ESSAYS ON THE ECONOMICS OF SCHOOL CHOICE AND EDUCATION MARKETS

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To my parents

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ABSTRACT

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Improving education quality is an important concern in many countries around the world. Over the last few decades, many governments have introduced market mechanisms in education with the objectives of enhancing choice and encouraging competition. In theory, increased competition between educational establishments should result in the provision of better quality education services to attract students. These reforms have given rise to fierce debates in political and scientific circles.

In the first chapter I study the mechanisms that underlie student sorting in a mixed public-private system using a 2008 education reform implemented in Chile aimed at decreasing education inequality. Specifically, I exploit the shock to schools incentives to test for whether schools select students based on socioeconomic characteristics. I show that low-SES parents school choices are restricted by private school cream-skimming behavior. I estimate a demand model incorporating these admission restrictions to capture parental preferences for different school characteristics and peer composition. I show that ignoring cream-skimming leads to underestimating poor parents' preferences for school quality. I find that the decrease in cream-skimming induced by the reform led to lower public school enrollment and that strong preferences for high-income peers drove increased enrollment in schools that opted out of the reform. Overall, this led to increased segregation with higher impacts in markets with greater competition.

In the second chapter I study the consequences of increased competition and geographic differentiation resulting from the deregulation of the Chilean college market and the increase in government scholarships and loans. We study the effects of these changes in market characteristics on the efficiency of the higher education system and the accessibility and quality of colleges. We estimate a sorting model to account for vertical and horizontal dimensions of differentiation and quantify the quality of public and private colleges. We find that most of the growth in enrollment comes from elite institutions that expand the size of existing programs and private universities that almost doubled their enrollment and at the same time doubling on average the number of programs offered. We calculate substitution patterns for when a program increase its quality. We find significant substitution between middle tier programs, whereas top tier universities tend to substitute mainly from other programs in that same range.

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1.1. 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; Chakrabarti, 2013; Contreras et al., 2010). 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 examines the demand and supply-side mechanisms behind observed increases in socioeconomic segregation resulting from school choice

[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).

programs. Separate empirical identification of these mechanisms is challenging because demand and supply are simultaneously determined and only equilibrium outcomes are observed. On the supply side, private 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. To measure the relative importance of these mechanisms on segregation, I exploit a 2008 reform to the Chilean voucher system.[4] 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 allows me to test for cream-skimming behavior among private schools 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. Moreover, the reform allowed schools to choose whether they wanted to participate in the new program (SEP schools) or opt out (non-SEP schools), separating private subsidized schools in two groups. This induced resorting of students that led to increased overall segregation. 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

[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 more value (Abdulkadiroglu et al., 2014; Cullen et al., 2006)

[4]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.

assumes that parents can choose any school they are willing to travel to and pay for which attributes any sorting pattern observed in the data to demand-side preferences, rather than school selection. [5] 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.

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 cream-skimming behavior. I show that admission thresholds decreased significantly following the reform, even for schools that did not charge any tuition. Consequently, low-SES parents who faced strict admission restrictions from private schools had more schools available to choose from after the reform. This resulted in a 10 percentage points increase in the probability of low-SES students enrolling in private subsidized schools. In the estimation of parental preferences, I use observed admission thresholds for private subsidized schools to account for school selection.

The reform constitutes an exogenous shock to schools' incentives to select more vulnerable students, uncorrelated with parent's preferences. Changes in SEP schools' admission thresholds, in response to the new voucher, create variation in school peer composition. I use this variation to estimate parents' preferences for school characteristics and peer quality, [6] 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 quality gives 10 times as much utility to

[5] Hastings et al. (2005), Neilson (2013), 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).

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

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. This 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 choosing a non-SEP school in the years following the reform. Overall, this resulted in increased socioeconomic segregation, particularly in more competitive educational markets.

My model shows 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 for high-SES parents. This could be especially critical given evidence that school segregation perpetuates long-term income inequality (Benabou, 1996).

My results fill a gap in the literature because little is known about the consequences of such reforms on school stratification, and about how private schools respond to such policies.

Nechyba (2009) argues that cream-skimming can be alleviated through the careful design of school choice programs, and that efficient programs should incentivize competition through innovation and increased resource efficiency, rather than through selecting the best students from public schools. Several studies have suggested deviating from the flat voucher. For example, 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. The Chilean reform we examined here did 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.

The remainder of this chapter is organized as follows. Section 1.2 provides institutional background on Chile's educational system and the 2008 reform. Section 1.3 describes the data. Section 1.4 provides a descriptive analysis of changes in school composition, and schools' participation decisions. Section 1.5 describes the demand model in the presence of cream-skimming and provides a simple framework for modeling admissions policies. Section 1.6 shows the estimation results and counterfactuals. Section 1.7 offers a summary and conclusions.

1.2. Background in Chile

Chile implemented a nationwide school voucher program in 1981 to introduce school choice and decentralize educational services in 1981. Under this program, students freely chose between public and private schools. Private schools that did not charge tuition began to receive from the government, the same per-student voucher as did the public schools. If a student decided 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. This reform also included decentralized public school administration, transferring responsibility for public school management from the Ministry of Education to local municipalities. Public schools continued to be funded centrally, 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 would now directly affect their education 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). 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 schools.

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. 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. A comparison of standardized test scores obtained by 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) show 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) find no evidence that choice improved average educational outcomes as measured by test scores, repetition rates, and years of schooling. They also 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.

1.2.1. 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 at the most vulnerable students (SEP law, for Subvencion Escolar Preferencial). The main objective of the reform was to decrease education inequality.

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, 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.[7]

[7] 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 the school, on top of the baseline SEP subsidy.

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 social program for the most vulnerable families in the country).

b) The first section of the public health system (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, other criteria were taken into account including family income and education of the parents, 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 it admits priority students. SEP schools are require to adhere to several conditions. These include submitting 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. In terms of enrollment, virtually all public schools and more than 60% of private subsidized are registered in the SEP program.

1.3. Data

My empirical analysis rely on data on student enrollment together with school and student characteristics. I uses four 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 money received from the program each year.

I use two additional datasets to construct school characteristics, like average test scores, pupil-teacher ratios. First, a dataset containing 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 data on teacher contracts for all public and private subsidized schools to construct pupil-teacher ratios. This data includes details about the number of teachers in each school and the hours in each contract.

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 exact income, but rather people report intervals 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 about 230,000 students per year in public and private subsidized schools.[8] Table 2 shows descriptive statistics for student characteristics in private subsidized and public schools before the program started in 2007. Student differences in the two types of school are apparent, with students in private schools coming from wealthier families with more educated parents. The table also reports descriptives statistics in 2012, showing that average family income and parental education decreased in both types of school. This is a result of student redistribution, as I will explain below.

Table 3 describes the number of schools by year and type of school, and from 2008, the number of schools registered in the SEP program. Almost all public schools, and more than 2/3 of the private subsidized schools, participated in the SEP program after 2008.

[8] 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.

1.3.1. Market Definition

In this setting, there is no clear market definition because students are free to choose a school without any geographic or administrative constraints. Distance is obviously a relevant variable, but how much students are willing to travel might depend on the region.

I define markets using data on student travel distance. For each school I join all municipalities where 5% or more of the students in that school live. This creates a network of municipalities that constitute a market. There are a total of 70 non-overlapping markets under this definition.

Table 12 shows the list of municipalities in each market.

1.4. Stylized Facts

1.4.1. Changes in Enrollment

There are important student redistribution patterns following the 2008 reform between the three types of schools: public, private subsidized that chose to participate in the program (private SEP schools), and private subsidized that chose to opt out of the program (private non-SEP schools).

Average first grade enrollment in different types of school are presented in Figure 3. It provides the coefficients of a regression of average first grade enrollment on school and year fixed effects, so it represents average changes within school.[9]

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

The share of students at public schools steadily declined before and after the reform. In

[9]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.

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 created incentives for private subsidized SEP schools to admit more vulnerable students. This explains increased enrollment for private SEP schools that are willing to admit low-SES students from public schools. On the other hand, increased enrollment in private subsidized non-SEP must be explained by changes in school characteristics or peer composition given that these schools are not directly affected by the reform and incentives of those schools are unchanged.

Changes in enrollment were not homogeneous across types of students, and they occurred at different times. I use mother's education as a proxy for the socioeconomic type. The probability of going to each type of school for different student types by year is shown in Figure 4. The probability of going to a public school dropped significantly for students in the bottom half of the distribution, with a correspondent rise of similar magnitude in the probability of going to a private subsidized SEP school.

The increase of about 10 percentage points in low-SES students' probability of going to a private SEP school occurred in a discrete way, right from the first year after the reform. This suggests that private SEP schools started admitting students they had not admitted before, given the rise in the value of the voucher. Further, it shows that students in the bottom half of the distribution suddenly chose to enroll in private subsidized schools suggesting that their previous enrollment in public school was likely determined by their inability to meet private schools admissions thresholds.

Additionally, students in the middle-high part of the distribution were increasingly likely to go to a private non-SEP school following the reform, in contrast with the sharp rise in the probability of enrollment in private SEP for low-SES students. This gradual rise in probability of going to private subsidized non-SEP schools for more educated parents has to be explained by changes in characteristics in the private SEP schools following the reform. If high-SES parents have preferences for peer quality, the changes in admissions by private SEP schools led high-SES parents to stop choosing private SEP schools and enroll instead in private subsidized non-SEP schools.

The SEP reform sought to decrease educational inequality by giving more resources to schools that served the more vulnerable population. However, policy makers did not consider the consequences that student resorting may have had on overall segregation. The SEP reform created incentives to decrease the cream-skimming behavior of private schools selecting students with higher socioeconomic characteristics. This resulted in a large migration of students from public schools, leaving only the most vulnerable students in public schools. On the other hand, it allowed private schools with higher proportion of high-SES students to opt out of the program, attracting more high-SES students. In sum, the program seems to have mainly caused a redistribution of the most vulnerable students between some private schools and public schools. Moreover, it kept higher-income students in the non-SEP private subsidized schools and the most vulnerable students in public schools.

Table 2 shows the differences in average family characteristics between public and private schools in 2007 and 2012, before and after the reform. It is clear that, in 2007 private subsidized schools served a wealthier and more educated population and obtained higher average test scores, compared to public schools. By 2012, the differences in parental education and family income were larger than 2007, but the gap in test scores dropped significantly, suggesting that the extra resources from the program had a positive effect on achievement.

1.4.2. Segregation Measures

In this section, I define the measures I use to quantify segregation. Following Hsieh and Urquiola (2006), we compare the average mother's education in public schools with the average in the market where the school operates. To this end, I calculate for each market-year, the ratio of average mother's education in public schools compared to the market average. Values closer to one reflect more integrated markets and lower values reflect more segregated markets. 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 way.

Figure 5 shows the average ratio from 2005 to 2012. The average type of student in public schools decreased in comparison with the market average, reflecting less integrated markets. It looks like the reform did not reverse the prior trend of increasing segregation.

Segregation may differ with market competitiveness. More competitive markets have a larger presence of private subsidized schools and are less concentrated in terms of market share. I separate markets into three groups depending on how concentrated they are, using the Herfindahl Index (HHI). This measure is calculated as the sum of the square of the market shares for each market and each year. Therefore, it reflects the level of concentration in the market, where a higher index is associated with more concentrated markets.

Average change within market of the ratio of the average mother's education in public schools to the market average for the three groups of markets is shown in Figure 6. Results show that segregation levels in 2005 were already lower in more competitive markets. This reflects the greater segregation in more competitive and larger markets. Furthermore, the drop during this period was larger in more competitive markets, consistent with the changes in enrollment shown above.

Additionally, dispersion of student types within schools reflect market stratification. If markets become more stratified, we would expect a decrease in the dispersion of student types within a school. I measure dispersion using the interquartile range (IQR) in each school, calculated as the difference between the 25th and 75th percentile. I then run the following regression to capture changes within schools for each type of school.

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

Table 4 shows the coefficients for 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 had lower student dispersion within school, while no significant change was seen in dispersion in private 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 were constrained by private school selection thresholds. If this was the case, we need to account for this restriction in order to correctly estimate preferences.

1.4.3. School Participation in the SEP Program

An important feature of the SEP program is that it gives schools the option to participate in the program. A school's decision to participate in the SEP program depends on several factors: the percentage of eligible students it has, the effect its choice may have on its current and future student body, and the costs associated with the program. To receive the voucher from eligible students, schools must be registered in the SEP program. Therefore, the fact that some private subsidized schools that have priority students still choose to opt out and forgo the new voucher, reflect some costs associated with joining the program.

