$ and $j = 1, 2$.

Let the first two most preferred options of a given preference profile of student i be $P_i = (s_h, s_l, \ldots)$. Consider a profile for other students such that their most preferred school is s_h, and a priority order P_s such that student i is ranked in the $(q_h + 1)$-th position. Given Claim 1, we know that at r every student submits truthfully her first option. Then, the best response of i implies that she should submit truthfully her second most preferred school.

Induction step: Suppose that all students submit truthfully their first $k - 1$ options, and consider a preference order for student i, $P_i = (s_1, \ldots, s_{k-1}, s_k, \ldots)$. Construct other students preference profile such that the first $k - 1$ options are the same than the first $k - 1$ options of i (but possibly in a different order). Consider a priority order P_s where i ranks as the $\left(\sum_{j=1,\ldots,k-1} q_j + 1\right)$-th student. A best response of i to $(r_{-i}(P_{-i}), P_s)$ implies that $\pi_k(P_i) = \pi_k(r_i(P_i))$. Then student i should submit her k-th choice truthfully.

Appendix B. Data Construction

B.1. **Distance.** First, we use the coordinates of post codes as students' home location. COMIPEMS collected information on the post codes where students reside. In Mexico City and its surrounding, each post code refers to a neighborhood, known as "colonias", usually consists of a few streets. In total, 3,845 post codes are reported by all students, 3,146 codes can be correctly retrieved their coordinates. The rest of 699 are wrong codes, or codes which do not match the reported neighborhood name. For the affected students (4.3 percent of total students), we use their secondary school's coordinates as proxy for their home locations, Admission to secondary schools is based on catchment areas, meaning students attend nearby secondary schools. Therefore, the location of secondary school is the best proxy for the location of students' home. The geographic coordinates for secondary schools and high schools are obtained from the Secretary of Public Education.

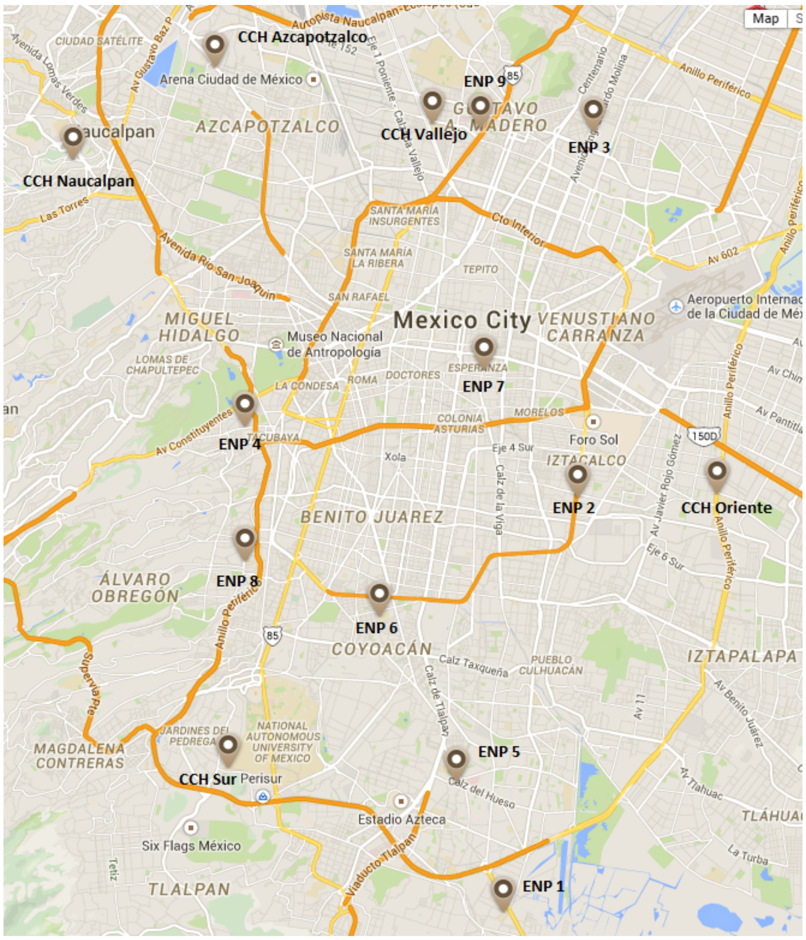
Finally, we use the Google Distance Matrix Application Programming Interface (API) and Python to compute the walking distance between students' home and high school options.

