School Segregation in the Presence of Student Sorting and Cream-Skimming: Evidence from a School Voucher Reform

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Abstract

This paper uses a reform to Chile's school choice system to study the drivers of student socioeconomic segregation. The reform increases the voucher value that participating schools receive for low-SES students. I exploit this shock to schools' incentives to test for student selection based on socioeconomic characteristics. I incorporate these admission restrictions in a demand model to estimate parents' preferences for school and peer characteristics. Ignoring admission restrictions leads to underestimating poor parents' preferences for school quality. Counterfactual simulations show that preferences of high-SES parents for high-SES peers are the main driver behind segregation as opposed to schools' selective behavior.

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1 Introduction

Educational reforms in numerous countries introduce competition between schools by increasing parental choice via school vouchers.[1] In theory, increased competition between educational institutions should result in the provision of better school quality to attract students.[2] However, there is concern that school choice programs may increase social stratification in education systems and weaken public schools if higher-income students migrate to private voucher schools (Manski, 1992; Epple and Romano, 1998; Nechyba, 1999). Indeed, previous studies have shown that private voucher schools ended up serving a wealthier population at the expense of public schools, leading to increased socioeconomic segregation across schools (Gauri, 1999; Hsieh and Urquiola, 2006; Contreras et al., 2010; Chakrabarti, 2013). Entry of private schools has been associated with stratification, consistent with private schools cream-skimming high income students from the public sector (McEwan et al., 2008). Such increased segregation may be an important contributor to long-run inequality. Studies on school desegregation plans in the late 1960s and 1970s have linked increased school segregation with increased criminal activity, lower educational attainment for minorities, and lower graduation rates (Guryan, 2004; Weiner et al., 2009; Billings et al., 2014).

This paper studies both demand and supply-side channels that could contribute to socioeconomic segregation in school choice programs. There are several factors that contribute to school segregation, schools' selection processes, choices of parents, the possibility of schools charging tuition fees, and residential segregation. Disentangling these is challenging due to simultaneity. On the supply side, even in the absence of tuition, private

[1] Chile, The Netherlands, Sweden, Denmark, New Zealand, India, Pakistan, Colombia, and the U.S have all implemented school choice programs of different scales.

[2] The case for educational vouchers and increased educational choice was initially made initially by Friedman (1962). Yet, empirical evidence does not show systematic effects in achievement or efficiency in either direction. Results depend on the context and design of the choice program and are heterogeneous across different groups. Hoxby and Murarka (2009) study charter schools in New York City, and Hoxby and Rockoff (2004) study charter schools in Chicago finding modest gains. Rouse (1998) studies a voucher program in Milwaukee and finds no effects on reading, but significant effects on math. Angrist et al. (2002) examine vouchers in Colombia, finding large positive effects. Muralidharan and Sundararaman (2015) analyze voucher experiments in India and find no effect on test scores, except for Hindi, but they also show that private schools spend much less than public schools. Several papers have studied the Chilean voucher program implemented in 1981, finding no evidence that choice improved average educational outcomes (Hsieh and Urquiola, 2006).

schools may have incentives to select higher-income students to improve overall test results.[3] On the demand side, the potential effects of school choice programs on segregation depend on parents' preferences for different school characteristics and peer composition. Heterogeneous preferences across different socioeconomic groups may explain how parents sort across different schools. For instance, high-income parents may focus more on school quality, while low-income parents may focus more on convenience factors, such as distance. Furthermore, high correlation between socioeconomic status and test scores, make it difficult to disentangle whether parents care more about test scores or peer quality.[4]

In order to measure the relative importance of supply- and demand-side mechanisms on segregation, I exploit a 2008 reform to the Chilean voucher system.[5] This reform changed the previous flat voucher (same per-student amount across schools) to a two-tier voucher based on students' socioeconomic status (SES), with a larger voucher for low-SES students. This change constitutes an exogenous shock to schools' incentives to select more low-SES students, uncorrelated with parent's preferences in the short term. This allows me to test for cream-skimming behavior among private schools (separately from the selection explained by tuition) and examine how low-SES students respond to the resulting decrease in admission restrictions to private schools. Cream-skimming in this context refers to private schools' preferential selection of students based on their socioeconomic characteristics. The reform allowed schools to choose whether they wanted to participate in the new program (SEP schools) or opt out staying with the original flat voucher per student (non-SEP schools), effectively separating private subsidized schools in two groups. To test for cream-skimming behavior I look at participating schools only, comparing the types of students admitted before and after schools start participating.

[3]Numerous studies show that family income and parental education are the main factors explaining student achievement and standardized test results. Thus private schools may attract parents and students on the basis of superior average levels of test scores, but higher average test scores may be explained by sorting of self-selected high achievers, so schools may not be actually adding much value (Abdulkadiroglu et al., 2014; Cullen et al., 2006)

[4]In this paper, I abstract from neighborhood sorting I focus on the mechanisms more likely to be affected by the educational reform. Given the characteristics of the reform explained below, it is unlikely to affect housing choices. Furthermore, Arteaga et al. (2018) show that in the Chilean context, residential segregation explains a very small part of overall school segregation.

[5]Chile is one of the few countries that has a nation-wide voucher program which has been in place since 1981. This makes it particularly suitable to studying student sorting and segregation in educational markets.

I provide strong evidence that private schools engage in substantial cream-skimming. I model schools' admissions process in terms of a threshold in admitted student's maternal education, a proxy for SES. While school admission thresholds are endogenous to student sorting, the timing of the 2008 reform allows me to test for schools' cream-skimming behavior. I show that admission thresholds decreased significantly following the reform in SEP schools, even for schools that did not charge any tuition (discarding the idea that all enrollment changes could be explained by a price effect only). Consequently, low-SES parents who faced strict admission restrictions from private schools before the reform, had more schools available to choose following the policy change. This resulted in a 10 percentage points increase in the probability of low-SES students enrolling in private subsidized schools following the reform.

I estimate a model of school choice that incorporates admission restrictions at private schools based on student socioeconomic characteristics and allows for heterogeneous parental preferences for school characteristics and peer composition. This contrasts with previous work that assumes that parents can choose any school they are willing to travel to and pay for, which in practice attributes any sorting pattern observed in the data to demand-side preferences, rather than school selection[6]. This is inconsistent with the evidence on school behavior and observed stratification in the Chilean system. I show that ignoring admission restrictions significantly underestimates low-SES parents' preferences for school quality. Furthermore, these changes in SEP schools' admission thresholds in response to the new voucher create variation in schools' peer composition, separately from schools results in standardized tests. I use this variation to estimate parents' preferences for school characteristics and peer quality[7], and to study the effects of post-reform enrollment changes on segregation. I show that low-SES parents care about quality characteristics like test scores, class size, and peer quality. At the same time, high-SES parents have strong preferences for high-SES peers. A one standard deviation increase in peer

[6] Hastings et al. (2005), Neilson (2017), and Gallego and Hernando (2010) also estimate parental preferences for school characteristics based on choices of schools, looking at heterogeneity in preferences across socio-economic groups. Several other papers estimate parent preferences for schools based on residential location (Black, 1999; Bayer et al., 2007).

[7] In this setting, by peer quality I mean peer socioeconomic status given by the mother's education. For first grade admissions, there is no information about student ability or test scores.

quality gives ten times as much utility to high-SES parents, as a one standard deviation increase in school average test scores.

These results point to two different effects of the Chilean reform on student sorting. First, the reform directly impacted cream-skimming behavior at private subsidized SEP schools. It decreased admission thresholds which together with low-SES parents' preferences for better schools account for higher enrollment of low-SES students in private subsidized SEP schools following the reform. Second, there was an indirect effect induced by changes in peer composition in SEP schools that accounts for the increased enrollment of high-SES students in private subsidized schools that opted out of the reform (non-SEP schools). This is explained by strong preferences for better peers among high-SES parents. These two changes in student sorting followed very distinct patterns. The first effect, caused by the change in incentives for private SEP schools, results in a discrete jump in the probability of low-SES students going to a SEP school immediately after the reform. The second effect is caused by a response of high-SES parents to changes in peer characteristics in SEP-schools, resulting from the first effect. This generated a gradual increase in the probability of high-SES students of choosing a non-SEP school in the years following the reform. Overall, this resulted in increased socioeconomic segregation in an already highly segmented educational system.

My counterfactuals show that heterogeneous preferences for high-SES peers seem to be the main driver behind segregation. I show that eliminating cream-skimming by schools may further increase migration of students from public to private schools, with only a moderate decrease on segregation. Policy makers may have major challenges in reducing segregation if preferences for peer quality are so large in high-SES parents. This could be especially critical given evidence that school segregation perpetuates long-term income inequality (Benabou, 1996).