I analyze the school and market characteristics that determine a school's decisions to enter the program with a probit model described in Equation (1). Here $\mathbb{1}(SEP\text{-}School_{jm})$ is an indicator equal to one if school j in market m participates in the SEP program. X_{jm} is a vector of school characteristics including average family income in 2007, test results in 2006 and 2007, proportion of low income students in 2007, school size in 2007, proportion of students with a computer at home and the proportion of students with internet at home, and the average size of the class. Also, Z_m is a vector of market controls, including three measures of competition in market m. The level of competition in the market might affect participation decisions if schools take other schools' decisions into consideration when making their own participation decision. The three measures are the proportion of private schools, proportion of low income students, and the Herfindahl index in market m.

$$\mathbb{1}(\underset{jm}{SEP\text{-}School}) = \alpha + \beta X_{jm} + \gamma Z_m + \varepsilon_{jm} \tag{1.1}$$

Lower average income, higher proportion of low income students, bigger class size, and more concentrated markets, all imply a higher probability of participation. Table 5 shows probit estimation results, and the marginal effects at the means of the other variables. Interestingly, the probability of entering the SEP program decreases with the competitiveness of the market where the school operates. This might be explained by the risk of losing their high-SES students to competitors. If high-SES students have a preference for better peers, they may prefer schools that opt out of the program. Students in more competitive markets have more choice about where to go. Therefore, for any given school, the risk increases with the competitiveness of the market. This is consistent with the results from preference estimation that are explained in Section 6.

1.5. Demand Model for School Choice

Section 4 established two main patterns of sorting following the SEP reform. (1) Low-SES students enrolled in private subsidized SEP schools instead of publics schools, and (2) middle-SES students went to 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, tuition differences, changes in school characteristics, and peer composition.

First, in subsection 5.1 I show evidence of private schools' cream-skimming behavior in terms of socioeconomic characteristics, and how this behavior changed following the reform. In particular, I show that mother's education is a good proxy for the characteristics that are relevant for admissions, and that there is a discrete drop in admission thresholds after a school register in the SEP program. This explains the higher enrollment of low-SES students in private subsidized SEP schools.

Next, I model parents' decisions as a discrete choice of a single school from their market. The reform changed important school characteristics and peer composition providing variation in average student type, class size, pupil-teacher ratio, and test scores. I use this variation to identify preference parameters in the parents' utility function.

Additionally, it is important to account for the admission restrictions of private schools to properly estimate preferences. That is, the choice set may be different for low-SES parents than for high-SES parents, because even if some schools were free, they might not admit some students based on their socioeconomics characteristics. To account for such cream-skimming restrictions, I use mother's education as a proxy for student type and assume that private schools selected students based on this observed characteristic.

Two types of schools interact in each market, public and private subsidized schools. Public schools accept any student that wants to attend, but private schools have an ability to select students. Assuming that private schools prefer higher to lower types and that they have limited capacity, I model the admissions process in private subsidized schools in terms of a threshold (θ_j^*) for admissions on the type of students they admit. I assume that each school accepts any student that applies as long as his type is above the threshold. Even though this is a simplification of the attributes that schools care about, in the next subsection I show that mother's education constitutes a good proxy for admission policies based on socioeconomic characteristics. I show evidence of cream-skimming in private schools and how this threshold changed following the reform, even for schools that did not charge tuition.

Students are characterized by their type θ_i, given by their mothers' education. Parents choose the school that maximizes their utility within the schools in their choice set ($\theta^*_{jt} \leq \theta_i$). The utility student i gets from attending school j is given by:

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

where

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

Here, 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.

In X_j I include several school attributes: the type of school, whether it participates in the SEP program, the previous years test scores and class size (to measure observed quality for parents), the previous years peer composition (average and variance of the type of students in the school), to account for preferences for certain 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, and I am abstracting from any social interactions that may affect the decision.

Furthermore, I assume that the admissions threshold for a school θ^*_{jt} is known. For the estimation, I use the observed lowest 1% in mother's education admitted in a school as a proxy for θ^*_{jt}. This is obviously an endogenous equilibrium outcome. The observed cutoff could be a school decision to exclude some students or just the last student that chose to apply to that school. The estimation of $\boldsymbol{\theta^*}$ requires solving a dynamic game between the competing schools that, for a large number of schools can be impractical.

Instead, I estimate the parameters from the utility function, considering the pseudo maximum likelihood estimator assuming the observed vector of $\boldsymbol{\theta}^{*}$.

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

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

Here

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

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. Since in each market there are many schools, most of them very small, and there is no outside option (everyone must choose a school and I observe the complete market), I take a third of the public schools in each market to normalize the utility. I assume that this group of schools share the same unobserved quality term. In the estimation, I control for observable characteristics of these schools in each market.

1.5.1. Schools' Cream-Skimming Policies

Private subsidized schools comprise a heterogeneous group of schools, including for-profit and non-profit organizations, religious and non-religious, single schools, and large corporations with multiple schools. Nonetheless, no matter the form of their objective function, they all have incentives to select students from higher socioeconomic status. Because most of these schools do not charge any tuition, discrimination is based on other indicators, one of the easiest most likely being parental education. Higher parental education is associated with better student behavior, more involved parents, the ability to attract better teachers, higher test scores, etc. This is also supported by the observed stratification shown in the stylized facts and the extensive political discussions over the implementation of mechanisms to deter selection.

The literature that estimates parents' preferences for school quality assumes that the only type of selection that schools have is through prices. In this section, I show that private schools do, in fact, select students based on socioeconomic characteristics. This process can be modeled as an admissions threshold on the student type that a school is willing to admit, using mother's education as a proxy for the student type. To show this, I use the variation in incentives to schools that participate in the SEP program to lower their admissions threshold.

I model school admissions processes as a threshold in the type of students admitted in a school, assuming that if a school is being selective in the enrollment, it prefers higher to lower types. I define a student's type as the education of the mother (the results are very similar if instead I take family income or socioeconomic status constructed using factorial analysis), and I use as the admissions threshold, the lowest 1% of mother's education in each school each year (θ^*_{jt}).

To show that student type is an effective proxy for private school selection process, I show changes in θ^*_{jt} with capacity increases (when a school adds another classroom) or when the value of the per-student subsidy increases. Table 1 shows variation in the value of the voucher in the studied period. We can also see how θ_{jt} changes when a school enrolls in the SEP program. Figure 7 shows within-school changes in the observed threshold for private subsidized SEP schools. There is a clear decrease in the threshold following the reform, but this hides variation in the timing when schools join the SEP program.

I estimate equations 2, 3, and 4 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. Also, $\mathbb{1}(\textit{SEP-School})_{jt}$ is an indicator for the year each school enters the SEP program.

$$\theta^*_{jt} = \alpha + \beta v_t + \gamma_j + \varepsilon_{jt} \tag{1.2}$$

$$\theta^*_{jt} = \alpha + \beta C_{jt} + \gamma_j + \varepsilon_{jt} \tag{1.3}$$

$$\theta^*_{jt} = \alpha + \beta \mathbb{1}(SEP\text{-}School)_{jt} + \gamma_j + \varepsilon_{jt} \tag{1.4}$$

Panel A of Table 6 shows estimation results for equations (1) and (2). The first column shows how θ^*_{jt} decreases, on average, when a school adds another classroom. This means that when a school increases its capacity, it is more likely that it will increase its range for admission.

Panel B of Table 6 shows estimation results for equation (3). 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. Part of this drop may be explained by a price effect, because 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. 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 was no price effect. The drop in the threshold is smaller, but still large and significant.

All regressions include school fixed-effects, so they capture the variation within schools, when the value of the voucher increases (2), when a school adds another classroom (3), or when it enters the SEP reform (4). These results suggest that schools are effectively cream-skimming students, and that mother's education can usefully proxy for schools' selection process in admissions.

1.5.2. Estimation and Identification

As explained above, the probability of student i of going to school j is given by:

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

where $v_{ij} = \alpha p_{ij} + X_j \beta^i - \gamma d_{ij} + \xi_j$, and $J(\theta_i)$ is the choice set of schools available to a student of type θ_i.

X_j includes several school-level characteristics: previous year test scores, class size, and peer composition (average and variance of the type of students in the school).

Parental heterogeneity is reflected in family income levels and mother's education. For mother's education, I 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.

These probabilities P_{ij} are conditional on the vector of $\boldsymbol{\theta^*}$, which is an endogenous equilibrium outcome. Let $\delta_{jt} = \bar{\beta} X_{jt} + \xi_{jt}$ the year-school specific term that does not vary across students, and $\eta = [\alpha, \gamma, \beta_0, \boldsymbol{\delta}]$ the set of parameters to estimate. I define the maximum likelihood estimator of η from the constrained likelihood (Aguirregabiria and Mira, 2007):

$\hat{\eta}_{MLE} = arg \max L(\eta, \boldsymbol{\theta^*})$ subject to $\boldsymbol{\theta^*} = \Phi(\eta, \boldsymbol{\theta}*)$.

To recover the parameters from the utility function, I consider the pseudo 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.

The estimation of $\boldsymbol{\theta^*}$ can be impractical for a large number of schools because it requires the mapping Φ and the Jacobian matrix $\partial \Phi / \partial \theta^*$.

For the estimation I proceed in two steps. First I obtain α, γ, and β_0 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 shares.

In the 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}.

Identification of α, γ, β_0, and δ_j is provided by the variation within markets of different types of students and the variation in enrollments 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, I assume that each parent is too small to have an effect on the admissions threshold. Also, because I use previous years' characteristics and I assume that this is what parents consider when choosing a school, and I abstract from any social interactions that may affect the decision.

1.6. Parameter Estimates

My results indicate that it is important to consider the cream-skimming restrictions when estimating parental preference parameters. Estimates for the average utility parameters are shown in Table 7. 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 his type. The second column shows results without considering restrictions on the choice set given by the admissions thresholds from the private subsidized schools. Column 1 of Table 7 shows that parents with low education (the omitted category in the parent education group) care about the average type of peers, the homogeneity of peers in the school (negative coefficient on IQR of peer type), and class size. Column 2 of Table 7 indicates that low-SES parents do not care about class size, and if anything they dislike higher test scores and higher average peer quality. The differences between columns 1 and 2 suggest that ignoring access restrictions leads to underestimating low-SES parents' preferences for quality. The model rationalizes the enrollment decisions in the data. In other words, if we ignore the restricted choice set and observe low-SES parents not selecting high-quality schools even when they are free to choose them, one might infer that they have low preferences for school quality and peers. Column 1 shows that this is in fact not true, and this explains the changes in enrollment of low-SES students following the reform.

Markets differ according to size, competitiveness, and income level, and this may be correlated with average utility parameters. For this reason, I estimate parameters separately for each market and regress each parameter on the log of the Herfindahl Index (HHI), market size, and average mother's education in the market. Table 8 shows these results. A larger parameter on peers is correlated with more concentrated and smaller markets, and a higher average parental education is correlated with less concentrated and larger markets, opposite to the parameter on test scores. It appears that parents in more competitive and more educated markets care more about peers and less about standardized test scores.

My results suggest that parents' most important consideration is the average type of students in the school, and the magnitude of this parameter increases with the level of parental education. Table 9 shows estimates for the heterogeneity parameters α, γ, and β_0 using the model with the restriction on the choice set for each student. Panel A shows weighted average coefficients by market size for income and education levels. Panel B shows coefficients for the average person in each group (considering they have average income for the group). For the best educated parents, a one standard deviation in the average type of student gives 10 times as much utility as a one standard deviation in test scores (1.751 compared to 0.148).

1.6.1. Segregation mechanisms

I use these estimates to quantify how much of the observed segregation in the data is explained by parental preferences and how much by school cream-skimming behavior. At first, I assume that parents have no preferences for peer characteristics. Figure 8 shows the ratio of average student in public schools compared to the market average, and the share of students in public schools. Shutting down this mechanism increases enrollment in public schools by 9 percentage points, on average and segregation decreases significantly. The ratio of student type in public school compared to the market average increasing approximately from 0.9 to 0.96.

It should be noted that this exercise shuts down only the direct effect of parental preferences for peers, and does not consider any indirect effects. It assumes that thresholds of admission for schools stay unchanged. Yet, if parents do not care about peers, schools might change their cream-skimming behavior. In fact, schools might prefer high-SES students for several reasons: lower marginal cost (because it could be easier to find teachers for better students), or if parents care about test scores when selecting a school (this would be a cheap way to improve achievement). 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.

In a second exercise I prevent schools from doing any selection in the admissions process, giving all students the same choice set, assuming no school cream-skimming behavior. Figure 9 shows the ratio of the average student in public schools compared to the market average, and the resulting share of students in public schools. Shutting down this mechanism on average decreases public school enrollment by two percentage points. Segregation decreases, but by much less than in the first exercise, with the student type ratio increasing approximately from 0.9 to 0.92.