B.2. **Income.** We reclassify the original 15 family monthly income categories into 3 levels: low-income (below 232 USD in Mexico City, and below 165 USD in Mexico State), middle-income (from 232 to 746 USD in Mexico City, and from 165 to 630 USD in Mexico State), and high-income (above 746 USD in Mexico City, and above 630 in Mexico State). In the new classification, low-income families have a monthly income which is equal to the bottom 10 percent of Mexico City and Mexico State by the standards of the 2010 Council of Social Development Assessment in Mexico City.[18]

[18] Source: http://www.evalua.df.gob.mx/encuestas.php

Appendix C. Information about UNAM high schools

Figure C.1. Location of UNAM high schools



Note: Each dot marks the location of one of the UNAM high schools.

Table C.1. Cutoffs by organizing institutions

	2010			2011		
	Min	Max	Mean	Min	Max	Mean
COLEGIO DE BACHILLERES	31	75	55	31	77	54
CONALEP	31	71	40	31	71	39
SE CONALEP ESTADO DE MEXICO	31	67	34	31	66	33
DIRECCIN GENERAL DEL BACHILLERATO	60	65	63	59	64	62
DGETA	31			31		
DGETI	31	67	47	31	70	45
IPN	75	99	82	77	101	84
UNAM	74	101	88	77	107	91
SE	31	85	46	31	87	44
UAEM	81			83		

Source: COMIPEMS.

Table C.2. Admissions to UNAM in 2013 by types of high school attended

	Applications		**Admissions**		**Admission Rate**
Attended high school type		Col %		Col %	
UNAM HS	30585	20.4	22701	60.9	74.22
Public non UNAM HS	91150	60.8	10473	28.1	11.49
Private HS	23301	15.5	3400	9.1	14.59
Both Public non UNAM and Private*	4398	2.9	638	1.7	14.51
No information	480	0.3	43	0.1	
Total	149914	100	37255	100	24.85

Source: UNAM Annual report 2013.
*Students who attended some years a public high school and other years a private one.

Appendix D. What influences self-selection?

D.1. **Baseline model.** We estimate the following equation in Table D.1:

$$\Pr\{y_i = 1|\mathbf{x}_i\} = \Phi(\mathbf{x}_i, \beta), \tag{1}$$

where y_i is a binary variable indicating whether student i self-selects (with $y_i = 1$ meaning self-select), Φ is the cumulative distribution function of normal distribution, and $\mathbf{x}_i$ is a vector of observable characteristics.

Column 1 presents a parsimonious estimation on average grade from secondary schools, distance, and income. All coefficients show the expected signs at 1 percent significance level in line with the descriptive statistics presented in the previous section. Students with high secondary school grades are less likely to self-select, students from low and middle-income families have a higher probability of self-selection than those from high-income families, and those who live closer to a UNAM high school tend to self-select less than those who live further away.

Columns 2 and 3 show that, after controlling for students' and their family characteristics, average grade, distance and income are still significant. The first group of controls captures students' characteristics such as age, gender, whether the student works with salary, and hours studied per week. Age shows a positive and significant relation. Gender also affects self-selection. Male students are less likely to self-select compared with female students. Work with salary is a dummy variable which accounts for options outside schooling, and students with paid work may be less motivated to continue schooling or go to UNAM high schools, however this variable is not significant when controlling for family characteristics. The controls for family characteristics contain information about parent's education level, whether the student is from single parent family or no parent, whether indigenous language is mother tongue, the number of siblings and persons at home, whether receives need-based fellowship, and parent's occupation. Students of parents without high school diploma are more likely to self-select, with a significance level of 1 percent.

Column 4 includes two variables to account for unobservable secondary school fixed effects. The first one is school quality. We see that students coming from a secondary school with better quality are less likely to self-select. The second variable is the percentage of self-selected students constructed at school level. This variable aims at capturing peer effects. The positive relation indicates that self-selection is influenced by the share of students that follow the same strategy in the secondary school.