Little is known about the stratification consequences of school voucher reforms and the mechanisms that explain increased sorting. In particular, how private schools respond to such policies in terms of admission criteria and which school characteristics drive parental choices. Most of the literature regarding voucher systems focuses on the effects on student achievement. There are several studies that examine how the SEP reform in Chile

has impacted student achievement (Neilson, 2017; Murnane et al., 2017; Navarro-Palau, 2017), finding significant improvements in terms of test scores, showing a reduction in the achievement gap between high- and low-SES students. These studies look exclusively at test-scores and abstract from student sorting. There is a smaller literature on school choice looking at the effects on segregation. Söderström and Uusitalo (2010) shows that allowing for school choice in Sweden's secondary schools, increases sorting by family background and segregation between immigrants and natives. There are several papers that associate the implementation of the 1981 voucher reform in Chile with increased stratification across schools, but without being able to reveal the channels through which these effects may operate. When studying this original reform, Hsieh and Urquiola (2006) trying to make sense of the puzzle presented by the fact that more choice was not associated with achievement gains, they mention the possibility that parents choose schools based on peer characteristics, and schools may respond by selection processes along these same criteria. In general this has been hard to show and the variation induced by the SEP reform helps to disentangle this mechanisms. My results are consistent with this intuition and help explain why in most countries, under different public education systems, segregation has been very difficult to decrease.

Several papers on school choice have suggested deviating from the flat voucher to alleviate cream-skimming and decrease segregation. Nechyba (2009) argues that efficient programs should incentivize competition through innovation and increased resource efficiency, rather than through selecting the best students from public schools. Neal (2002) and González et al. (2004) argue that vouchers that fall in value as household income rises may partially offset incentives to cream-skim for competitive advantage. My results fill a gap in this literature by empirically looking at the effects of these targeted vouchers. The Chilean reform examined here effectively decreased cream-skimming, but had little effect on overall segregation. Though the reform sought to decrease inequality by giving more resources to schools serving low-SES students, it ignored the possibility of student resorting.

Furthermore, my results relate to the school choice literature that estimates parental preferences. Most of this literature describes parents' heterogeneous preferences for school

quality and the trade-offs they make in terms of quality, distance, and tuition. Several studies show high-SES parents putting higher weight on school quality, which could explain why they are more likely to opt-out of public schools when implementing a school choice program (Hastings et al., 2005; Chakrabarti, 2013; Böhlmark et al., 2016). Yet, in general it is not clear what school quality means in each context given that it comprises both school and peer characteristics. Therefore, what exactly is being measured when estimating parental preferences, could be very different depending on the context. The characteristics of the SEP program and the variation that it induced in terms of student composition in each school, allow me to estimate preferences for school and peer characteristics.

The remainder of the paper is organized as follows. Section 2 provides a general framework of school choice model and some of the mechanisms behind socioeconomic segregation. Section 3 provides institutional background on Chile's education system and the 2008 reform. Section 4 describes the data. Section 5 provides a descriptive analysis of changes in school enrollment and segregation. Section 6 describes the demand estimation in the presence of cream-skimming and discuss the results. Section 7 shows some counterfactual exercises and Section 8 offers a summary and conclusions.

2 Model for School Choice

In many settings where policies are set in place to increase parental choice [8], the level of socioeconomic segregation across schools tends to increase, even in settings where private schools do not charge tuition (Hsieh and Urquiola, 2006; Chakrabarti, 2013). Different demand- and supply-side mechanisms could drive these sorting patterns. On the supply side, private schools may have incentives to select students in the admission process. If schools are using information on socioeconomic characteristics to select students, this would explain at least part of the sorting. On the demand side, heterogeneous preferences for school characteristics by parents from different socioeconomic background could also contribute to increase socioeconomic sorting.

In this model parents have to choose an elementary school for their children in a setting

[8] Parental choice policies can take different forms like for example, charter schools, school vouchers, etc.

where public and private schools interact and private schools are able to select applicants at admission based on observable characteristics.

A market consists of a set of students I and a set of schools J. Students choose to apply to certain schools and schools decide whether to admit or reject each applicant. The application process is decentralized and parents need to apply to each school they are potentially considering through a separate admission process. Two types of schools interact in each market, public and private subsidized schools. Public schools are assumed to admit all students that apply, but private schools have the ability to select students. Since these are primary schools, they do not observe students' abilities, but do observe families sociodemographic characteristics. Most schools are tuition free and financed through government per-student vouchers payed directly to each school (both to public and private subsidized). I model parents' decisions as a discrete choice of a single school from their market. Students are characterized by their type θ, which is given by their socioeconomic status.

Demand Model

The utility student i of type m gets from attending school j is given by:

$$U_{imjt} = X_{jt-1}\beta_m - \gamma_m d_{ijt} + \xi_{jt} + \varepsilon_{ijt}$$

where

$$\beta_m = \bar{\beta} + \beta_o \theta_m, \text{ and } \gamma_m = \bar{\gamma} + \gamma_o \theta_m$$

X_{jt} includes observed school characteristics, specifically the school j's average test scores in standardize tests, average type of students, average class size, number of students per teacher, and an indicator for being a private subsidized school. Preference parameters on each characteristic k, β_{mk} are allowed to differ by student type m. d_{ijt} is the distance for student i to school j, ξ_{jt} is a year-school specific term that represents unobserved school quality. ε_{ijt} represents an unobserved idiosyncratic preference of student i for school j, assumed to be distributed independently across schools and students. It is assumed that

parents consider a school's past characteritics when making the decision to which school apply to.

Parents choose the school that maximizes their utility within the set of schools that admit them given the type. Parents are also assumed to have perfect knowledge regarding admission policies so they don't have to consider different admission probabilities.

Private School Admissions

Under a voucher program, public and private subsidized schools compete in each market to attract students. All schools (both public and private subsidized) receive a voucher v from the government per student enrolled, and this accounts for the totality of schools funding[9].

Each school has an unobserved capacity q_j. Given a set of applicants, schools need to decide who they admit to fill up that capacity. Schools' utility depends on the number of students(this will determine the sum of funds payed by the government), and the type of students registered.

I am not going to directly model the schools' optimization problem.[10] This is a complicated game with several players in each market (even a small market has at least 20 private subsidized schools that compete with each other in an oligopolistic way with differentiated products). When schools are making their decisions regarding the type of students to admit, they have to consider the impact over marginal costs and over students' demand.

It is assumed that elementary schools cannot directly observe achievement during the admission process, but they are able to observe applicants' types. The validity of this assumption will be discussed further in the empirical analysis.

There are two main mechanisms linking students' types and schools' utility. First, student achievement is known to be positively correlated with the socioeconomic status,

[9]Private subsidizes schools in Chile are allowed to charge a top-up tuition and about half of them charge a small amount. This feature is not included in the model given that the purpose of the model is to describe possible segregation mechanisms beyond price differences, but of course tuition will be considered in the empirical analysis

[10]Private schools are heterogeneuous entities, therefore their utility functions are likely to differ across different schools. Some schools are profit-maximizers, but many schools are non-profit institutions. Regardless, even for non-profit organizations, schools care about rankings that are based on results from nationwide standardized test scores.

with higher types performing on average better than lower types. Therefore, the marginal cost of educating a student is decreasing in the type.[11] Second, if parents have preference for schools with higher test scores and/or for peers of higher types, demand for a school will be affected by the decision of which types to admit. Given these mechanisms, schools would prefer higher types to lower types.

Therefore, private subsidized schools will give priority in admissions to higher types over lower types among their applicants. Schools' capacity is assumed to be fixed in the short term. This translates into a cutoff rule in the socioeconomic type for admission. Conditional on the school's capacity, admission thresholds adjust endogenously to clear the market, working like prices in a regular supply and demand model.

3 Background in Chile

Chile implemented a nationwide school voucher program in 1981 to introduce school choice and decentralize educational services. Under this program, students freely choose between public and private schools. Private schools that did not charge tuition began to receive the same per-student voucher from the government as did the public schools. If a student decides to move to another school, the new school would receive the entire subsidy. Tuition-charging private schools continued to operate mostly without public funding, staying mainly unaffected by the reform. Figure 1 shows the evolution in the share of public and private schools from 1979 to 2012. The share of students in private schools rose to over 50% of all students in 2012. Public schools had a little over 40% of students and about 7% went to private non-subsidized tuition-charging schools.

Starting in 1994 with the establishment of the 'Financiamiento Compartido' program, private subsidized schools were allowed to charge a top-up in addition to the voucher with limits in the maximum amount they can charge to keep receiving the government subsidy. Still, more than half of these schools did not charge anything. Figure 2 shows the distribution of average tuition in private subsidized schools in 2007.

An extensive literature has studied the Chilean voucher program. Hsieh and Urquiola

[11] Additionally, higher parental education is associated with better student behavior, more involved parents, the ability to attract better teachers, higher test scores, etc.

(2006) find no evidence that choice improved average educational outcomes as measured by test scores, repetition rates, and years of schooling and they show that the voucher program led to increased sorting. Contreras et al. (2010) offer evidence that private subsidized schools were more selective than public schools. Even though there is extensive evidence of this sorting, it is less clear whether this is exclusively and mainly explained by private subsidized schools' selective behavior. The empirical analysis of this paper shows evidence of both, schools selective behavior, but at the same time, strong heterogeneity in preferences from the demand side. In the counterfactuals, it is shown that eliminating selective admission from private subsidized school would not be sufficient to eliminate sorting.