Table 11 shows the changes in public school market shares and the ratio of student type in public schools compared to the market average for the two exercises.In a first step, the model predicts the change in enrollment in one year. Even in this case, I need to assume capacity constraints for schools which are unobserved. For this exercise I assume that schools have a maximum capacity equal to the maximum enrollment observed in 2004, 2005, 2006, and 2007 and that they cannot expand beyond this level.

After the first year, the counterfactual exercises become complicated because changing student allocations in 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 after predicting how school characteristics will change. It is likely that, after the first year, there will be an increase in enrollment in public schools when characteristics of the two types of schools adjust.

1.7. 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 and peer quality. My estimates of structural parameters for parent preferences show that low-SES students care about school quality and better peers. This explains the migration of students from public to private subsidized schools. Third, parents all care about better peers, with magnitudes increasing in parental education and wealth. This explains the shift of middle income students from private schools that participated in the program to schools that opted out. It also explains the decision of schools in more competitive markets to opt out of the reform, seeking to avoid the risk of losing high-SES students.

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 better peers.

The results in this chapter also attenuate concerns regarding school choice policies as responsible for increased socioeconomic segregation. If high-SES parents have such strong preferences for peers, when school choice is not allowed these parents are always able to choose the school by choosing the neighborhood where they live. This neighborhood segregation is observed extensively in countries that do not have school choice policies.

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.

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 Subsid.	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 Subsid.	-	-	-	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: Probit Regression of the Probability of Being a SEP School

Panel A

	Probit Regression Coefficients			
Average Income	-0.208**	-0.184**	-0.166*	-0.203**
	(0.090)	(0.090)	(0.089)	(0.090)
Prop. of Low Inc. Stud.	1.488***	1.560***	1.470***	1.416***
	(0.342)	(0.343)	(0.348)	(0.348)
Avg. Score in 2006	-0.186***	-0.187***	-0.207***	-0.201***
	(0.069)	(0.068)	(0.070)	(0.070)
Avg. Score in 2007	-0.072	-0.071	-0.081	-0.078
	(0.064)	(0.064)	(0.064)	(0.064)
Average Class Size	0.172***	0.166***	0.186***	0.184***
	(0.046)	(0.046)	(0.047)	(0.047)
Herfindahl Index	2.493***			2.285***
	(0.660)			(0.721)
Proportion Private		-0.715*		-0.040
		(0.383)		(0.434)
Prop. Low Inc. Market			1.302**	0.743
			(0.601)	(0.648)
Constant	-0.419**	0.060	-1.160***	-0.838
	(0.201)	(0.310)	(0.413)	(0.565)

Panel B

	Marginal Effects			
Average Income	-0.070**	-0.062**	-0.056*	-0.068**
	(0.030)	(0.030)	(0.030)	(0.030)
Prop. of Low Inc. Stud.	0.499***	0.526***	0.495***	0.474***
	(0.114)	(0.115)	(0.117)	(0.116)
Avg. Score in 2006	-0.062***	-0.063***	-0.070***	-0.067***
	(0.023)	(0.023)	(0.023)	(0.023)
Avg. Score in 2007	-0.024	-0.024	-0.027	-0.026
	(0.021)	(0.022)	(0.022)	(0.022)
Average Class Size	0.058***	0.056***	0.063***	0.062***
	(0.015)	(0.015)	(0.016)	(0.016)
Herfindahl Index	0.836***			0.765***
	(0.220)			(0.240)
Proportion Private		-0.241*		-0.013
		(0.129)		(0.145)
Prop. Low Inc. Market			0.439**	0.249
			(0.202)	(0.217)
N	1279	1279	1279	1279

Note: Panel A presents Probit estimation coefficients for private schools of the probability of being a SEP school on different school and market characteristics. Panel B presents marginal effects at the average of the other variables. The estimation is based on school characteristics in 2007. *,**, and *** denotes significance at the 10, 5 and 1% level. Standard errors are presented in parenthesis.

Table 6: Changes in Admissions Threshold

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

Dep Variable - Lowest 1% of Student Mother's Education			
	Public Schools	Priv. 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

Panel B: 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

Note: This table presents changes in the observed lowest 1% in the mother's education when school changes capacity (adds another classroom) or increases the value of the voucher or joins the SEP program. The estimation is based on regression with school fixed effects to capture variation within schools, showing that this 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 7: Estimation Results - Average Utility Parameters

Dep Variable: Average Utility (δ_{jt})		
	Restricted	Unrestricted
Class Size	-0.004*	-0.002
	(0.002)	(0.003)
Average Peer Type	0.128**	-0.183**
	(0.045)	(0.069)
IQR Peer Type	-0.055*	-0.038
	(0.024)	(0.051)
Avg Math Score	-0.004	-0.084*
	(0.028)	(0.043)
SEP School	0.023	0.224
	(0.094)	(0.228)
Constant	-1.668***	-2.057***
	(0.024)	(0.045)
School FE	X	X
R-squared	0.848	0.672
N	9665	9665

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 8: Heterogeneity of Average Utility Parameters across Markets

	Average Peer Type	Avg Math Score	Class Size	IQR Peer Type
Log(HHI)	0.054***	-0.048***	0.011***	0.058***
	(0.013)	(0.008)	(0.001)	(0.006)
Std Market Size	-0.043***	-0.014	0.008***	0.046***
	(0.012)	(0.008)	(0.001)	(0.006)
Std Market Size Sq	0.114***	0.024***	-0.001*	0.017***
	(0.007)	(0.005)	(0.000)	(0.004)
Avg Mother's Education	0.365***	-0.274***	-0.003*	-0.301***
	(0.027)	(0.017)	(0.001)	(0.013)
Constant	0.256***	-0.264***	0.031***	0.080***
	(0.048)	(0.031)	(0.002)	(0.023)
R-squared	0.063	0.034	0.064	0.124
N	9665	9665	9665	9665

Note: This table presents regression coefficients of average utility parameters on different market characteristics: log of Herfindahl Index, standardized market size, and size squared, and average mother's education in the market. *,**, and *** denotes significance at the 10, 5 and 1% level. Standard errors are presented in parenthesis.

Table 9: Estimation Results - Heterogeneity Coefficients 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 and tuition.

Table 10: Average Coefficient for Each Mother's-Education Group

	High School	More than High School	University
Average Peer Type	0.066	1.109	2.342
Avg Math Score	-0.102	0.001	0.169
IQR Peer Type	-0.076	-0.077	-0.027
Class Size	0.001	0.014	0.012
Distance	-0.265	-0.225	-0.261
Tuition	0.014	0.031	-0.011

Note: This table presents average preference parameter for each education group for the average income for that group in each market. All the estimates in this table correspond to the full model that includes the restriction on the choice sets depending on the student type.

Table 11: Simulation Results - No Preference for Peers

	Ratio of Mother's Education			Share of Students in Public Schools		
Year	Baseline	No Pref. for Peers	No Cr-Sk	Baseline	No Pref for Peers	No Cr-Sk
2006	0.914	0.962	0.933	0.578	0.660	0.551
2007	0.910	0.962	0.930	0.568	0.654	0.541
2008	0.906	0.958	0.926	0.550	0.632	0.523
2009	0.894	0.949	0.918	0.501	0.584	0.474
2010	0.890	0.954	0.922	0.516	0.601	0.491
2011	0.894	0.951	0.917	0.501	0.587	0.474
2012	0.896	0.954	0.919	0.507	0.596	0.481

Note: This table presents simulation results assuming two different scenarios: first, that parents have no preference for peers, assuming that admissions thresholds stay unchanged (columns 2 and 5) and assuming no cream-skimming (columns 3 and 6). It shows averages across markets for the share of the outside option and the ratio of average mother's education of students in public schools compared to the market average.

Table 12: Municipalities by Market

Region	Municipality	Market	Region	Municipality	Market	Region	Municipality	Market
1	IQUIQUE	1	5	LOS ANDES	17	7	RAUCO	23
1	ALTO HOSPICIO	1	5	SAN ESTEBAN	17	7	ROMERAL	23
1	ARICA	2	5	SAN FELIPE	17	7	SAGRADA FAMILIA	23
2	ANTOFAGASTA	3	5	CALLE LARGA	17	7	TENO	23
2	CALAMA	4	5	PANQUEHUE	17	7	TALCA	24
2	TOCOPILLA	5	5	LLAILLAY	17	7	SAN CLEMENTE	24
3	COPIAPO	6	5	CATEMU	17	7	MAULE	24
3	TIERRA AMARILLA	6	5	PUCHUNCAVI	18	7	PELARCO	24
3	CALDERA	7	5	QUINTERO	18	7	SAN RAFAEL	24
3	DIEGO DE ALMAGRO	8	5	SAN ANTONIO	19	7	SAN JAVIER	25
3	CHANARAL	8	5	SANTO DOMINGO	19	7	VILLA ALEGRE	25
3	HUASCO	9	5	EL QUISCO	19	7	CONSTITUCION	26
3	VALLENAR	9	5	CARTAGENA	19	7	COLBUN	27
4	LA SERENA	10	5	ALGARROBO	19	7	LONGAVI	27
4	COQUIMBO	10	6	CODEGUA	20	7	LINARES	27
4	VICUNA	10	6	RENGO	20	7	YERBAS BUENAS	27
4	ANDACOLLO	10	6	REQUINOA	20	7	PARRAL	28
4	SALAMANCA	11	6	COLTAUCO	20	7	RETIRO	28
4	LOS VILOS	11	6	MOSTAZAL	20	7	CAUQUENES	29
4	ILLAPEL	11	6	MACHALI	20	8	HUALQUI	30
4	CANELA	11	6	RANCAGUA	20	8	TOME	30
4	OVALLE	12	6	GRANEROS	20	8	PENCO	30
4	MONTE PATRIA	12	6	SAN VICENTE	20	8	HUALPEN	30
4	PUNITAQUI	12	6	MALLOA	20	8	TALCAHUANO	30
5	QUILPUE	13	6	DONIHUE	20	8	CONCEPCION	30
5	VILLA ALEMANA	13	6	PICHIDEGUA	20	8	CORONEL	30
5	VINA DEL MAR	13	6	PEUMO	20	8	LOTA	30
5	VALPARAISO	13	6	OLIVAR	20	8	CHIGUAYANTE	30
5	CONCON	13	6	COINCO	20	8	SAN PEDRO DE LA PAZ	30
5	CASABLANCA	14	6	QUINTA DE TILCOCO	20	8	FLORIDA	30
5	QUILLOTA	15	6	LAS CABRAS	21	8	SANTA JUANA	30
5	LA CRUZ	15	6	CHIMBARONGO	22	8	CURANILAHUE	31
5	OLMUE	15	6	SAN FERNANDO	22	8	LOS ALAMOS	31
5	HIJUELAS	15	6	CHEPICA	22	8	LEBU	31
5	LIMACHE	15	6	NANCAGUA	22	8	ARAUCO	32
5	NOGALES	15	6	SANTA CRUZ	22	8	CANETE	33
5	CALERA	15	6	PALMILLA	22	8	LOS ANGELES	34
5	LA LIGUA	16	6	PERALILLO	22	8	NACIMIENTO	34
5	CABILDO	16	7	CURICO	23	8	MULCHEN	34
5	PAPUDO	16	7	MOLINA	23	8	NEGRETE	34