Column 5 includes further interactions between income and average grade, and income and distance.

Table D.1. Probit regression results

Self-select	(1) Baseline	(2) Students' controls	(3) Families' controls	(4) Schools' controls	(5) Interactions and others
Average grade	-0.418***	-0.389***	-0.390***	-0.399***	-0.322***
	(0.006)	(0.006)	(0.007)	(0.007)	(0.026)
Dist to nearest UNAM HS	0.051***	0.052***	0.050***	0.025***	0.020***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
Family income (base: high)					
- Low	0.640***	0.578***	0.390***	0.353***	1.098***
	(0.020)	(0.020)	(0.022)	(0.023)	(0.218)
- Middle	0.371***	0.344***	0.233***	0.195***	0.681**
	(0.020)	(0.020)	(0.021)	(0.022)	(0.216)
Student's characteristics controls					
Age		0.091***	0.082***	0.079***	0.080***
		(0.005)	(0.005)	(0.005)	(0.005)
Male		-0.075***	-0.066***	-0.078***	-0.078***
		(0.010)	(0.010)	(0.010)	(0.010)
Work with salary		0.070**	0.045	0.023	0.022
		(0.023)	(0.023)	(0.024)	(0.024)
Family's characteristics controls					
Parent's education (base: $\geq$ HS)					
- Primary and below			0.320***	0.253***	0.254***
			(0.016)	(0.017)	(0.017)
- Secondary			0.199***	0.164***	0.166***
			(0.013)	(0.014)	(0.014)
Mother tongue = indigenous			0.013	0.002	0.001
			(0.029)	(0.029)	(0.030)
Single parent			0.021	0.002	0.003
			(0.012)	(0.012)	(0.012)
No. of siblings			0.020***	0.008	0.008
			(0.004)	(0.004)	(0.004)
No. of persons at home			0.019***	0.019***	0.019***
			(0.003)	(0.003)	(0.003)
Fellowship			-0.004	0.026	0.025
			(0.014)	(0.014)	(0.014)
Secondary schools controls					
School quality				-0.001***	-0.001***
				(0.000)	(0.000)
Pct of self-selection				0.074***	0.075***
				(0.001)	(0.001)
Constant	1.570***	0.128	0.070	0.199	-0.375
	(0.050)	(0.101)	(0.103)	(0.128)	(0.236)
Hours studied/week	No	Yes	Yes	Yes	Yes
Parent occupation	No	No	Yes	Yes	Yes
Income × Average grade	No	No	No	No	Yes
Income × distance	No	No	No	No	Yes
N	106,623	106,623	106,623	106,623	106,623
Pseudo R^2	0.13	0.14	0.15	0.21	0.21

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table D.2. Average marginal effects