3.1 The 2008 Reform: SEP Law

In response to critics of the old voucher system, in February 2008, Chile adopted a new policy creating a targeted schooling subsidy for the most vulnerable students (SEP law, for 'Subvencion Escolar Preferencial'). The main objective of the reform was to decrease education inequality (Mineduc, 2015). The SEP reform modified the existing flat subsidy per student by introducing a two-tier voucher, with a higher subsidy for the most vulnerable students. The main purpose of the program was to improve equity within the education system, promote equal opportunity, and improve the quality of education (Weinstein et al., 2010). Starting in 2008, participating schools received an extra voucher for students defined as priority by the SEP law. In addition, participating schools were required to design and implement a plan for educational improvement. These schools were also required to accept the value of the voucher as full payment of tuition for preferential students, eliminating extra tuition and other fees for eligible students.

The monthly values of the extra subsidy are defined by the government and are adjusted for inflation every year, same as the original subsidy. These values are described in Table 1.[12]

Student eligibility for the SEP voucher is determined annually by the Ministry of Ed-

[12]In addition, more resources were given to schools having a high concentration of priority students. This is also described in the second part of Table 1, which shows the resources assigned according to the concentration of SEP students in a school, on top of the baseline SEP subsidy.

ucation according to several criteria. By 2012, 44% of elementary students were classified as eligible for the SEP benefits. Details about eligibility are explained in the Appendix.

Schools have the choice to register in the SEP program and only participating schools receive the SEP benefits. If a school chooses not to participate, it cannot receive the benefits even if priority students are enrolled, but still continues to receive the original voucher. SEP schools are require to adhere to several conditions, including the exemption to eligible students from any out-of-pocket expenses. In terms of enrollment, virtually all public schools and more than 60% of private subsidized schools registered in the SEP program.

More details regarding the Chilean voucher program and the SEP reform may be found in the Appendix

4 Data

My empirical analysis rely on data on student enrollment together with school and student characteristics. I use three datasets. The first is a comprehensive dataset on yearly school and student-level data from 2005 to 2012. It contains the universe of students and the schools where they are enrolled, along with school characteristics. It reports the type of school, the concentration of SEP students in each school, which schools are registered in the SEP program, and the total amount of money received from the program each year.

I use an additional dataset to construct school characteristics like average test scores. This dataset contains SIMCE test results of all 4th grade students from 2005 to 2012. The SIMCE is a standardized test taken by all 4th graders in the country.

Additionally, I use student demographic characteristics like family income, parental education, whether they have a computer and internet at home. This information is included in a questionnaire sent to the families of students taking the SIMCE test. The question about family income does not ask the exact income, but rather household income is reported in intervals of between $100 and $200 dollars. To calculate average family income per school, I assign to each student the mean income in the corresponding bin.

My analysis focuses on approximately 230,000 students per year enrolled in public and

private subsidized schools.[13] Table 2 shows descriptive statistics for student characteristics in private subsidized and public schools before the program started, in 2007. Student differences between the two types of school are apparent, students in private schools come from wealthier families with more educated parents, and on average obtain higher test scores. The table also reports descriptives statistics after the reform. By 2012, differences in parental education and family income were larger than 2007, but the gap in test scores dropped significantly. These changes reflect student redistribution following the SEP reform, which will be explored further below, and it suggests that the extra resources from the program had a positive effect on achievement.

Table 3 describes the number of schools by year and type of school, and starting from 2008, the number of schools registered in the SEP program. Almost all public schools, and more than two thirds of private subsidized schools, participated in the SEP program after 2008.

4.1 Market Definition

In this setting, there is no clear market definition because students are free to choose a school without geographic or administrative constraints. Distance is obviously a relevant variable, but how much students are willing to travel might depend on income, quality of public transportation, weather, etc.

I use data on student travel distance to define markets. For each school, I aggregate all municipalities where 5% or more of the students in that school live, with a maximum of 200 kms of travel distance. This creates a network of municipalities that constitute a market. There are a total of 37 non-overlapping markets under this definition.

[13] I exclude private fee-paying schools from the analysis below. These schools charge high tuition and do not receive any public funding, so they were mainly unaffected by the reform. They serve less than 8% of students, a share that did not change during the study period.

5 Descriptive Analysis

5.1 Changes in Enrollment

The SEP reform sought to decrease educational inequality by giving more resources to schools that served a more vulnerable population. However, this could result in significant resorting of students with important consequences on overall segregation.

In this analysis, I distinguish between three types of schools in each market: public, private subsidized that choose to participate in the program (private SEP schools), and private subsidized that choose to opt out of the program (private non-SEP schools). There are important student redistribution patterns following the 2008 reform between these three types.

Average first grade enrollment in different types of school are presented in Figure 3. It shows the year fixed-effects coefficients from a regression of average first grade enrollment on school and year fixed effects, so it represents average within school changes in enrollment.[14]

$$AverageEnrollment_{jt} = \gamma_j + \eta_t + \varepsilon_{jt}$$

The share of students in public schools steadily declines before and after the reform. In contrast, private subsidized schools increased their share of students around the time of the reform, both in SEP and non-SEP schools. The new program creates incentives for private subsidized SEP schools to admit more vulnerable students. This explains the increased enrollment in private SEP schools that are willing to admit low-SES students from public schools. On the other hand, private subsidized non-SEP schools are not directly affected by the reform and incentives to them are unchanged. Therefore these increase in enrollment must be explained by changes in schools characteristics or peer compositions.

Changes in enrollment are not homogeneous across types of students, and they occur

[14]Changes in enrollment in this section are detrended for demographic country-level changes. Unrelated to this reform, there are long-term demographic trends of reduced number of children in the country. This has mostly impacted public school enrollment.

at different times. Figure 4 shows the probability of going to each type of school for different student types across the sample time. These probabilities are calculated from a multinomial logistic regression where the choice options are the four types of school (public, private SEP, private non-SEP, private fee-paying) and the explanatory variables are mother's education and year fixed-effects. The year the reform was implemented, the probability of going to a public school dropped significantly for students in the bottom half of the distribution of mother's education, with a correspondent rise of similar magnitude in the probability of going to a private subsidized SEP school.

There is an increase of about 10 percentage points in the probability of going to a private SEP school for students with mothers with fewer than twelve years of education. This increase occurrs in a discrete way, starting in 2008, the first year of the SEP reform. This suggests that private SEP schools started admitting students they had not admitted before, given the rise in the value of the voucher for vulnerable students. Further, it suggests that the high enrollment in public school of students in the bottom half of the distribution before the SEP reform, was likely determined by their inability to meet private schools admission requirements.[15]

Additionally, there is a gradual increase in the probability of students in the middle-high part of the distribution of going to a private non-SEP school in the years following the implementation of the reform. This contrasts with the sharp rise in the probability of enrollment in private SEP schools for low-SES students. Since only schools participating in the SEP program are directly affected by the reform, this gradual rise in probability of going to private subsidized non-SEP schools for more educated parents is likely to be associated with changes in the characteristics of SEP schools following the reform. If highly educated parents have preferences for peer quality, the changes in admissions by private SEP schools, admitting more vulnerable students, may have led high-SES parents to stop choosing private SEP schools and enroll instead in private subsidized non-SEP

[15] A similar explanation is related to schools actively pursuing low-SES students because of the new subsidy, as opposed to selecting them out before 2008. I discuss this in section 6 where I provide some evidence against this explanation. For the demand estimation, the distinction between these two have analogous implications. Either lack of information from low-SES students about schools available or low-SES students being selected out has similar would mean that some schools are not in the choice set of low-SES students.

schools.

5.2 Segregation Measures

In this section, I compute different measures of segregation to quantify changes in student sorting during the years around the SEP reform.

First, I look at changes in the average student type in public schools compared to the average student type in the market. As mentioned above, one concern regarding the school choice system in Chile is the fact that private subsidized schools cream-skim students from public schools. Hsieh and Urquiola (2006) show that the average parental education in public schools is much lower than in private subsidized schools and that this difference is stronger in municipalities with higher private school enrollment. Using this same measure, I compare for each market-year pair, the average mother's education in public schools with the average mother's education in the market, to test for whether sorting increased after the implementation of the SEP reform in 2008. Values closer to one reflect more integrated markets whereas lower values reflect more segregated markets, where public schools serve a lower socioeconomic population compared to the market average. Notice that the measure is not bounded by one. If public schools had the most educated parents in the market the measure would be larger than one, reflecting segregation in the opposite direction.

Figure 5 shows the average ratio weighted by market size, from 2005 to 2012. The average type of student in public schools in comparison with the market average decreased sharply in 2008 and continued to decrease thereafter. This reflects the fact that the increased enrollment in private subsidized schools was not a random sample of students that would have gone to public schools before the reform, but rather a selected set of students of higher socioeconomic characteristics, further increasing the differences in student types across different types of schools. This is consistent with the admission model explained above where private subsidized schools have a threshold for admission that decreased following the SEP reform.

The most common measure of segregation is the dissimilarity index, that measures the evenness with which two groups are distributed in a particular place across spacial units (in this case schools within a market). It represents the proportion of a group that

needs to move in order to create a uniform distribution (Duncan and Duncan, 1955). In the Chilean context, we would need to define a minority group to measure how it is distributed across schools. I define this group as students with mothers with at most eight years of education, which account for approximately 20% of the population. This is a natural choice given the nature of the school system in Chile, where 8, 12, and 16 are natural break points defined by the end of middle school, end of high school, and end of a 4-year higher education.