Continued on next page

Table 12 – continued from previous page

Region	Municipality	Market	Region	Municipality	Market	Region	Municipality	Market
8	QUILLECO	34	10	PUERTO MONTT	49	13	COLINA	70
8	SANTA BARBARA	34	10	LLANQUIHUE	49	13	LA PINTANA	70
8	YUMBEL	35	10	LOS MUERMOS	49	13	MAIPU	70
8	CABRERO	35	10	CALBUCO	49	13	RENCA	70
8	PEMUCO	35	10	FRUTILLAR	49	13	SANTIAGO	70
8	YUNGAY	35	10	PUERTO VARAS	49	13	LA FLORIDA	70
8	CHILLAN	36	10	MAULLIN	49	13	PUENTE ALTO	70
8	BULNES	36	10	CASTRO	50	13	PENALOLEN	70
8	SAN CARLOS	36	10	ANCUD	51	13	QUINTA NORMAL	70
8	QUILLON	36	10	DALCAHUE	52	13	SAN BERNARDO	70
8	NIQUEN	36	10	QUELLON	53	13	SAN MIGUEL	70
8	COIHUECO	36	10	OSORNO	54	13	PUDAHUEL	70
8	SAN IGNACIO	36	10	PURRANQUE	55	13	ESTACION CENTRAL	70
8	PINTO	36	10	VALDIVIA	56	13	LO PRADO	70
8	CHILLAN VIEJO	36	10	FUTRONO	57	13	CONCHALI	70
8	SAN NICOLAS	36	10	LAGO RANCO	58	13	NUNOA	70
8	EL CARMEN	36	10	LA UNION	58	13	LA CISTERNA	70
8	LAJA	37	10	RIO BUENO	58	13	QUILICURA	70
9	TEMUCO	38	10	LANCO	59	13	EL BOSQUE	70
9	VILCUN	38	10	PAILLACO	60	13	RECOLETA	70
9	PADRE LAS CASAS	38	10	LOS LAGOS	60	13	CERRO NAVIA	70
9	CUNCO	39	10	MARIQUINA	61	13	LAS CONDES	70
9	GORBEA	40	10	PANGUIPULLI	62	13	SAN JOAQUIN	70
9	FREIRE	40	11	COYHAIQUE	63	13	CERRILLOS	70
9	PITRUFQUEN	40	11	AYSEN	64	13	INDEPENDENCIA	70
9	CURACAUTIN	41	12	PUNTA ARENAS	65	13	LO BARNECHEA	70
9	LAUTARO	41	12	NATALES	66	13	LAMPA	70
9	LONCOCHE	42	13	PENAFLOR	67	13	LO ESPEJO	70
9	CARAHUE	43	13	TALAGANTE	67	13	PROVIDENCIA	70
9	NUEVA IMPERIAL	43	13	PAINE	67	13	PEDRO AGUIRRE CERDA	70
9	TEODORO SCHMIDT	43	13	MELIPILLA	67	13	LA REINA	70
9	CHOLCHOL	43	13	EL MONTE	67	13	HUECHURABA	70
9	TOLTEN	44	13	PIRQUE	67	13	MACUL	70
9	VILLARRICA	45	13	ISLA DE MAIPO	67	13	LA GRANJA	70
9	PUCON	45	13	BUIN	67	13	SAN RAMON	70
9	ANGOL	46	13	PADRE HURTADO	67	13	VITACURA	70
9	ERCILLA	47	13	CALERA DE TANGO	67			
9	COLLIPULLI	47	13	MARIA PINTO	67			
9	TRAIGUEN	48	13	CURACAVI	68			
9	VICTORIA	48	13	TILTIL	69			

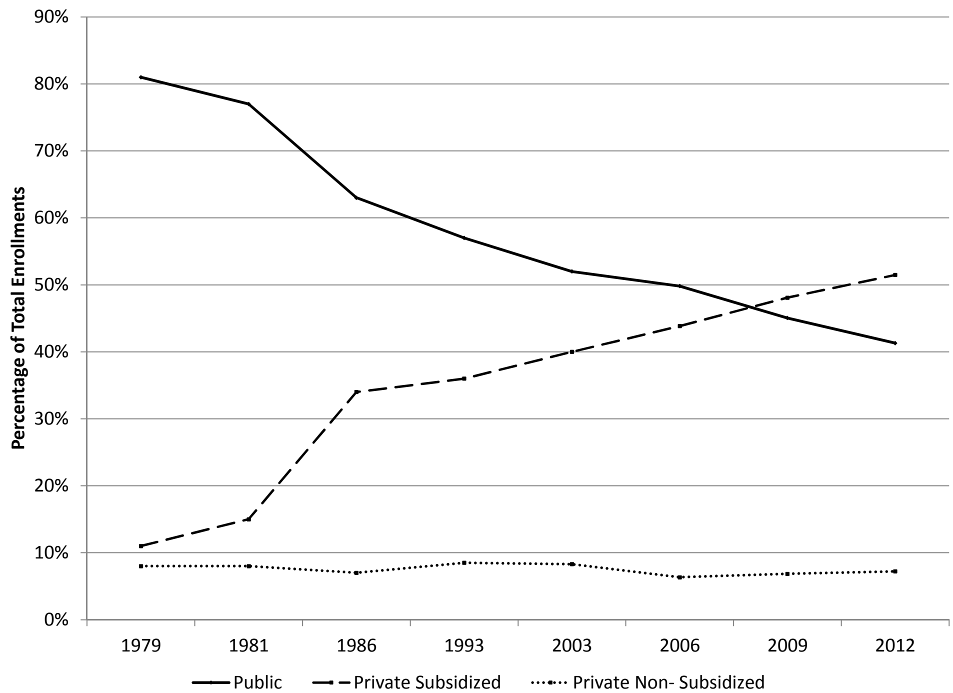
Note: This table shows the municipalities and markets used in the estimation.

Table 13: Probability of Switching Schools by Grade and Year

	Probability of Switching Schools
SEP Student	0.013***
	(0.001)
3 grade	0.001**
	(0.001)
4 grade	-0.008***
	(0.001)
5 grade	-0.006***
	(0.001)
6 grade	-0.013***
	(0.001)
7 grade	0.031***
	(0.001)
8 grade	-0.031***
	(0.000)
3 grade*SEP	-0.006***
	(0.001)
4 grade*SEP	-0.007***
	(0.001)
5 grade*SEP	-0.011***
	(0.001)
6 grade*SEP	-0.018***
	(0.001)
7 grade*SEP	-0.007***
	(0.001)
8 grade*SEP	-0.009***
	(0.001)
Constant	0.120***
	(0.000)
R-squared	0.003
N	8,418,372

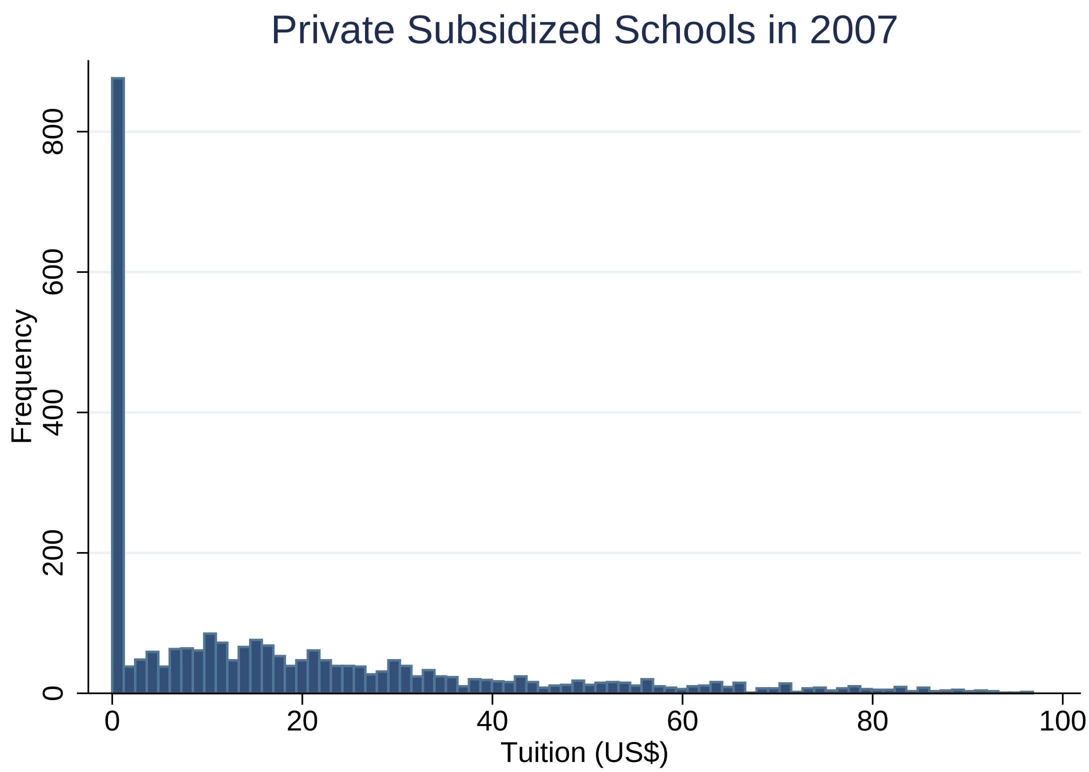
Note: This table shows coefficients of a linear probability model of the probability of switching schools on indicator for being a SEP student and grade fixed effects.

Figure 1: Changes in Enrollment by Type of School



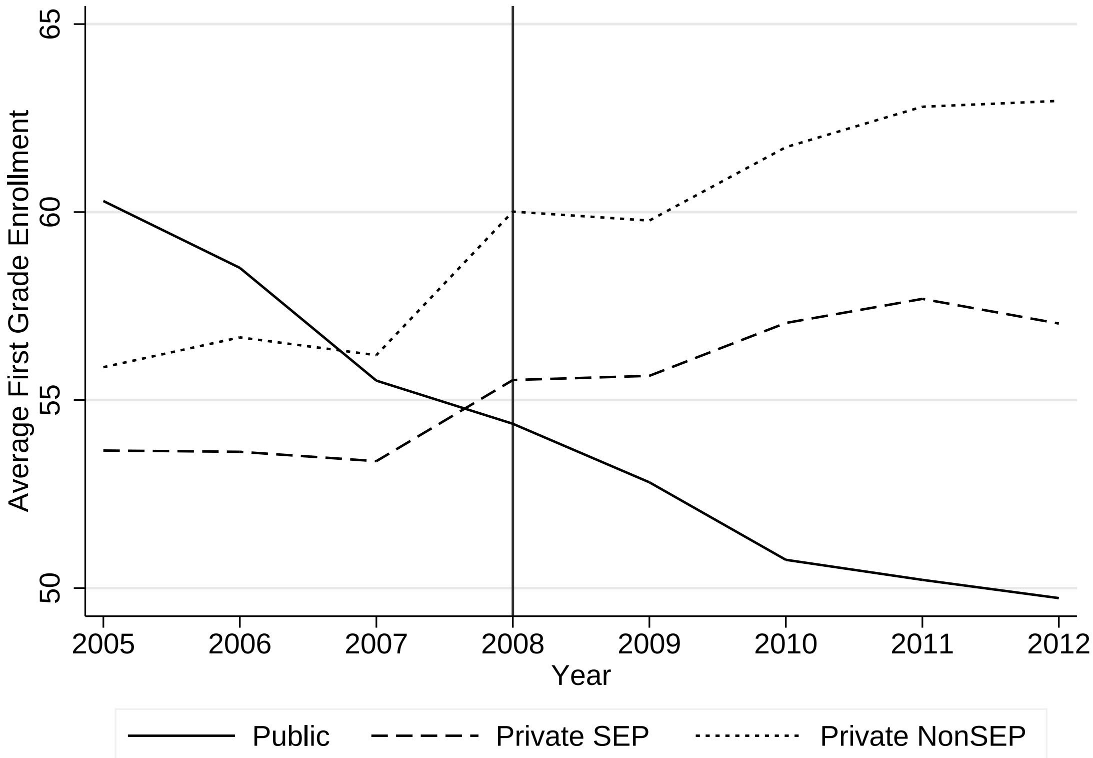
Note: This figure shows the evolution on the share of students that is enrolled in each type of school from the beginning of the voucher system in Chile.

Figure 2: Distribution of Average Tuition in 2007



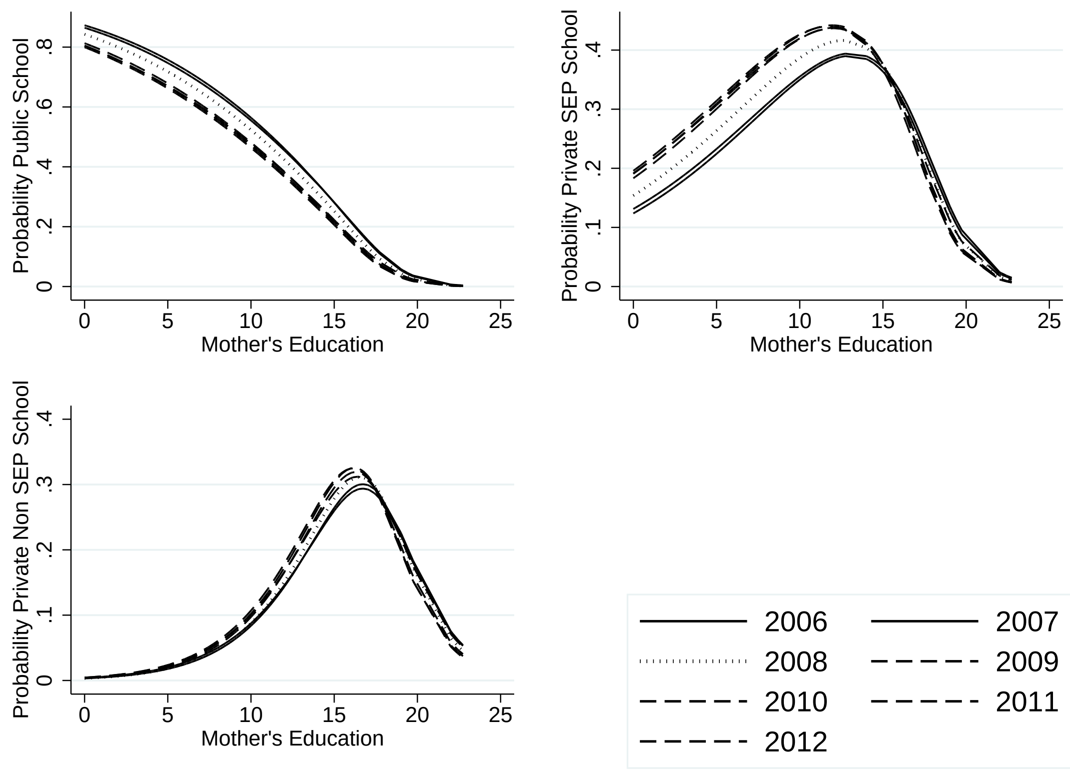
Note: This figure shows the distribution of average tuition charged by private subsidized schools in US$ in 2007, before the program started. More than half of the schools did not charge any tuition.