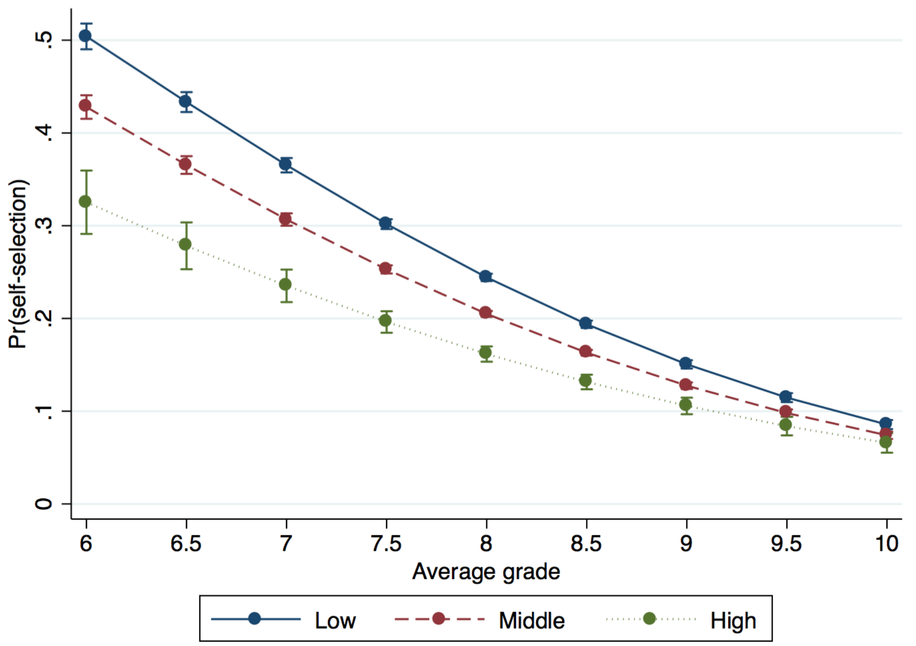
Self-select	(1) Baseline	(2) Students' controls	(3) Families' controls	(4) Schools' controls	(5) Interactions and others
Average grade	-0.1038***	-0.0957***	-0.0948***	-0.0896***	-0.0897***
	(0.0014)	(0.0015)	(0.0015)	(0.0015)	(0.0015)
Dist to nearest UNAM HS	0.0126***	0.0128***	0.0122***	0.0056***	0.0057***
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Family income (base: High)					
- Low	0.1450***	0.1304***	0.0898***	0.0759***	0.0777***
	(0.0037)	(0.0039)	(0.0045)	(0.0045)	(0.0046)
- Middle	0.0749***	0.0704***	0.0503***	0.0397***	0.0408***
	(0.0035)	(0.0036)	(0.0041)	(0.0042)	(0.0042)
Parent's education (base: $\geq$ HS)					
- Primary and below			0.0773***	0.0563***	0.0565***
			(0.0039)	(0.0037)	(0.0037)
- Secondary			0.0460***	0.0355***	0.0357***
			(0.0030)	(0.0029)	(0.0029)
School quality				-0.0002***	-0.0002***
				(0.0000)	(0.0000)
Pct of self-selection				0.0167***	0.0167***
				(0.0002)	(0.0002)
N	106,623	106,623	106,623	106,623	106,623

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To interpret our results, we compute in Table D.2 the average marginal effects of the main variables on self-selection. The results confirm our theoretic explanation that through influencing priors, average grade plays an important role on self-selection. Take for example the full specification from Column 5, if a student increases her average grade by 1 point (and fixing other variables), then the probability of self-selection decreases by about 9 percentage points. The average marginal effects of income evaluate the differences in probabilities of self-selection when varying a student's family income level. A student coming from a low-income family, is about 7.8 percentage points more likely to self-select with respect to someone from a high-income family. Finally, it is worth noting that, although significant, distance has a small influence on the probability of self-selection.

Average grade and family income stand out as two driving variables for self-selection. We further use the results from Column 5 to compute the predicted probability of family income for students with average grade from 6 to 10 by a grid of half

FIGURE D.1. Predictive margins of income by average grade with 95% CIs



Note: The predicted margins are calculated for each income group, by substituting the observation's average grade with grade 6, 6.5, 7 and so on. The whiskers are the confidence intervals for the predicted margins.

point. Figure D.1 illustrates *income-typical* behavior and *performance-typical* behavior (Hoxby and Avery, 2013). Overall, students from low-income backgrounds are more likely to self-select. However, as grade improves, the gaps across income groups are narrowed down. In fact, the middle-income group behaves almost the same as high-income group when students grades belong to the top 10 percent (higher than 9). This indicates that better performance convinces students to submit top choice truthfully, yet it happens more often for middle and high-income students than for their low-income counterparts.

To summarize, the evidence presented in this appendix shows that students are more likely to self-select if they have a poor performance in the secondary school. Moreover, past grades have different effects on self-selection across income groups: given the same grade, those students from low economic backgrounds tend to self-select more often, even if for the same grades families with high economic background and more educated do not.

D.2. **Robustness check.** We perform additional robustness checks for our main empirical findings, and the main variables affecting self-selection remain important and significant.

The first concern rises from the fact that UNAM high schools require a minimum average grade of 7 in the secondary school for admission. Thus, some students may self-select with the fear of not being able to fulfill the minimum grade. Column 1 of Table D.3 considers only those students with secondary grade higher than or equal to 7. Results show that in this restricted sample, average grade, distance and family income are still significant.