The index is defined by:

$$D_i = \frac{1}{2} \sum_{j=1}^{J_i} \left| \frac{n_j - m_j}{N_i - M_i} - \frac{m_j}{M_i} \right|$$

where n_j is the number of students in school j, m_j is the number of minority students in school j. J_i, N_i and M_i are the total number of schools, students and minority students in market i, respectively.

Panel A of Figure 6 shows the evolution of the index from 2005 to 2012 depicting an upward trend, showing a less even distribution of the lower SES students across schools. This is consistent with the trend observed in Figure 5, where the average SES in public schools is decreasing over time.

A disadvantage of the dissimilarity index is that it only measure segregation among two groups. Given that socioeconomic status is a variable that can take many values, dividing population between just two groups (high and low SES), only accounts for how segregated one particular group is (in the case above, students with mothers with less than middle school education). Therefore, I divide students in four groups according to mother's education using the three points defined above: less than middle school, less than high school, some college, higher education degree. These are the same groups that I use in the demand estimation in Section 7 to allow for heterogeneity in preferences. Following Reardon and Firebaugh (2002), I construct a multigroup version of the dissimilarity index using the following expression,

$$D_i^{MG} = \sum_{s=1}^{4} \sum_{j=1}^{J} \frac{n_j}{2N_i I} \left| \frac{n_j - m_{sj}}{N_i - M_{si}} - \frac{m_{sj}}{M_{si}} \right|$$

where s indicates each of the four socioeconomic groups, m_sj, and M_si are the number of students of group s in school j and market i respectively. I is an interaction index defined by the following expresion,

$$I = \sum_{s=1}^{4} \pi_s (1 - \pi_s)$$

where π_s is the proportion of students from group s in the market. This index is maximized when individuals of each group are distributed evenly among the four socioeconomic groups.

Panel B of Figure 6 shows changes in the multigroup dissimilarity index. There are some notable differences between the two panels. In 2009, there is a drop in the index that goes back up in 2010. This could be explained by the fact that SEP schools are incorporating SEP eligible students after 2008, coming mostly from the second group (mothers with less than high school education). It goes up again in 2010, where it looks like there is a response from the demand side for private schools opting out from the SEP program (see Figure 3).

Additionally, to analyze what changes may explain the differences in segregation measures, I look at the dispersion of student types within school. If markets become more stratified, we would expect schools to become more homogeneous. For each school-year I compute the interquartile range (IQR) of student types, calculated as the difference between the 25th and 75th percentile of mother's education in each school-year. I then run the following regression to capture changes within schools for each of the three types of school, public, private subsidized that participate in the SEP program, and private subsidized that opt out from the reform.

$$IQR_{jt} = \gamma_j + \eta_t + \varepsilon_{jt}$$

Table 4 shows the coefficients on the year fixed effects that represent the average change

in IQR within school compared to 2005. Consistent with the changes in enrollment shown above, public and private SEP schools decrease student dispersion within school, while no significant change is observed for private non-SEP schools. The timing of the changes is also interesting. For public schools, changes are stronger starting in 2009, the year after the implementation of the SEP reform, while for private SEP schools large changes start in 2010. There seems to be a trend for these schools before 2008 becoming more homogeneous, but there is a very large change starting in 2010.

Overall, there seems to be an increase in segregation, mostly explained by schools becoming more homogeneous, with the lowest SES students remaining in public schools, mid-low SES students getting access to private subsidized SEP schools, and higher SES students increasingly enrolling in private subsidized non-SEP schools. Several mechanisms could explain these changes in enrollment. On the supply side, schools may be changing their admission decisions in response to the program. Additionally, changes in school characteristics or peer composition could have changed parent sorting. To explain what drives parents' enrollment decisions, we must model their preferences for school characteristics and peer quality. From the discrete changes in enrollment for low-SES parents, shown in Figure 4, it looks like low-SES parents' decisions are constrained by private school selection thresholds. If this is the case, we need to account for this restriction in order to correctly estimate parental preferences.

The SEP reform created incentives for participating schools, to decrease the cream-skimming behavior shown before the reform, when they were selecting students with higher socioeconomic backgrounds. Following the reform there is a large migration of students from public schools to private SEP schools, leaving only the most vulnerable students in public schools. On the other hand, the new program allowed private schools with higher proportion of high-SES students to opt out of the program. If parents have preferences for certain peer types, this could attract more high-type students, explaining the increased enrollment in non-participating schools. In sum, the program seems to have mainly caused a redistribution of students, keeping higher-income students in the non-SEP private subsidized schools and the most vulnerable students in public schools.

6 School Admissions

As introduced in Section 2, the admission process is modelled as a threshold on the student type that a school is willing to admit. In most cases, given the correlations between academic performance and socioeconomic characteristics, schools have incentives to select students from more educated parents. This selective behavior is also supported by extensive political discussions over the implementation of mechanisms to deter selection and the observed stratification shown in the stylized facts.

Nevertheless, the literature that estimates parents' preferences for school quality assumes that the only type of selection that schools have is through prices. Yet, most of these schools do not charge any tuition [16].

Schools' selective behavior is something generally difficult to show, mainly because the admission process is decentralized and there is no data on individual applications (only enrollment is observed). Therefore, the admission process is highly opaque, and in particular the relevant sociodemographic variables that may matter for the school, and the admission thresholds are unobserved.

In this context, the SEP reform provides incentives for schools that participate in the program to admit more vulnerable students. The question is whether schools have the means to react given that they do not have any measure of student performance at the moment of admission. Furthermore, by law elementary schools are not allowed to test students on admission and they do not have any information about prior performance. Therefore, if schools are selecting students, discrimination has to be based on other indicators. One of the easiest being parental education, likely observed through parental interviews. [17]

I exploit the variation in incentives to schools that participate in the SEP program to test for whether schools are able to respond by lowering their admissions thresholds. Using mother's education as a proxy for the student type [18], I show that there is a large change in

[16] Aproximately half of the private subsidized do not charge any tuition and 75% charge less than $30 per month, see 2

[17] A survey of 4th grade parents conducted along the SIMCE test, shows that aproximately half of voucher schools request parental interviews.

[18] Results are very similar if instead I take family income or socioeconomic status constructed using factorial analysis

the type of students being admitted following the reform for participating school, evidence that private schools are, in fact, able to select students based on this characteristic.

I take the lowest 1% of mother's education in each school each year, as the 'observed' admissions threshold (θ^*_{jt}), and look at how θ^*_{jt} changes among participating schools when they join the program (schools join in different years, not necessarily all in 2008), separately for public and private-SEP schools. I estimate equation 1 by OLS using school fixed effects and $\mathbb{1}(SEP\text{-}School)_{jt}$ as an indicator for whether school j is participating in the SEP program in year t.

$$\theta^*_{jt} = \alpha + \beta \mathbb{1}(SEP\text{-}School)_{jt} + \gamma_j + \varepsilon_{jt} \tag{1}$$

Panel A in Table 5 shows the average within-school change in the observed threshold for SEP schools, when the school starts participating in the SEP program. The first and second columns show the results for public schools and private subsidized schools, respectively. We see a large drop in a school's admissions threshold after the school enrolls in the reform for private subsidized schools, but not for public schools. Yet, part of this drop may be explained by a price effect, given that the program prevents schools from charging any tuition to eligible students. Therefore, schools that were charging tuition before 2008 now become free for eligible students. To get at this issue, the third column estimates the drop in the threshold using just the sample of schools that did not charge any tuition before 2008. For these schools there is no price effect and there is still a large and significant drop.

To further test whether mother's education is a good proxy for how schools set admission thresholds, I look at how $theta^*_{jt}$ changes when the value of the per-student subsidy increases or when capacity increases (when a school adds another classroom). Table 1 shows variation in the value of the voucher during the period of 2005-2012. Of course, the SEP reform constitutes an arguably more exogenous shock than both of these cases, but it is still worth checking whether changes are consistent. I estimate equations 2 and 3 by OLS using school fixed effects, where v_t is the value of the per-student subsidy in year t, and C_{jt} is the number of classrooms at school j in year t.

$$\theta^*_{jt} = \alpha + \beta v_t + \gamma_j + \varepsilon_{jt} \tag{2}$$

$$\theta^*_{jt} = \alpha + \beta C_{jt} + \gamma_j + \varepsilon_{jt} \tag{3}$$

Panel B in Table 5 shows a significant drop in the cutoff values when a school adds a classroom or when the voucher increases in value. This means that when a school increases its capacity or when the voucher program gets more generous, schools are likely to increase their range for admission.

These results suggest that schools are effectively able to select students based on socioeconomic characteristics and that mother's education can usefully proxy for the socioeconomic variables relevant for schools' selection process in admissions.

7 Demand Estimation

Section 5 established two main patterns of sorting following the SEP reform. First, more low-SES students enrolled in private subsidized SEP schools instead of publics schools, and second, more middle-SES students enrolled in private subsidized non-SEP schools instead of private SEP schools. Different demand and supply mechanisms could drive these sorting patterns: changes in schools selection policies resulting from the SEP incentives, changes in tuition from SEP requirements, changes in school characteristics, and peer composition that could drive parents to change their choice of school.