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



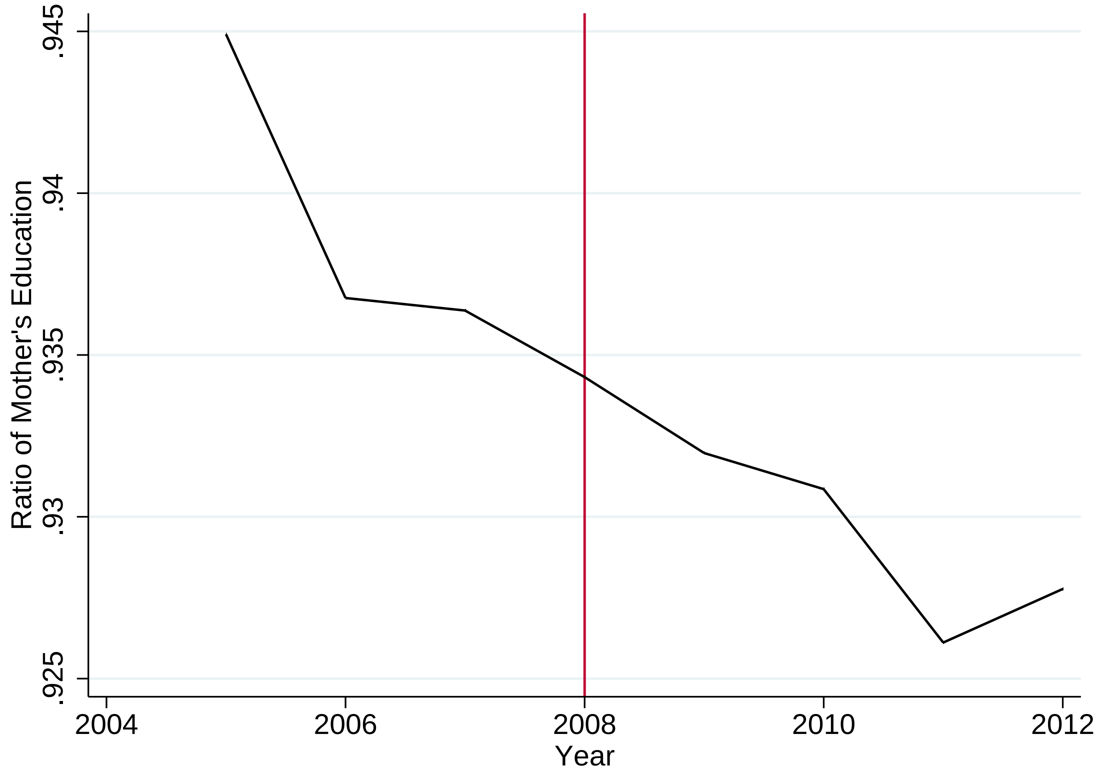
Note: This figure shows changes in average first grade enrollment within schools. It shows coefficients from a regression of enrollment on year and school fixed effects.

Figure 4: Probabilities of Enrollment by Type of School



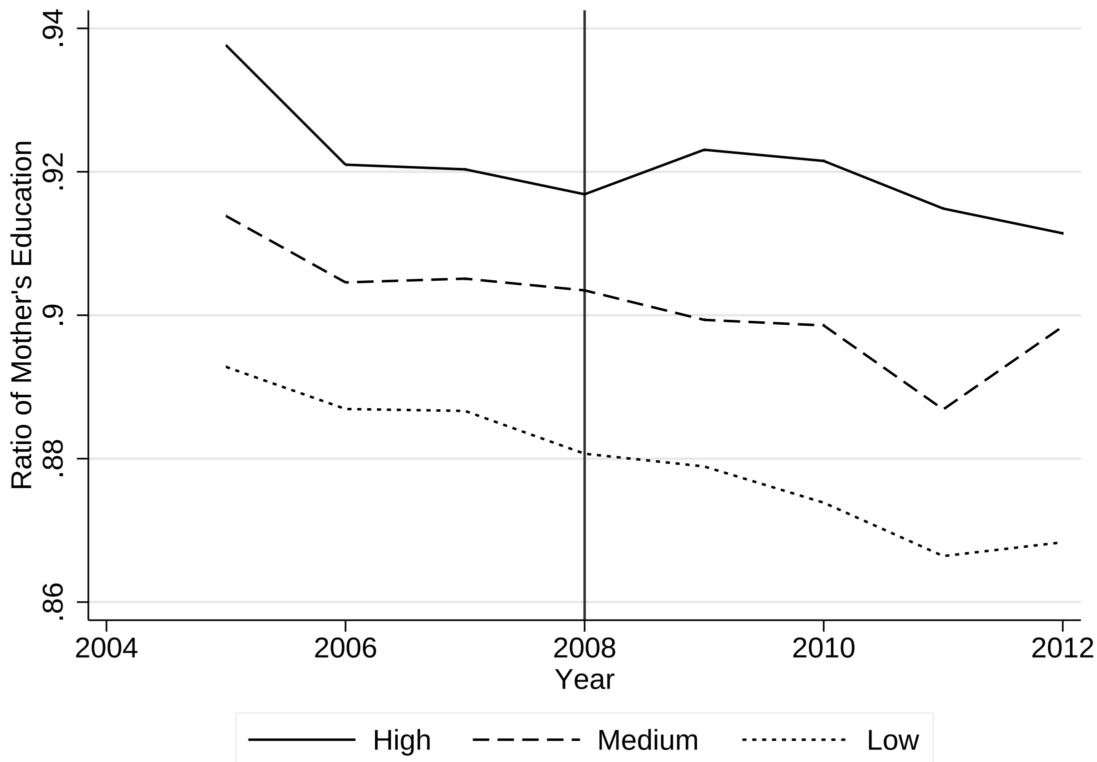
Note: Each graph shows the probabilities for each level of mother's education of enrolling in different type of school each year. The probabilities are calculated based on the coefficients from a multinomial logit model where a student has the option of enrolling in four types of schools: public, private 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 Segregation within Markets



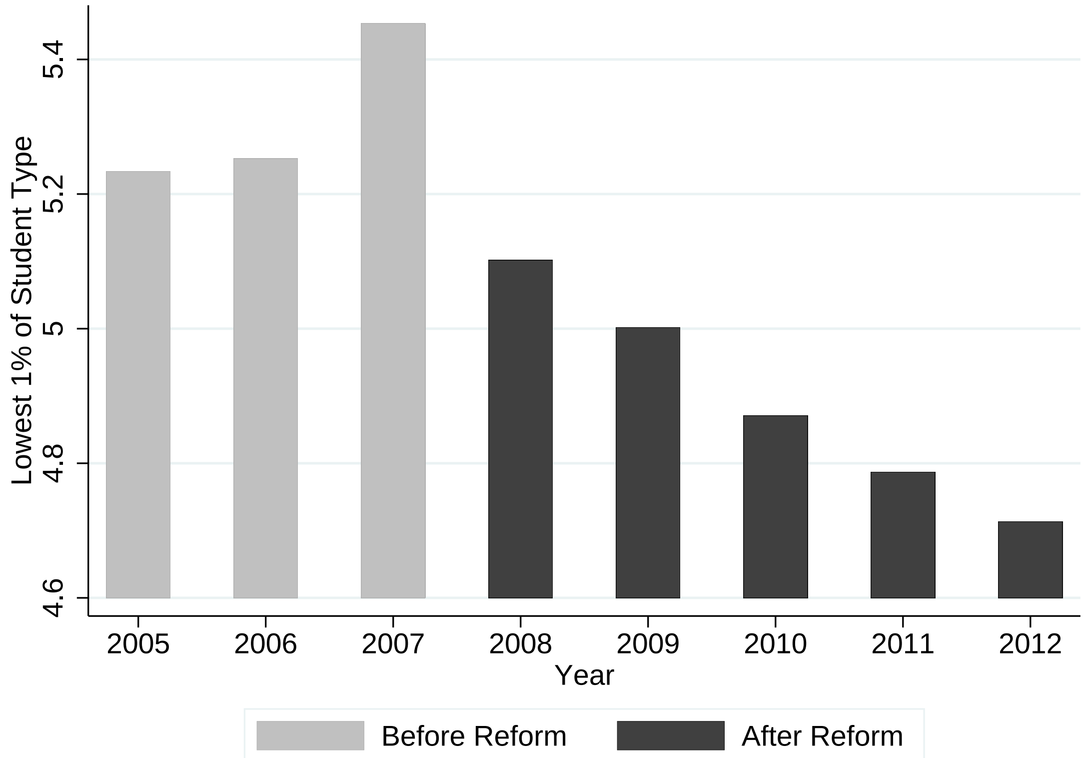
Note: This figure shows average within market changes in the integration measure. The ratio is constructed as the average student type in public schools over the average student type in the market where the public schools operate. Higher values mean more integrated markets where public schools have a more representative student body compared to the market where they operate. Each point in the graph represents the coefficients of a regression of the ratio on year and market fixed effects.

Figure 6: Changes in Segregation by Market Concentration



Note: This figure shows average changes in the ratio of mother's education within market for three groups of markets depending on the level of concentration. Concentration in each market was calculated as the Herfindahl Index, which is equal to the sum of the squares of the shares of each school in the market. A high index means high concentration which is associated with lower participation of private subsidized schools. 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. Each point in the graph represents the coefficients of a regression of the ratio on year and market fixed effects.

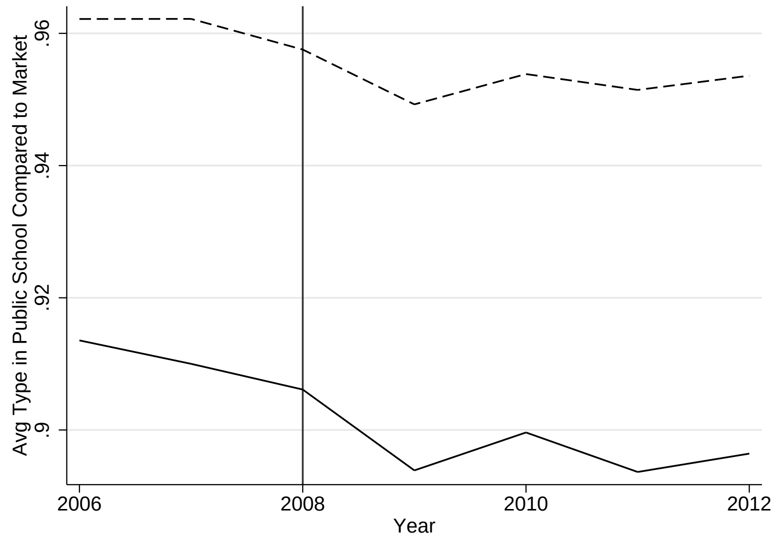
Figure 7: Admissions Thresholds in Private SEP Schools



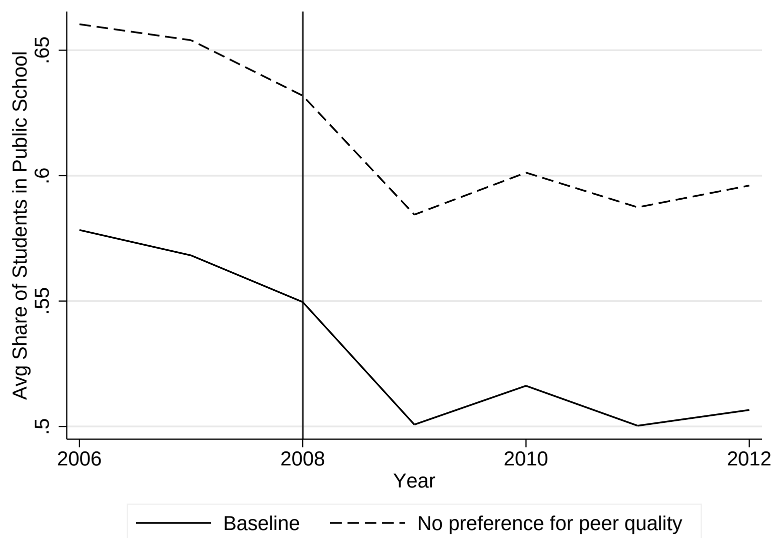
Note: This figure shows average admission thresholds in private subsidized schools in the years before and after the SEP reform. Each point in the graph represents the coefficients of a regression of the lowest 1% of mother's education on year and school fixed effects.