TABLE D.3. Robustness check for probit results

Self-select	(1) Min 7	(2) # COMIPEMS exams	(3) Average distance	(4) Teachers' attention	(5) Aspiration
Self-select					
Average grade	-0.239***	-0.320***	-0.324***	-0.321***	-0.299***
	(0.028)	(0.026)	(0.026)	(0.026)	(0.026)
Dist to nearest UNAM HS	0.021***	0.021***		0.020***	0.021***
	(0.002)	(0.002)		(0.002)	(0.002)
Family income (base: High)					
- Low	0.927***	1.102***	1.101***	1.085***	1.106***
	(0.239)	(0.219)	(0.219)	(0.220)	(0.221)
- Middle	0.641**	0.686**	0.679**	0.667**	0.700**
	(0.237)	(0.217)	(0.217)	(0.217)	(0.219)
Parent's education (base: $\geq$ HS)					
- Primary and below	0.276***	0.254***	0.249***	0.251***	0.219***
	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)
- Secondary	0.179***	0.165***	0.163***	0.163***	0.141***
	(0.015)	(0.014)	(0.014)	(0.014)	(0.014)
No. of COMIPEMS exams taken		0.033*			
		(0.014)			
Avg dist to UNAM HS			0.016***		
			(0.002)		
Expected education < postgraduate					0.259***
					(0.010)
Teachers' evaluation	No	No	No	Yes	No
N	100,035	106,121	106,623	105,229	104,198
Pseudo R^2	0.21	0.21	0.21	0.21	0.22

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Second, some students participated more than once in the exam, and they may have different application strategies than the first-time applicants. Column 2 includes a variable measuring the number of times a student has taken the COMIPEMS exam, and the more one has taken, the more likely she will self-select.

The third concern relates to our construction of distance using the postal codes of students' home (see more details in Appendix B). The importance of distance may be underestimated as the result of measurement bias. Moreover, our definition of self-selection is agnostic about the exact choice for UNAM high school, however in the main regression we take the distance to the nearest UNAM high school for each student, imposing that the distance to nearest UNAM high school actually reflects the real traveling cost faced by students. For these reasons, Column 3 uses another variable, the average distance to all UNAM high schools, while keeping everything else the same as in the full specification from Column 5 of Table D.1. The term average distance to all UNAM high schools now has a smaller impact, but this change does not undermine the significance of average grade nor family income.

Column 4 adds an additional variable taken from the survey where students are asked to rate how frequently their teachers evaluate their studies. If a teacher evaluates students almost all the time, implying the teacher pays a high attention to students. The coefficients are omitted due to insignificance.

The last robustness check introduces the student's expected education level, which measures students aspiration. A student who wishes to reach a higher level of study can be more motivated to top rank a selective high school, therefore controlling for expected education level could reduce the impact of average grade and family income. Additionally, the chance to be admitted in postgraduate studies in Mexico is higher if the student graduates from UNAM, and the chance to go to UNAM is higher if the student goes to UNAM high schools.

Table D.4 reports the average marginal effects of our robustness checks. As we expected, the impact of average grade and family income declines after adding robustness controls, however it is still important and significant.

Table D.4. Robustness check for average marginal effects

	(1) Min 7	(2) # COMIPEMS exams	(3) Average distance	(4) Teachers' attention	(5) Aspiration
Average grade	-0.065***	-0.089***	-0.090***	-0.089***	-0.085***
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Dist to nearest UNAM HS	0.006***	0.006***		0.006***	0.006***
	(0.000)	(0.000)		(0.000)	(0.000)
Family income (base: High)					
- Low	0.071***	0.078***	0.078***	0.077***	0.069***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
- Middle	0.036***	0.041***	0.041***	0.040***	0.035***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Parent's education (base: $\geq$ HS)					
- Primary and below	0.058***	0.057***	0.055***	0.056***	0.048***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
- Secondary	0.036***	0.036***	0.035***	0.035***	0.030***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
No. of COMIPEMS exams taken		0.007*			
		(0.003)			
Avg dist to UNAM HS			0.004***		
			(0.001)		
Expected education < postgraduate					0.057***
					(0.002)
N	100,035	106,121	106,623	105,229	104,198

Robust standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Appendix E. Score distribution of students who make strategic mistakes

Figure E.1. Density distribution of the score for students who make strategic mistakes by income