In Section 6 I show evidence of private schools' cream-skimming behavior in terms of socioeconomic characteristics, and how this behavior changed following the reform for participating schools. Furthermore, I show that mother's education is a good proxy for characteristics that are relevant for admission to private subsidized schools, and that there is a discrete drop in admission thresholds in terms of mother's education after a school chooses to register in the SEP program. This explains the higher enrollment of low-SES students in private subsidized SEP schools. Therefore, following the SEP reform there are changes in the peer composition in most schools, providing exogenous variation in average student type, class size, and test scores. This variation is useful to identify preference

parameters in the parents' utility function. Further discussion about identification is provided in the next subsection.

Additionally, because of the evidence shown in Section 6 regarding private school cream-skimming behavior, it is important to account for these admission restrictions to low-SES parents to properly recover preference parameters. That is, choice sets of feasible schools may be different for low-SES parents than for high-SES parents, depending on schools' admission thresholds. Even if some schools are tuition-free, they might not admit some students based on their socioeconomics characteristics. The assumption commonly made in the literature estimating demand, that every school is available to every student is not innocuous and it biases the estimation of preferences.

Therefore, it is necessary to define the set of feasible schools for each student. If thresholds were observed, the choice set for each student would be easily defined. In this context, admission criteria in each school is unknown, and could differ across schools. Most private subsidized schools have interviews for applicants' parents. It has been long discussed in the literature and in politics, that private subsidized school use these parental interviews to get information in order to select students. It is reasonable to assume that during these interviews, schools are able to observe some socioeconomic characteristics.

For the estimation, I assume that the admission threshold for a school θ^*_{jt} is known. I use the observed lowest 1% in mother's education of enrolled students for each private subsidized school as a proxy for θ^*_{jt}. In this context, admission thresholds are obviously an endogenous equilibrium outcome, but this should not affect the estimation of parental preferences. Fack et al. (2015) show that estimates do not change when endogenizing the cutoffs, suggesting that in large enough markets, cutoffs can be treated as exogenous to estimate the demand parameters. Therefore, if equilibrium thresholds were known, estimates of utility parameters can be obtained by restricting the choice set for each student to the feasible schools only. Once recovered the utility parameters, for the counterfactual exercises, admission thresholds are allowed to adjust.

In summary, a student of type θ_i, which is defined as the mother's education, will choose a school that maximizes the utility within the schools in the choice set ($\theta^*_{jt} \leq \theta_i$).

The utility student i gets from attending school j is given by:

$$U_{ijt} = \alpha_i p_{ijt} + X_{jt}\beta^i - \gamma_i d_{ijt} + \xi_{jt} + \varepsilon_{ijt}$$

where

X_{jt} are school characteristics, d_{ijt} is the distance for student i to school j, ξ_{jt} is a year-school specific term that represents unobserved school quality. ε_{ijt} represents an unobserved idiosyncratic preference of student i for school j, distributed independently across schools and students.

X_{jt} includes several school attributes from year $t-1$: the previous year test scores and class size, and the previous years peer composition (average and interquartile range of the type of students in the school) to account for preferences for certain type of peers beyond their effect on test scores. I use previous year characteristics on grounds that this is the information available to parents when making school decisions, abstracting from any social interactions that may affect the decision. This is supported by the descriptive analysis shown in Figure **??** where changes in enrollment probabilities for middle- and high-SES families seem to gradually respond to changes in school characteristics that followed the SEP reform.

Parents are allowed to have heterogeneous preferences according to observable characteristics. This is reflected in parameters $\alpha, \beta, \text{and} \gamma$ indexed by i, where

$$\beta_i = \bar{\beta} + \beta^o W_i$$

W_i includes family income and mother's education. Income is a continuous measure of per-capita family income, and mother's education include indicators for being in one of four groups: less than eight years, less than high-school, high-school or more, and university degree. The omitted category is less than eight years.

If we assume that ε_{ij} is distributed type I extreme value, this produces a logit functional form for the probability that student i chooses school j.

$$P_{ij} = P(j|\boldsymbol{\theta^*}, \boldsymbol{\xi}, W_i) = \mathbb{1}(\theta_i > \theta_j^*)\frac{exp(v_{ij})}{1 + \sum_{k \in J(\theta_i)} exp(v_{ik})}$$

where

$$v_{ij} = \alpha_i p_{ij} + X_j \beta^i - \gamma_i d_{ij} + \xi_j$$

and $J(\theta_i)$ is the choice set of schools available for a student of type θ_i.

Since only differences in utility matter, it is necessary to normalize the utility for one alternative to zero. Effectively, there is no outside option because all students are required to enroll in a school and I effectively observe the entire market. Most schools in each market are quite small, so instead of just normalizing the utility with respect to one particular school, I take a third of the public schools in each market as the outside option to normalize the utility. I assume that this group of schools share the same unobserved quality term, and public schools are assumed to be available to everyone. In the estimation, I control for observable characteristics of these schools in each market.

7.1 Estimation and Identification

The probabilities P_{ij} are conditional on the vector of $\boldsymbol{\theta^*}$. Let $\delta_{jt} = \bar{\beta} X_{jt} + \xi_{jt}$ the year-school specific term that does not vary across students, and $\eta = [\alpha^o, \gamma^o, \beta^o, \boldsymbol{\delta}]$ the set of parameters to estimate. To recover the parameters from the utility function, I consider the maximum likelihood estimator assuming the observed vector of $\boldsymbol{\theta^*}$:

$$\hat{\eta} = arg\max L(\eta, \boldsymbol{\theta^*}),$$

where

$$L = \sum_{i=1}^{I} \sum_{j=1}^{J} x_{ij} log(P_{ij})$$

where $x_{ij} = 1$ if student i chooses school j and 0 otherwise.

For the estimation I proceed in two steps. First, for each market separately, I obtain α^o, γ^o, and β^o that maximize L, and following Berry (1994), I estimate δ_{jt} matching the observed market shares for each school to the estimated shares as a function of the parameters in each iteration. This way, δ_{jt} (year-school specific term) allows the model to perfectly match school-level market shares. I exclude markets too large for estimation to

be feasible as well as markets with only one municipality. Markets need to have at least two municipalities to assure meaningful variation in the measure of distance to schools. [19] After these restrictions, 18 medium size markets are considered for the estimation. These are scattered through out the country across all geographic areas.

In a second step, from the panel of $\hat{\delta}_{jt}$ and X_{jt}, I estimate the average utility parameters $\bar{\beta}$ from an OLS regression using school fixed effects to control for unobservable school level characteristics that may be correlated with X_{jt}. In this step, I pooled together all schools across markets.

Identification of $\alpha^o, \gamma^o, \beta^o$, and δ_j is provided by the variation within markets of different types of students and the variation in enrollment before and after the reform given by the changes in the choice set for each type of student and the changes in school characteristics and peer composition. The variation that identifies $\bar{\beta}$ comes from the within-school variation generated by the SEP reform. The identification assumption is that changes in X_{jt} are uncorrelated with changes in the unobserved quality ξ_{jt}. I also assume that parents take $\boldsymbol{\theta^*}$ as given, similar to a price taking assumption. Effectively, I assume that markets are large enough that the decision of each parent can not have an effect on admissions thresholds. Also, I assume that parents only consider previous years' school characteristics when choosing a school and I abstract from any social interactions that may affect the decision.

7.2 Parameter Estimates

Estimates for the average utility parameters are shown in Table 6. My results indicate that it is important to consider the restrictions that some parents face because of the selective behavior of private subsidized schools when estimating parental preference parameters. I estimate the model both with and without cream-skimming restrictions in admissions. The first column shows results of the full model including the admission restrictions where each student has a limited number of schools available depending on the socioeconomic type. The second column shows results without considering restrictions on the choice set.

[19] Since the location of each student is defined only by the municipality where he lives, I cannot include markets with only one municipality where all students would be located in the same point.

Column 1 of Table 6 shows that parents with low education (the omitted category in the parent education group) prefer peers of lower type and have a positive taste for schools with better results in standardized tests (negative and significant sign for average peer type and positive and significant sign for average math scores). Differences between columns 1 and 2 suggest that ignoring admission restrictions leads to underestimating low-SES parents' preferences for quality, and overestimates their utility from lower type peers. In other words, the model rationalizes the enrollment decisions in the data. Therefore, if we ignore the restricted choice set and observe low-SES parents not selecting high-quality schools, one might infer that they have low preferences for school quality. Column 1 shows that this is in fact not true, and this explains the changes in enrollment of low-SES students following the reform when participating schools start accepting more low-SES students.

Table 7 shows estimates for the heterogeneity parameters α, γ, and β_0 using the model with the restriction on the choice set for each student. It shows weighted average coefficients by market size for income and education levels. My results suggest that parents' most important consideration is the average type of students in the school, and the magnitude of this parameter increases significantly with the level of parental education and income. Distance is measured in kilometers, tuition in dollars per month, mother's education and test scores are standardized to have mean zero and standard deviation of one. Therefore, we can interpret the coefficients on average peer type in terms of willingness to travel for a one standard deviation in peer quality. Students with a mother of at most high school education are willing to travel approximately 0.6 km, compared to 4 km and 6.7 km for the groups of more than high school and university education, respectively. The coefficient on tuition is negative and significant only for the lowest education group, which is the only group that experiences significant variation in tuition within schools because they are the group targeted by the SEP reform.