Figure 8: Segregation with No Preferences for Peers

Panel A: Average Student Type in Public Schools Compared to Average in the Market



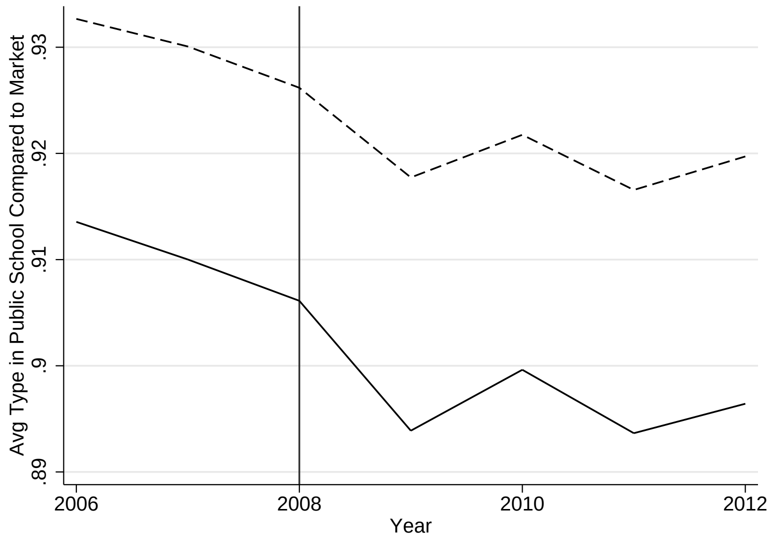
Panel B: Share of Students in Public Schools



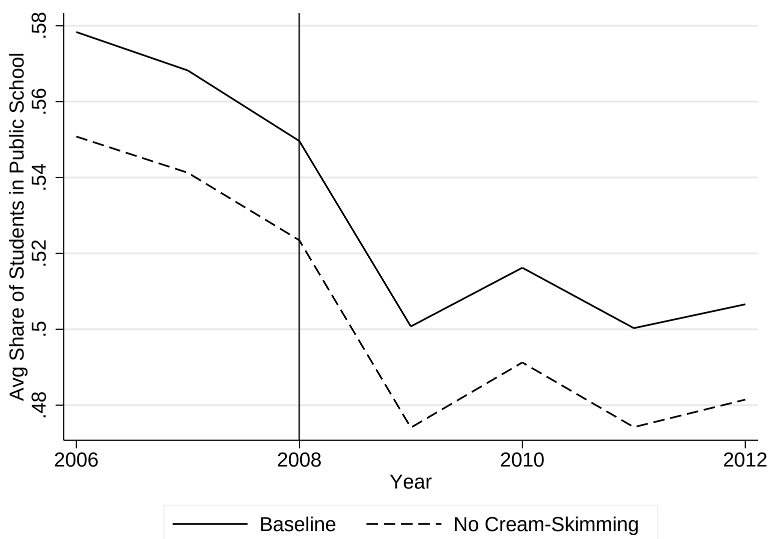
Note: This figure shows simulation results assuming that parameters on peer quality are equal to zero. Panel A shows the ratio of average mother's education in public schools compared to the market average. Panel B shows the share of students going to public schools.

Figure 9: Segregation with No Cream-Skimming

Panel A: Average Student Type in Public Schools Compared to Average in the Market



Panel B: Share of Students in Public Schools



Note: This figure shows simulation results assuming no cream-skimming from private subsidized schools. Panel A shows the ratio of average mother's education in public schools compared to the market average. Panel B shows the share of students going to public schools.

CHAPTER 2 : Competition and the Cannibalization of College Quality [10]

2.1. Introduction

Over the last 30 years, the Chilean government deregulated the higher education market. As a result, universities massively expanded their network of campuses, which intensified the competition between institutions and rapidly increased enrollment. In 1990, most Chilean universities were public, and concentrated their activity around one region. Over the following 20 years, the number of private campuses eligible for government financial aid nearly doubled, while the fraction of students enrolled in any private university increased from 25% to 54.3%. At the same time, traditional universities diversified their operation, and now cover on average two regions through multiple campuses.

From 2001-2010 the average number of campuses increased from 1.57 to 2.56 for public universities, and from 1.25 to 3.9 for private universities. On average, 84% of students enrolled at a public university are affiliated with its main campus, compared to nearly 100% in the early 1990s. This trend is even more pronounced among private universities: 58% of their students are affiliated with the main campus (compared to 97% in 1992), and an average private university is present in four regions (compared to one in 1992).

The Chilean higher-level education system is, like in the U.S., highly decentralized and competitive. This decentralization can lead to substantial benefits for students, mostly by lowering tuitions and improving access to education. In this project, we also point to another effect of competition in this sector. By independently choosing the optimal size and characteristics of their own campuses, universities ignore the potentially adverse impact of their actions on competing universities. This stems from the fact that the quality of universities is in part determined by the quality of students who choose to enroll (see Epple et al. (2006) for a sorting model in which that is the case). For instance, the enrollment at new campuses is generated in part by attracting students who would

[10] The work in this chapter is joint with Chao Fu and Jean-François Houde

otherwise be admitted at existing campuses serving the same population. This competition can in turn force incumbent colleges to reduce their admission thresholds and lower their quality levels.

This "cannibalization" of school quality caused by competition is analogous to the business stealing effect of price competition in oligopoly markets with product differentiation (see Bresnahan (1987) and Berry et al. (1995) for examples in the car market). The main difference in the education context is that this externality does not only reduces tuitions, but also affects the quality of colleges. This is in contrast with standard differentiated product framework, where quality is fixed in the short-run and determined by firms' investments only.

The importance of this inefficiency depends on the level of spatial and quality differentiation between colleges. The first originates from the fact that students tend to favor campuses located near their home locations, and the second is due the fact that universities differ substantially in the quality of their facilities and programs.

In this project we study the consequences of the increase in competition and geographic diversification on the efficiency of the Chilean higher education system, and in particular on the accessibility and quality of colleges. We estimate an equilibrium sorting model, designed to account for both, vertical and horizontal dimensions of differentiation, and quantify the quality of public and private colleges. We use this model for two purposes. First, we quantify the evolution over time of the quality of different universities, and quantify the impact of the Chilean education expansion policy on the distribution of education quality. Second, we estimate patterns of substitution between programs to have a measure of cannibalization.

Our results show that a significant part of the growth in enrollment is explained by elite institutions expanding existing programs and private universities increasing the differentiation of programs offered, with significant entry and exit of programs. The exit and entry of new programs is mostly present in private universities. Our model show considerable preference for geographically close programs, and a strong preference of females for social sciences programs. We find significant substitution between middle tier programs, whereas programs in the top quartile tend to substitute from other programs in that same category.

The remainder of this chapter is organized as follows. Section 2.2 provides a description of the trends in the Chilean college market. Section 2.3 describes the data used in this project. Section 2.4 provides a descriptive analysis of the growth in enrollment. Section 2.5 describes the sorting model with selective programs. Section 2.6 describes the estimation and identification strategies. Section 2.7 shows the estimation results, and Section 2.8 offers a summary and conclusions.

2.2. Trends in the Chilean College Market

Higher education in Chile went through a radical reform in the early 1980s. This reform modified the education system structure and its funding mechanisms, resulting in an expanded, more diverse and highly privatized system.

The number of higher education institutions and enrollment in higher education programs increased significantly following this reform. In 1980, before this reform, approximately one out of four people graduating from high school enrolled in some type of higher education, by 2012 this proportion has increased to more than one out of two.

Currently, the Chilean higher education system is organized in three types of institutions: universities, professional learning institutes, and technical training centers. By 2012, there were 60 universities, 45 professional institutes, and 73 technical training centers. The 60 universities are divided in two groups, 25 that existed before the 1980 reform (these institutions constitute a council called CRUCH,16 are public and 9 are private) and 35 private universities that were created after 1980.

In the 1990s, higher education policies carried out two major changes in terms of financial aid programs for postsecondary education. A means-tested loan scheme (FSCU) to cover tuition fees in one of the traditional universities with a fixed interest rate of two percent and income contingent repayment. Second, a scholarship scheme for students coming from low income families was set up to cover partial or total payment of tuition fees. Financial aid programs have recently expanded. In 2006, a new law established a need-based student loan system for all accredited institutions (including private institutions that were not part of traditional universities), complementing existing privately funded scholarships. The new loan scheme provides qualified students with government backed student loans to cover their tuition fees.

Also, in 2011 there was an expansion in the generosity of the government grants to include eligible students up to the third income quintile. As a result, almost half of students enrolled in higher education receive some type of financial aid, with the majority of this aid being in the form of loans.

The 25 traditional CRUCH universities plus eight out of the other 35 private universities share a single admission process based exclusively in a score calculated from a nationwide admission test (PSU) and high school grades.

The PSU test consists of several parts. Everyone has to take math and language tests, but social sciences and science tests are optional. Each program has different requirements in terms of what parts of the test the applicant must take to be able to apply. Each of these 33 universities that participates of the centralized admission process, publicly announces the number of seats available and the weights to calculate the admission score for each program. Students apply to up to eight programs ordered by preference, after knowing their scores. Admission to each program is managed in a centralized way, where each program is filled by the students with the best scores that applied to that program until the number of seats are filled.

2.3. Data

The empirical analysis rely on two datasets. Microdata on student college applications together with student sociodemographic characteristics for 2012, and aggregate data for university enrollment from 2005 to 2014, for every university that participates in the centralized admission process.

The 2012 dataset on student applications contains the universe of students that applied to some program in one of the 33 universities (25 traditional plus 8 private non traditional) that participate in the centralized admission process, even if the student was not admitted. The aggregate dataset for the institutions, includes total enrollment and admission thresholds for every major.

There are more than 2000 majors offered by these 33 universities. We grouped these majors in 21 categories, so each category is a collection of programs with comparable academic requirements (weights for each of the admission tests). There are 54 campuses that are part of these 33 universities. Overall, students have access to 428 choices (campus/category combination).

The total universe of students considered is every student that took the admission test each year, about 180,000 student per year.

Table 14 shows the growth in the number of majors and campuses by institution. There is a large growth in the number of majors offered during this period, mostly in private non-traditional universities. On average these institutions have approximately 3 campuses in different regions.

Table 15 shows descriptive statistics for student characteristics in each type of institution for 2012. Students attending elite institutions are on average comparable to student going to private universities in family income and mother's education, but with significantly better scores and more likely to have a government scholarship.

2.4. Growth decomposition

During our sample period, there is a significant increase in the share of students enrolling in higher education and the number of programs offered by universities.

Figure 10 shows the share of students enrolling in higher education programs from 2005 to 2014, where there is a sharp increase, especially after 2011. Furthermore, Figure 11 shows that this growth is mostly coming from private universities.

To understand whether the growth in the number of programs is similar across institutions, first we divide the institutions in four groups. Type 1 institutions are the six elite universities that usually appear in international rankings (Pontificia Universidad Catolica de Chile, Universidad de Chile, Universidad de Concepcion, Universidad Tecnica Federico Santa Maria, Pontificia Universidad Catolica de Valparaiso, and Universidad de Santiago). Type 2 corresponds to public universities that are not included in the first group. Type 3 are private universities in CRUCH that are not included in the first group, and type 4 are the eight private non-CRUCH universities that participate from the centralized admission process. Panel A in Table 16 shows the trends in number of programs for each group. It is apparent that growth in the number of programs is mostly coming from private universities, both private-CRUCH and private non-CRUCH. The average annual growth in number of programs is 4.4% in group 3 and 5.9% in group 4.