In summary, these results show that distance is an important factor determining the choice of school, and the largest heterogeneity in preferences across groups is explained by the coefficients on peer quality. This explains some of the patterns described in Section 5, showing that high-SES students after the implementation of the SEP reform gradually started preferring non-SEP schools.

In the next section, I use these estimates to simulate different counterfactuals to isolate the effects of the different segregation mechanisms.

8 Counterfactuals: Segregation mechanisms

I use the model to quantify how much of the observed segregation in the data is explained by parental preferences and how much by school cream-skimming behavior. In both exercises, I assume that schools cannot increase capacity beyond their maximum observed enrollment over the data period.[20]

Simulating market outcomes in counterfactual experiments requires computing equilibrium admission thresholds. For this, an allocation mechanism has to be defined to obtain the new thresholds. In a first exercise, I assume a centralized admission system to effectively eliminate all cream-skimming behavior from schools. To do this, I assume a random serial dictatorship mechanism for assignment. In a second exercise, I do the same, but giving priority to SEP students, to match a reform implemented in Chile in 2017.

For each case, I compute the average mother's education in private and public schools and the share of students going to public school. I also compute actual values from 2007 and 2012 for comparison. These values do not match the magnitudes from the descriptives because mother's education is standardized for the estimation.

Next, I change preference parameters to eliminate all preferences for peer quality. In this case, to do the matching, I assume that school preferences over students are known and given by the admission model from Section 2. I assume private subsidized schools maintain their admission policy of preferring higher types to lower types and allow admission thresholds to adjust given the new preferences. This would generate new equilibrium thresholds. Schools preferences for higher types may very well change in response to the change in preferences, but I assume that this is not the case in order to isolate the demand side effect on segregation.

Each of these is computed separately for each market, results are similar across markets. Table 8 show the results for the largest market in the estimation. The first two

[20] Allowing schools to increase capacity do not qualitative change the results on segregation, but exaggerates the negative effect over enrollment in public schools.

columns show the results for eliminating school selection via a centralized lottery, and the third column show the case of eliminating preference for peer characteristics. Eliminating school selection, decreases enrollment in public schools by 2.5 percentage points, and only reduces the gap in mother's education by 30% compared to 2012 (depending on the market, this number goes from 20% to 38%). Giving priority to vulnerable students in the admission lottery marginally increases the reduction in the gap. On the other hand, shutting down parental preferences for peers, increases enrollment in public schools by 3.5 percentage points compared to 2012, and the gap on average mother's education between public and private, decreases by more than 50% (depending on the market, this number goes from 20% to 38%).

It should be noted that this exercise shuts down only the direct effect of parental preferences for peers, and does not consider any possible effects this may have on schools admission behavior. Schools may prefer high-type students for several reasons: lower marginal cost, school rankings, increase enrollment. The model is silent about the reasons for schools engaging in cream-skimming behavior. Therefore, my results represents a lower bound on the total effect. Furthermore, these counterfactuals only simulate short term responses considering the school characteristics from 2012. After the first year, the simulations become significantly more complicated because changing student allocations one year changes schools' characteristics with respect to peers, test scores, and class size. Therefore, I would need to estimate the choices year by year and would require a model to predict how test scores would change.

9 Summary and Conclusions

This paper studies the mechanisms behind school segregation using the variation generated by a reform to the Chilean school voucher system. The reform intervened in the educational system in an innovative way that makes it useful to study cream-skimming behavior from private schools. The within school variation in peer composition, class size, and admission thresholds allows me to estimate parental preferences for school and peer characteristics.

My main results can be summarized in three points. First, I show that private subsidized schools effectively cream-skimmed students based on socioeconomic characteristics. Second, estimates for parents preferences differ when accounting for supply-side selection in admissions. Ignoring these restrictions leads to underestimates of preferences for school quality. My estimates of structural parameters for parent preferences show that low-SES students care about quality which explains the migration of students from public to private subsidized schools. Third, as parental education increases, so does the magnitudes of the coefficients for peer quality. This explains the shift of middle income students from private schools that participated in the program to schools that opted out.

Previous research has suggested that that cream-skimming concerns can be alleviated through better program design, for example a tiered voucher system. While this paper shows that a tiered voucher, in fact, decreases cream-skimming by schools, it shows that this may have little effect on overall stratification if parents have strong preferences for high-SES peers.

Understanding the role of parental preferences and the mechanisms that underlie school segregation is crucial to evaluating the potential impact of school choice programs on social stratification in schools. School socioeconomic segregation is particularly important given evidence that it can perpetuate long-term income inequality.

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Table 1: Increase in the Value of the Voucher for SEP Students

	Preschool to 6th grade		
	2005-2007	2008-2011	2012
Baseline Subsidy	\$68	\$79	\$81
SEP Subsidy	\$0	\$46	\$56
% of Priority Students	Preschool to 6th grade		
$15\% - 30\%$		\$3.6	
$30\% - 45\%$		\$6.2	
$45\% - 60\%$		\$8.3	
$> 60\%$		\$9.3	

Note: This table presents the values for the preferential subsidy for 2008 and 2011, and the extra voucher the schools get for a high concentration of priority students in US dollars. Source: Mineduc (2012)

Table 2: Student Characteristics for Public and Private Subsidized Schools in 2007 and 2012

Student Characteristics in 2007			
	Public	Priv. Subsid.	T-Test
Mother's Education (yrs)	10.29	12.47	-34.24
Family Income (US\$)	351.54	629.87	-27.06
Math Score	229.38	251.55	-23.65
Language Score	240.10	260.15	-24.19
Class Size	25.49	25.96	-1.42
Student Characteristics in 2012			
	Public	Priv. Subsid.	T-Test
Mother's Education (yrs)	10.06	12.15	-37.91
Family Income (US\$)	294.08	571.40	-28.91
Math Score	246.71	261.27	-18.20
Language Score	253.59	268.41	-20.97
Class Size	23.19	26.29	-11.18

Note: This table presents average statistics in each type of school in 2007 and 2012. The average is calculated over all students in 4th grade in the school and over the 4 years of the program.

Table 3: Number of Schools by Type and Year

	2005	2006	2007	2008	2009	2010	2011	2012
Total	7,425	7,457	7,896	7,764	7,857	7,890	7,704	7612
Private Non Subsidized	409	399	406	406	401	406	405	393
Private Subsidized	2,694	2,698	2,923	2,936	3,060	3,085	3,094	3,124
Municipal	4,322	4,360	4,567	4,422	4,396	4,399	4,205	4,095
All SEP	-	-	-	6,553	6,629	6,649	6,456	6,328
SEP Private Subsidized	-	-	-	2,137	2,235	2,252	2,253	2,237
SEP Municipal	-	-	-	4,416	4,394	4,397	4,203	4,091

Note: This table presents the number of schools each year by type of school starting in 2005, and the number of schools enrolled in the SEP program from 2008.

Table 4: Changes in the Interquartile Range by Type of School Over Time

	Public	Private SEP	Private NonSEP
2006	-0.079	-0.068	0.066
	(0.038)	(0.048)	(0.060)
2007	-0.098	-0.185	0.064
	(0.039)	(0.050)	(0.063)
2008	-0.033	-0.165	-0.079
	(0.038)	(0.047)	(0.061)
2009	-0.145	-0.173	-0.018
	(0.038)	(0.047)	(0.061)
2010	-0.158	-0.298	-0.085
	(0.038)	(0.047)	(0.061)
2011	-0.196	-0.293	-0.040
	(0.039)	(0.047)	(0.061)
2012	-0.147	-0.277	0.004
	(0.039)	(0.047)	(0.061)
Constant	3.950	3.464	3.273
	(0.027)	(0.034)	(0.043)
R-squared	0.286	0.295	0.346
N	13331	12181	5293

Note: This table presents average changes in interquartile range by type of school, in terms of mother's education. *,**, and *** denotes significance at the 10, 5 and 1% level. Standard errors are presented in parenthesis.

Table 5: Changes in Admissions Threshold

Panel A: Cutoffs changes when a school joins SEP program

Dep Variable - Lowest 1% of Student Mother's Education			
	Public Schools	Private Subsidized SEP Schools	
		All	Tuition=0
SEP School	0.055	-0.458	-0.344
	(0.035)	(0.044)	(0.065)
Constant	3.201	5.336	4.210
	(0.027)	(0.031)	(0.047)
School FE	X	X	X
R-squared	0.371	0.527	0.401
N	13246	12181	4824

Panel B: Cutoffs changes with changes in voucher values and school capacity

Dep Variable - Lowest 1% of Student Mother's Education			
	Public Schools	Private Subs. Schools	All Schools
Voucher Value	0.158	-1.353	
	(0.099)	(0.104)	
Number of Classes			-0.368
			(0.038)
Constant	2.281	9.047	6.069
	(0.225)	(0.239)	(0.064)
School FE	X	X	X
R-squared	0.273	0.541	0.742
N	13317	17474	33833

Note: This table presents changes in the observed lowest 1% in the mother's education when schools join the SEP progra, or changes capacity (adds another classroom) or increases the value of the voucher. The estimation is based on regression with school fixed effects to capture variation within schools, showing that mother's education is a good proxy for the admissions threshold. *,**, and *** denotes significance at the 10, 5 and 1% level. Standard errors are presented in parenthesis.

Table 6: Estimation Results - Average Utility Parameters

Dep Variable: Average Utility (δ_{jt})		
	Restricted	Unrestricted
Class Size	-0.002	0.001
	(0.002)	(0.002)
Average Peer Type	-0.359	-0.714
	(0.063)	(0.065)
IQR Peer Type	-0.019	0.008
	(0.030)	(0.029)
Avg Math Score	0.076	0.021
	(0.032)	(0.033)
Constant	-1.485	-2.296
	(0.069)	(0.068)
School FE	X	X
R-squared	0.993	0.989
N	6482	6482

Note: This table presents regression coefficients of average utility of a school on different lagged school characteristics: average class size, average standardized mother's education, interquartile range of mother's education, average standardized math test score, and an indicator for participating in the reform. It shows estimates for both, the model including the restriction on the choice set and for the unrestricted version. *,**, and *** denotes significance at the 10, 5 and 1% level. Standard errors are presented in parenthesis.

Table 7: Estimation Results - Heterogeneity on Preferences by Income and Mother's Education

	< 8 years	High School	More than High School	University	Income
Avg Peer Type		0.211	1.041	1.751	0.743
		(0.047)	(0.052)	(0.094)	(0.058)
Avg Math Score		-0.001	0.054	0.148	0.101
		(0.033)	(0.031)	(0.029)	(0.048)
IQR Peer Type		-0.016	-0.048	-0.047	0.07
		(0.096)	(0.102)	(0.123)	(0.036)
Class Size		0.008	0.021	0.017	0.002
		(0.005)	(0.005)	(0.007)	(0.002)
Distance	0.023	-0.263	-0.224	-0.260	0.004
	(0.022)	(0.012)	(0.009)	(0.010)	(0.006)
Tuition	-0.301	0.023	0.003	-0.019	0.013
	(0.012)	(0.008)	(0.006)	(0.006)	(0.001)

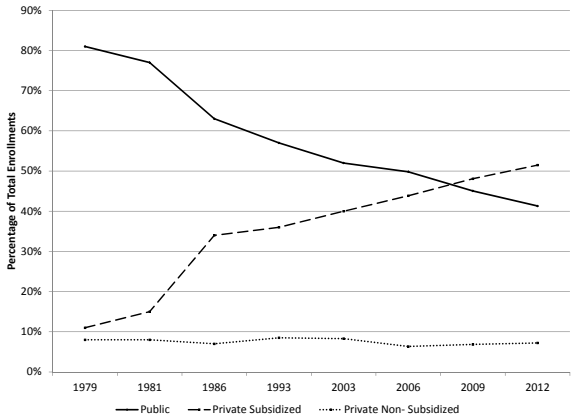
Note: This table presents average heterogeneity coefficients across markets weighted by market size. The model allows for heterogeneity in preferences depending on income and mother's education. Income is measured as a continues variable and mother's education as an indicator for being in one of four groups. School characteristics included are average class size, average standardized mother's education, interquartile range of mother's education, average standardized math test score. Also the distance between the school and the student's municipality measured in kilometres and tuition measured in dollars per month. The estimates shown in this table correspond to the full model that includes the restriction on the choice sets depending on the student type.

Table 8: Counterfactual Comparisons

	Lottery for School Selection	Lottery with Priority for low-SES	No Pref. for Peer Quality	Actual 2012
Avg M.Ed Private	0.2815	0.2742	0.2676	0.3647
Avg M.Ed Public	-0.3041	-0.2881	-0.1659	-0.4642
Share Public Schools	0.2589	0.2585	0.3180	0.2835

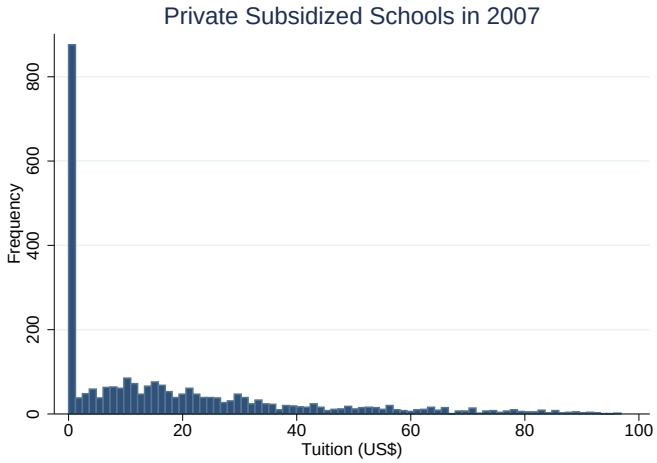
Note: This table presents simulation results for one representative market assuming different scenarios: columns (1) and (2) show the average mother's education in public and private school, as well as the share of students in public schools when there is a centralized lottery for admission, eliminating selection from schools. Column (1) gives the same priority to everyone, whereas column (2) gives higher priority to vulnerable students. Column (3) shows these same statistics for a hypothetical scenario where parents have no preference for peer characteristics, assuming that schools selection mechanism does not change. Column (4) show the actual values for 2012 as a comparison.

Figure 1: Changes in Enrollment by Type of School



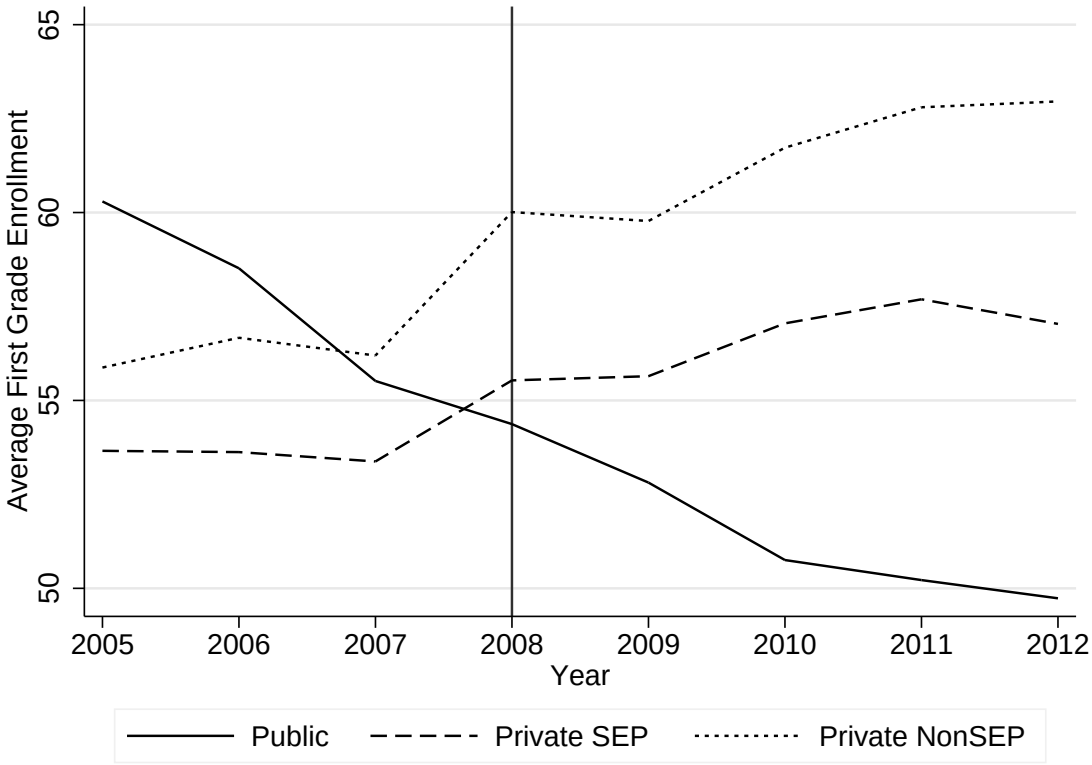
Note: This figure shows the evolution on the share of students that is enrolled in each type of school from the beginning of the voucher system in Chile. It is calculated as the percentage of total students enrolled in public, private subsidized, and private non-subsidized schools.