Second, we look at enrollment for these same groups (Table 16, panel B). Enrollment has increased by about 50% in elite institutions (group 1), and considering that they did not increase significantly the number of programs offered, this means that existing programs are becoming larger on average in these institutions. Enrollment in public universities (group 2), was decreasing significantly from 2005- 2009 and started increasing again in 2010 probably due to the increase in generosity of government grants. Group 3 institutions follow a similar trend than elite institutions. The largest growth in enrollment comes from private non-CRUCH universities (group 4) that almost doubled their enrollment in 10 years.

Next, we divide the sample period in two periods. Period 1 from 2005-2009 and period 2 from 2010-2015 and we look at what part of this growth is explained by incumbent programs, and entry/exit of programs.

Table 17 shows this decomposition of growth in total enrollment for each of the two periods. Total growth corresponds to 10.4% in the first period and 17.9% in the second one. In total, incumbent programs decreased in enrollment and most of the growth is explained by entry of programs. Nevertheless, when looking at different type of institutions, this decomposition looks very different. For elite institutions, more than 50% of the growth is explained by growth of incumbent programs (56% in period 1 and 54% in period 2), whereas for the rest, most of the growth is explained by entry, especially in the second period.

We can also look at the growth in the average program size and how entrants and exits compared to incumbents. Table 18 shows this decomposition. Growth is defined as growth in enrollment and it is calculated as the average growth in the number of students in an individual major for each of the four groups. The average growth is decomposed between average growth of incumbent programs, growth explained by entry of programs larger than the average, and exit of programs smaller than the average. Incumbent programs in elite and private non-traditional universities seem to have grown during both periods. On the other hand, for all institutions, new programs are smaller than the average and the programs existing are also smaller than the average.

If we look at the information in Table 18 in combination with Table 17, it seems like private non-traditional universities are opening a significant number of small programs and at the same time increasing the size of incumbent programs. Public universities that are not included in the first group, are decreasing enrollment overall, mostly explained by incumbent programs, but nevertheless opening a large number of small programs.

Table 19 shows changes in the minimum test score in programs in each of the four groups. Given the large increase in the size of programs in institutions in group 1, it is expected that admission thresholds decrease in this group. Institutions in groups 2 and 3, have maintained similar trends with the difference that public institutions have not increased their enrollment in a way that would explain this decrease. Private non-CRUCH universities show an impressive increase in their thresholds having the lowest scores at the beginning of the period and the second highest by after 2010. This is even more impressive considering that they have almost doubled their enrollment over this period.

Table 20 shows the decomposition of the changes in thresholds.The Olley-Pakes decomposition shows that on aggregate, thresholds decrease in 5.6 points. When we look at the aggregate decomposition, the unweighted average shows a decrease in 2 points, showing that larger programs decreased their threshold about 3 points more. If we look at the same decomposition, but within the four groups defined above, they look very different, but in all cases, larger programs decreased their thresholds more relative to the average (negative within covariance).

2.5. A Sorting Model of College Enrollment

We develop a short-run model describing the allocation of students to campuses, and the endogenous determination of admission thresholds. The model has three components: (i) students preferences, (ii) the admission process, and (iii) market clearing conditions. We describe each in turn.

2.5.1. Student Preferences

When deciding which college to attend, we assume that students trade-off the convenience of each option, with the quality and cost of the education provided. This modeling framework has been used recently by researchers to study demand for schools, mostly in the context of elementary schools (e.g. Hastings et al. (2009), and Neilson (2013)). It is closely related to models of product differentiation used in the Industrial Organization literature (e.g. Berry et al. (1995)). In contrast, the sorting model provided Epple et al. (2006) imposes a common quality ranking across colleges, and assumes that students sort between college options solely based on quality and prices.

Student Characteristics

Students are characterized by different gender (g), family income (y), home location (l), abilities (a) and academic interests.

Let (j, m) index each option (university, category), and $\mathcal{J}$ denotes the set of options available. Admissions are subject to program-specific standards. An outside option is available to all students.

Program characteristics are given by admission requirements ω_j (weights on each test and high-school GPA), p_j (price), location (l_j).

A student has multi-dimensional knowledge in subjects such as math, language, social sciences and science, summarized by $s = [s_1, s_2, ..., s_S]$, the vector of test scores. Various elements of such knowledge are combined with the publicly known category-specific weights to form category-university-specific application test score,

$$t_{ij} = \sum_{l=1}^{S} \omega_{jl} s_{il},$$

where $\omega_j = [\omega_{j1}, ..., \omega_{jS}]$ is the vector of univerity-category-j-specific weights and $\sum_{l=1}^{S} \omega_{jl} = 1$. ω_j's differ across categories: for example, an engineer uses math knowledge more and language knowledge less than a journalist. Notice that abilities are correlated across majors as multi-dimensional knowledge is used in various majors.

Given the different academic tracks they follow in high school, some students will consider only majors that emphasize knowledge in certain subjects, while some are open to all majors. Such general interests are reflected in their abilities and choices of which tests to take.[11] Let M_t be the set of categories within the general interest of a student with test vector t.[12] Every student that takes the test, takes at least the math and language tests. There are no programs within the complete choice set $\mathcal{J}$ that does not require both these tests. We use these two tests to define the student ability a_i

$$a_i = math_i + language_i,$$

Denote student characteristics that are observable to the researcher, i.e., the vector of test scores, family income and gender by the vector $x \equiv [t, y, g,]$, and its distribution by $F_x(\cdot)$.

Utility

Each option j is characterized by a geographic location l_j, a common quality index δ_j, a tuition level p_j, and an admission threshold $\bar{t}_j$. We take as given the financial aid program offered by the government, and assume that qualifying students use all available financial resources. Let $g(p_j, y_i)$ denotes the out-of-pocket cost of choosing option j, m for a student with income y_i.

The utility of attending category (j, m) depends on the quality of the program δ_j, a student's x, peer quality (A_j), distance to the school (d_{ij}) , out-of-pocket cost, and an idiosyncratic taste shock distributed according to a type-1 extreme value distribution ε_{ij}.[13] In particular, A_j is the average ability of enrollees in (j) .

[11]Without increasing the test fee, taking both the science and the social science exams will only enlarge a student's opportunity set. A student who does not take the science exam will not be considered by programs that require science scores, but her admissions to programs that do not require science scores will not be affected even if she scores poorly in science. However, some students only take either the science or the social science exam, we view this as indication of their general academic interests. We treat students' preferences and abilities as pre-determined.

[12]Letting $t_{ij} = n/a$ if a student does not take the subject test required by category m, M_t is given by

$$M_t = \{m \in \{1, ..., M\} : t_{ijm} \neq n/a\}.$$

[13]Peer quality may affect market returns via different channels, such as human capital production, statistical discrimination, social networks, etc. Our data does not allow us to distinguish among various channels. For ease of illustration, we describe peer quality in the framework of human capital production.

In summary, indirect utility for student i attending campus/category j:

$$u_{ij} = \delta_j + \mu_{ij} + \alpha_{ij} g_{ij} + \lambda d_{ij} + \varepsilon_{ij} \tag{2.1}$$

where μ_{ij} is the idiosyncratic evaluation, d_{ij} is the spacial differentiation which includes two variables, the distance between the student and the campus municipalities, and an indicator for whether the campus j is located in a different administrative region to the student.

$$\mu_{ij} = \mu^0 x_i + \mu^1 r_{ij} + \mu^2 a_{ij} + \mu^3 w_i \cdot \omega_j^{\text{math+science}}$$

where

$x_i = \{\text{Gender}_i, \text{Family education}_i, \text{Income}_i/\text{Family Size}_i\}$

r_{ij}(selectivity ratio)$= \tau_{ijm}/\tau^{\max}$

a_{ij}(ability distance)$= |a_i - \bar{A}_j|$

$w_i = \{\text{Gender}_i, t_i^{\text{math}}\}$

The price sensitivity parameter α_{ij} is allowed to vary by type of institution and student's family income and ability:

$\alpha_{ij} = z_i \alpha_{\text{private}}$ or $\alpha_{ij} = z_i \alpha_{\text{traditional}}$

where $z_i = [a_i, y_i]$.

The average quality of each college/category option is measured by the fixed-effect parameter δ_{jt}, common across consumers, and a function of the average peer quality in the program, and an unobserved (to the econometrician) measure ξ_{jt}:

$$\delta_{jt} = \gamma A_{jt} + \bar{\xi}_j + \xi_{jt}, \tag{2.2}$$

2.5.2. Admission Process

The choice of a college major depends in part of the admission process. The Chilean admission process is very transparent, and we use the admission thresholds and weights used by each campus to determine the set of available options for each student. Under the Chilean system, option j is in a student's choice set if only if $t_{ij} \geq \bar{t}_j$, the institution-category-specific admissions cutoff.

The admission threshold of major j is determined by the score of the marginal admitted student:

$$\bar{t}_j = \sum_{l=1}^{S} \omega_{jl} \tilde{s}_{il}, \tag{2.3}$$

where $l = 1, \ldots, S$ indexes the required tests (i.e. language, math, high-school GPA, etc), $\tilde{s}_{il}$ is the result of the marginal student in campus/major j to test l, and ω_{jl} is the weight put on test-score l by option j. Note that schools and categories can use different weighting scheme to determine the admission threshold, including weights of zero on tests that are not required for certain majors. Information about each program weights is easily available to students, and we assume that students know perfectly their admission score associated with each program.

We make two important assumptions to simplify the model. First we assume that students have rational expectations over the admission thresholds for each option. Therefore, the admission thresholds determine the choice-set of each student, and there is no uncertainty about the probability of getting admitted to a particular program. Let $\mathcal{J}_i$ denotes the set of available options to student i.

Second, since we are aggregating over 400 individual programs into 21 major categories, we are assuming that students get admitted based on the smallest admission threshold within a category, and automatically enroll into the *best* available program within that category conditional on accepting an offer.

For instance health category at Universidad de Chile contains 7 programs with thresholds ranging from 635 to 686. Under our admission assumption a student with a test score of 640 would get admitted in this major category, but enroll in the lowest-qualify program; as measured by the admission score of 635. In contrast, a student with a test score of 700, would enroll into the best program, associated with the score 686.

To differentiate between programs within each major category, we assign to each student the highest available threshold. This corresponds to a student-specific measure of program quality. It is denoted by a function $\tau_j(t_i)$, where t_i is the vector of test results of student i.

Students also have an outside option of not attending any program in these 33 institutions (either choose a program in an institution outside the centralized admission process or not attending any program), denoted by 0. This option is available to all students, and has a value normalized to zero.

Conditional on choosing to attend college, and the vector of peer quality in every program, students face the following discrete-choice problem:

$$U(x, \varepsilon | \bar{t}_j, A) = \max \left\{ \max_{j \in \mathcal{J}(t_i)} \{u_j(x, \varepsilon, A_j)\}, \varepsilon_0 \right\}.$$

The probability of choosing option j is therefore given by the following multinomial logit model:

$$\sigma_j(\boldsymbol{\delta}, \bar{\boldsymbol{t}} | x_i) = \frac{\exp\left(\delta_j + \mu_{ij} + \alpha_{ij} g_{ij} + \lambda d_{ij}\right)}{1 + \sum_{k \in \mathcal{J}(t_i)} \exp\left(\delta_k + \mu_{ik} + \alpha_{ij} g_{ik} + \lambda d_{ik}\right)} \tag{2.4}$$

To calculate the market-share and enrollment of each campus/major, we integrate over the empirical distribution of student attributes:

$$\sigma_j(\boldsymbol{\delta}, \bar{\boldsymbol{t}}) = \sum_{l=1,\ldots,L} \int \sigma_j(\boldsymbol{\delta}|x_i) dF(t_i, y_i|l)\phi(l) \tag{2.5}$$

where $F(t_i, y_i|l)$ is the conditional distribution of student test-score and family income in municipality l, and $\phi(l)$ is the density of applicants in location l. The population of applicants is defined as the set of students taking the required qualifying exams to enter college, and includes about 40% of students who chose either to work or attend a technical college.

Similarly, the average test-score of students enrolled in program j is implicitly defined as:

$$\bar{t}_j = \sum_{l=1,\ldots,L} \int t_i \frac{\sigma_j(\boldsymbol{\delta}, \bar{\boldsymbol{t}}|x_i)}{\sigma_j(\boldsymbol{\delta}, \bar{\boldsymbol{t}})} dF(t_i, y_i|l)\phi(l) \tag{2.6}$$

where t_i is the average test-score of student i, and δ_j is function of $\bar{t}_j$ through the effect of peers on school quality in equation 2.2.