Figure 2: Distribution of Average Tuition in 2007



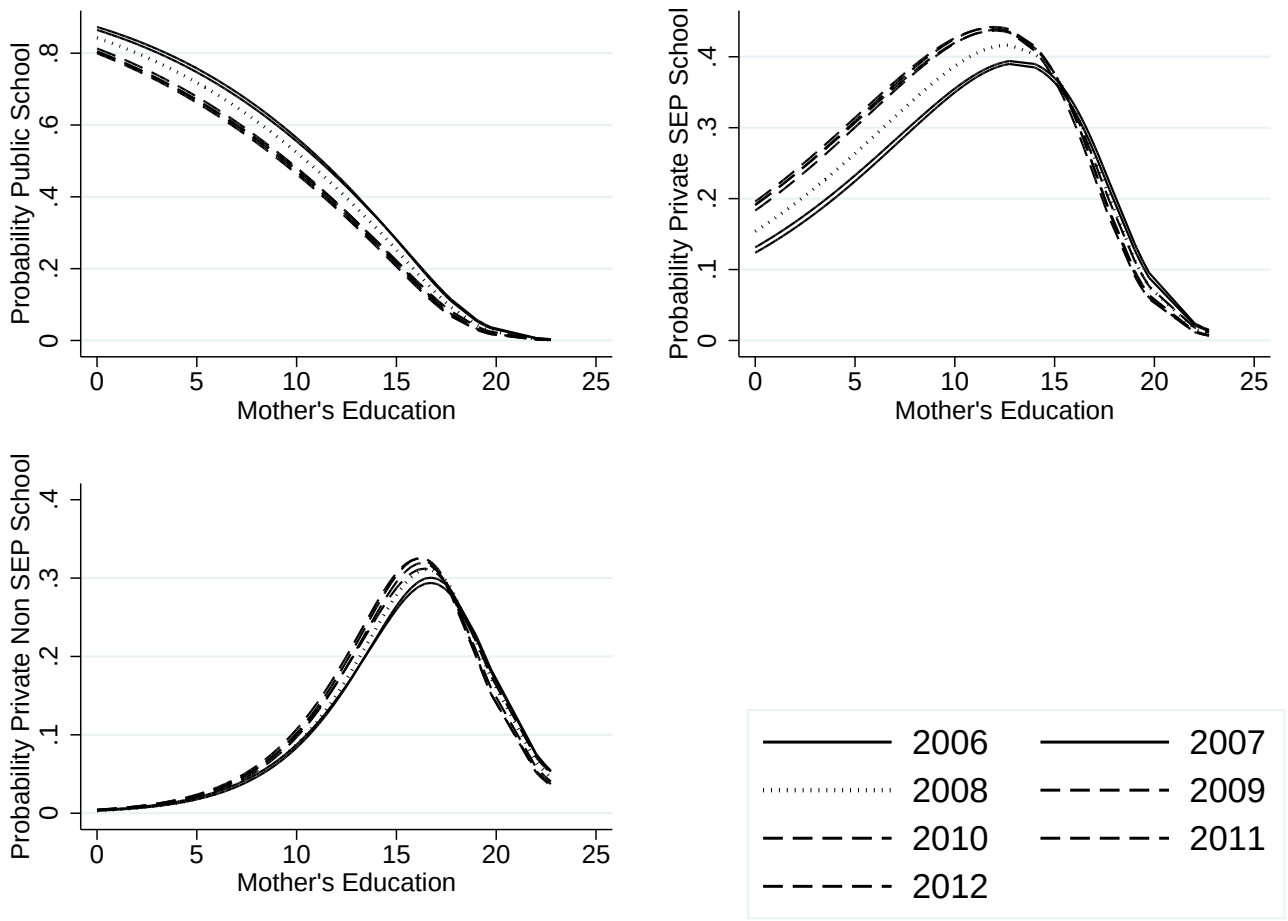
Note: This figure shows the distribution of average tuition charged by private subsidized schools in US$ per month in 2007, before the SEP program started. More than half of the schools did not charge any tuition.

Figure 3: Evolution of First Grade Enrollment in Public and Private Schools



Note: This figure shows the evolution of average first-grade enrollment within-school. It shows the coefficients on the year fixed-effects from a regression of first grade enrollment in a school on year and school fixed effects.

Figure 4: Probabilities of Enrollment by Type of School



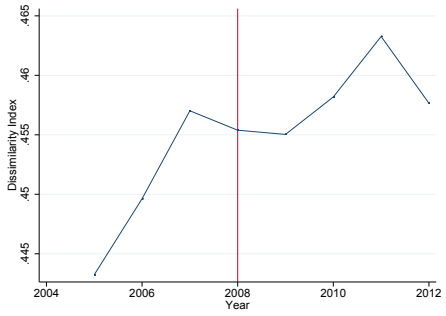
Note: Each graph shows the probabilities for each level of mother's education of enrolling in different type of school each year. The probabilities are calculated based on the coefficients from a multinomial logit model where a student has the option of enrolling in four types of schools: public, private subsidized SEP, private subsidized non-SEP, and private fee-paying schools. The probabilities for the last type of school are not shown here because no significant changes are observed in this period.

Figure 5: Changes in Average SES in Public Schools Compared to Market Averages

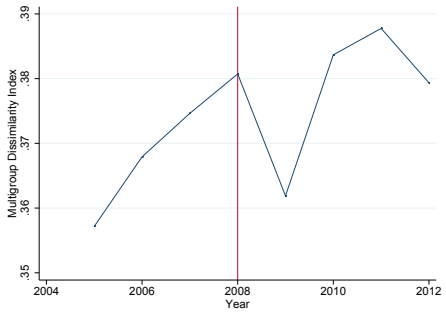
Note: This figure shows average changes in the sorting ratio measure. The ratio is constructed as the average student type in public schools over the average student type in the market where the public schools operate. Higher values mean more integrated markets where public schools have a more representative student body compared to the market where they operate. Each point in the graph represents the average ratio across markets, weighted by total number of students in the market.

Figure 6: Changes in Dissimilarity Index

Panel A: Dissimilarity Index



Panel B: Multigroup Dissimilarity Index



Note: This figure shows average changes in the dissimilarity index. Panel A shows dissimilarity index of the group of students with mothers of at most middle school education. Panel B shows a multigroup dissimilarity index, where population of students is divided in four groups depending on mother's education: less than 8 years, less than 12 years, less than 16 years, and more than 16 years. Lower values mean a more even distribution. Each point in the graph represents the average index across markets, weighted by total number of students in the market.

A Details of the Chilean Education System

Chile implemented a nationwide school voucher program in 1981 to introduce school choice and decentralize educational services. This reform also included the decentralization of public schools' administration, transferring responsibility for public school management from the Ministry of Education to local municipalities. Public schools continued to be funded centrally at the municipality level, but municipalities began to receive the per-student voucher for every child attending their schools, just as for private subsidized schools. As a result, enrollment losses directly affects schools' budgets.

This voucher system separated the financing from the provision of education, and created incentives for the private sector to expand their role as provider. The share of private schools in Chile's education system grew dramatically: more than 1,000 private schools entered the market, increasing enrollment in private subsidized schools from 15 to 40% in 20 years. This shift was more notable in larger, more urban, and wealthier communities (Patrinos and Sakellariou, 2009; Elacqua et al., 2011).

A comparison of standardized test scores of private and public schools shows that private subsidized schools have obtained consistently and significantly better results than public schools, but these results stem from the lack of random assignment of students to schools. Bellei (2005) outlines some reasons why it is difficult to make comparisons between public and private schools in Chile: private schools tend to be located in urban areas and serve middle- to middle-high-income students. Contreras et al. (2010) shows that the public-private test score gap drops to zero after controlling for family and school characteristics, and student selection criteria. Thus there is no evidence that, on average private subsidized schools perform better than public schools. Hsieh and Urquiola (2006) show that the voucher program led to increased sorting, where the main effect of unrestricted school choice was an exodus of middle-class students from the public to the private sector. Contreras et al. (2010) offer evidence that private subsidized schools were more selective than public schools. Facing excess demand, the better private subsidized schools practiced screening, seeking to select the best students. As a result, private subsidized schools ended up serving a better-informed and wealthier population, at the expense of municipal schools that served the less-well-off. Even though there is extensive evidence of this sorting, it is less clear whether this is exclusively and mainly explained by private subsidized schools' selective behavior. The empirical analysis of this paper shows evidence of both, schools selective behavior, but at the same time, strong heterogeneity in preferences from the demand side. In the counterfactuals, it is clear that eliminating selective admission from private subsidized school would not be sufficient to eliminate sorting.

In February 2008, Chile adopted a new policy creating a targeted schooling subsidy for the most vulnerable students (SEP law, for 'Subvencion Escolar Preferencial'). This reform modified the existing flat subsidy per student by introducing a two-tier voucher, increasing the subsidy schools receive for the most vulnerable students. The main purpose of the program was to improve equity within the education system, promote equal opportunity, and improve the quality of education (Weinstein et al., 2010). In addition, participating schools were required to design and implement a plan for educational improvement. These

schools were also required to accept the value of the voucher as full payment of tuition for preferential students, eliminating extra tuition and other fees for eligible students.

Student eligibility for the SEP voucher was determined annually according to several criteria. By 2012, 44% of elementary students were classified as eligible for the SEP benefits. SEP eligible students are drawn from families in:

a) The program 'Chile Solidario' (a government social program for the most vulnerable families in the country).

b) The first section of the public health system (the poorest families given by a classification of beneficiaries of the health system according to household income).

c) The most vulnerable 33% according to the 'Ficha de Proteccion Social' (FPS).

d) If a student did not qualify under the first three points, other criteria are taken into account including family income and education of the parents, each case evaluated by the Ministry of Education using the FPS.

Schools have the choice to register in the SEP program and only participating schools receive the SEP benefits. If a school chooses not to participate, it cannot receive the benefits even if priority students are enrolled, but continues to receive the original voucher. SEP schools are require to submit an annual report on the use of SEP resources, presenting a plan for educational improvement, and establishing academic goals. Moreover, SEP schools must exempt eligible students from any out-of-pocket expenses, and cannot discriminate based on academic performance in the admissions process. Finally, the funds must be destined to measures approved in the school's educational improvement plan.