2.5.3. Market Clearing Conditions

We assume that the capacity and tuition of each program are fixed in the short-run, and that schools adjust the admission thresholds in order to fill every available seat. If κ_{jm} denotes the capacity of option j (expressed as a fraction of the applicant population), the equilibrium allocation is implicitly defined by the following condition:

$$Q_j^0 = \sigma_j^{-1}(\boldsymbol{\kappa}, \bar{\boldsymbol{t}}) - \rho \bar{y}_j, \forall j \tag{2.7}$$

where $Q_j^0 = x_j \beta^0 + \xi_j^0$ is the true quality index of college of j, $\bar{t}_j$ defined in equation 2.6, and σ_j^{-1} is the inverse-demand function. From Berry et al. (1995), there exists a unique inverse demand that rationalizes the observed capacities, conditional on the admission thresholds. However, due to the presence of the peer effects, existence and uniqueness of a sorting equilibrium is not guaranteed. This will have consequences on our ability to solve for equilibrium allocations under alternative policy environments, but, as we discuss below, will not prevent us to obtain consistent estimates of college quality.

2.6. Estimation and Identification Strategy

Our objective is to construct a measure of college quality that accounts for students endogenous sorting and college admission policies. To do so, we follow a reveal-preference approach, in which we estimate students' preferences, conditional on a perceived quality index that is consistent both with schools admission policies and students equilibrium sorting decisions. In order words, we estimate a vector of perceived quality δ_j that is consistent our assumption that the market satisfies the sorting equilibrium described above.

We impose the equilibrium conditions on the data in two stages. First, we estimate by maximum likelihood the preference of students for convenience and price sensitivity parameters, without decomposing the perceived quality of colleges into a pre-determined and peer effect components. Then in a second stage, we estimate the quality of colleges by imposing additional assumptions on the distribution of the unobserved quality of programs. We describe both stages in the next two sections.

2.6.1. Student Preferences

The parameter vector can be divided in two parts: $\theta_1 = \{\alpha, \lambda, \gamma\}$ determines the choice-probability of each student, and $\theta_2 = \{\beta, \rho\}$. In the first stage of our estimation strategy, we estimate θ_1 only, by treating the net quality index δ_j as a fixed-effect. This leads to a constrained maximum-likelihood estimator similar to the one used in Goolsbee and Petrin (2004) and Bayer et al. (2007).

Our sample corresponds to the population of high-school students taking the admission tests in 2012. Let c_i denotes the choice of campus/program made by student i. The maximum likelihood estimator can be written as follows:

$$\max_{\theta_1} \quad \sum_i \log \sigma_{c_i}(\boldsymbol{\delta}, \boldsymbol{t} | t_i, y_i, l_i) \tag{2.8}$$

$$\text{s.t.} \quad \delta_j = \sigma_j^{-1}(\boldsymbol{\kappa}, \boldsymbol{t}) \tag{2.9}$$

2.6.2. Quality Decomposition

The presence of the quality of peers enrolled in each program creates a standard simultaneity problem, since we assume that students sort across schools after observing the quality of each option, and while holding rational expectations about the quality of programs. This simultaneity problem is akin to the endogenous of prices in differentiated product settings.

To get around this simultaneity problem, we will combine standard panel-data techniques with an instrumental variable approach. In particular, assuming that preference parameters (θ_1) remained stable over time, we can recover an estimate of the combined quality of programs for every options available between 2001 and 2012:

$$\hat{\delta}_{js} = \sigma_{js}^{-1}(\boldsymbol{\kappa}_s, \boldsymbol{t}_s) \tag{2.10}$$

where $\boldsymbol{\kappa}_s, \boldsymbol{t}_s$ are the observed vector of enrollment capacity and admission thresholds for year $s \in \{2001, \ldots, 2012\}$. Notice also that the the inverse-demand system has a year subscript to capture the fact that the set and characteristics program available have been changing over time, as well as the generosity of the government loan and grant program. While we observe all of these changes, we do not observe micro-data on students enrollment choices for years prior to 2012. This prevents us from estimating time-varying preference parameters.

Treating the quality index as data, we obtain the following panel-data linear regression model:

$$\hat{\delta}_{jt} = \rho \bar{t}_{jt} + \mu_j + \xi_{jt}, \tag{2.11}$$

where μ_j is a major/campus fixed-effect.

In order to identify the effect of peer characteristics on college quality, we construct an instrument for $\bar{t}_{jt}$. Since the characteristics of students enrolled naturally depends on the characteristics of alternative college options, we will construct instruments based on the time-varying characteristics of programs available at campuses that are close-substitutes to option j. Measures of "close-substitutes" can be obtained using spatial variation.

The main threat to the validity of this class of instruments is that the physical characteristics of competing colleges can be correlated with the unobserved college quality. This can be the case for instance if colleges invest in technologies that we fail to observe and are able to react to investments made by other colleges. Additionally, ξ_{jt} can proxy for time-varying omitted attributes that are spatially correlated.

The second threat can be addressed in part by incorporating time-varying region fixed-effects. The first threat on the other hand cannot be easily tested, and we must rely on a timing assumption. In particular, we assume that competing colleges react to ξ_{js} with a lag, due for instance to the presence of sunk adjustment costs. This an often invoked assumption in the production function literature (e.g. Ackerberg et al. (2006)).

2.7. Estimation Results

2.7.1. Preference parameters

Table 21 shows estimates for the taste parameters. The negative coefficient on the absolute difference between own ability and average peer ability suggests that students dislike being far from the average (either better or worse by a large difference). The coefficient on the interaction between science weight ($\omega_j^{\text{math+science}}$) and gender, helps to fit the fact that females sort into social science majors that is not explained by their math test score.

Additionally, students with high math score, tend to sort into programs with high science weight. The negative coefficient in distance and different region show a taste for geographic proximity, showing that students are willing to pay between 0.8 ands 1.2 million pesos (approximately 2000 US dollars) to attend a program in their region. The intercept on the price coefficient is significantly higher for public than private institutions, that could be explained by the fact that private institutions offer scholarships that are not included in the data.

There estimates can be used to calculate substitution patterns between different types of programs when there is an increase in average quality (δ_{jm}) of a given program. Table 22 shows these patterns. Programs are arranged in four groups by average peer ability, and diversion ratios are calculated between each program and rival programs, including the outside option. When a program in the lower quartile of peer ability increases its average quality, 55% of the new students come from the outside option and 32% from programs in the lowest two quartiles. The percentage of students coming from the outside option decreases as the average peer quality goes up. When a program in the top quartile improves its quality, 61% of the new students come from other programs in that same group, and only 20% from the outside option.

2.7.2. Quality decomposition

Table 23 shows the first stage using three sets of instruments for average peer ability and university-program fixed effects. For instruments we use measures of changes in competition in the region, either share of traditional programs, or share of highly ranked programs in the same category, or number of new programs. As expected, most of these variables are negatively correlated with average peer ability since the entry of new competitors or an increase in the share of competitors in the region should decrease the peer ability of a program in that region. The validity of these instruments is discussed in the previous section.

Table 24 shows the decomposition of college quality. The different IV specifications tend to increase the coefficient on average peer ability compared to the OLS estimation. This suggests that the error term is negatively correlated with the average peer quality. This could be explained by low quality programs in private institutions offering scholarships that we do not observe in the data to students that have high test scores.

Additionally, in all specifications, there seem to be an upward trend starting around 2011. This could be associated with an increase in investments that may influence perceptions of quality.

2.8. Conclusion

This paper studies the effects of increasing competition and differentiation on accessibility to higher education and quality of university programs. The Chilean higher education system suffered radical modifications in the early 1980s that resulted in a highly privatized and competitive system. Access to higher education increased significantly, with about half of the students graduating from high-school enrolling in some type of higher education by 2012.

We do not study the first round of reforms that led to the existence of private universities, but a second round of reforms in 2006 and 2011 that modified the access and generosity of government grants and loans. These changes led to a significant expansion and diversification of university programs, with institutions trying to meet the demand of a society with increased means to finance higher education.

We find that most of the growth in enrollment comes from elite institutions that expand the size of existing programs and private universities that almost doubled their enrollment and at the same time doubled the number of programs offered. Also, we find significant entry and exit of programs in private universities compared to public institutions.

We estimate a sorting model where we find considerable taste for geographically close programs, and females having preferences for social sciences careers, as opposed to programs stronger in math and sciences, even after controlling for math test scores. Using these estimates, we calculate substitution patterns to see where are students coming from when a program increase its quality. We find significant substitution between middle tier programs, whereas top tier universities tend to substitute mainly from other programs in that same range. For middle tier programs about 40% of the increase in share associated with an increase in quality come from students choosing the outside option, and about 60% from students in other programs.

We decompose the quality term in investment and peers, using the entry of competitors as an instrument for peer quality. There seems to be an improvement in average quality of programs over this period, especially after 2011.

Further work is necessary to be able to use these results to simulate a counter-factual distribution of education quality under an alternative configuration in which the Chilean government would have limit the expansion of private colleges. This will allow us to shed light on the tradeoff between the quality and accessibility of higher education.

Table 14: Increase in Number of Programs

Year	Nb. Majors	Campus /Inst.	Majors per Institution Private	Majors per Institution Traditional
2005	1634	2.5	59.3	66.9
2006	1678	2.6	61.9	67.9
2007	1643	2.5	60.7	66.6
2008	1737	3.5	65.3	74.2
2009	1796	3.5	71.7	73.2
2010	1850	3.4	82.4	75.5
2011	1946	4.0	95.2	78.1
2012	1910	2.5	101.4	71.8
2013	2051	2.6	105.8	76.8
2014	2099	2.7	108.7	77.1
2015	2148	2.7	109.1	79.3

Note: This table presents the number of undergraduate programs and number of campuses in traditional and private universities. Source: DEMRE

Table 15: Average Student Characteristics across Types of Institutions

	Elite	Public	Private CRUCH	Private Non-CRUCH	Outside Option
Avg. Family Income	8.99	5.25	5.79	9.98	4.58
Avg. Mother's Educ.	13.47	12.03	12.09	13.49	10.99
Avg. PSU Score	646.53	572.65	576.29	596.36	467.43
Prop. of Students w/ Scholarship	0.45	0.45	0.43	0.22	0.16
Prop. of Students w/ Loan	0.25	0.38	0.39	0.36	0.23
Prop. Of Students from Private School	0.31	0.09	0.12	0.38	0.12

Note: This table present average characteristics of students attending each type of higher education institution. Family income is annual income measured in millions of pesos. Mother's education is measured in years of education. The outside option includes any high-school graduate that applied to some program in these universities but either was not admitted or chose not to enroll in a program to which he was admitted.

Table 16: Growth by Type of Institution

Panel A: Total Number of Programs

Year	Type 1	Type 2	Type 3	Type 4
2005	435	727	191	281
2006	447	735	207	296
2007	426	739	193	292
2008	427	791	211	312
2009	447	784	231	343
2010	452	785	240	373
2011	453	838	236	419
2012	462	748	255	445
2013	489	808	283	471
2014	479	830	299	491
2015	488	873	290	497
	1.20%	1.99%	4.43%	5.94%

Panel B: Total Enrollment

Year	Type 1	Type 2	Type 3	Type 4
2005	21,152	30,386	7,903	15,888
2006	22,618	28,164	8,054	19,133
2007	24,221	25,221	8,301	19,024
2008	23,931	25,072	8,413	21,576
2009	24,134	24,774	9,370	22,903
2010	25,983	25,527	10,189	24,117
2011	26,584	25,362	10,346	25,125
2012	28,364	24,941	10,597	27,028
2013	28,345	28,011	11,082	28,488
2014	28,282	28,136	11,664	29,851
2015	30,174	30,349	11,860	28,829
	3.67%	0.18%	4.19%	6.32%

Note: Panel A presents the number of programs in each year by type of institution. Institutions are classified in four groups: Type 1 corresponds to six elite institutions, private or public that commonly appear in international rankings. Type 2 corresponds to CRUCH public universities that are not in group 1. Type 3 corresponds to CRUCH private universities that are not in group 1. Type 4 corresponds to private non-CRUCH universities that participate in the centralized admission process. The last row shows the average yearly growth. Panel B presents the total enrollment by type of institutions and the last row shows the average yearly growth.

Table 17: Growth Decomposition

	Total	Type 1	Type 2	Type 3	Type 4
Period 1					
Incumbent	-1,132	2,559 (56.5%)	-6,953 (-109.9%)	-423 (-22.1%)	3,685 (47.6%)
Entry	14,860	2,257 (49.8%)	5,185 (81.9%)	2,649 (138.6%)	4,769 (61.6%)
Exit	-5,878	-286 (-6.3%)	-4,561 (-72.1%)	-315 (-16.5%)	-716 (-9.3%)
Total Growth	10.4%	4,530	-6,329	1,911	7,738
Period 2					
Incumbent	-36	2,282 (54.5%)	-787 (-16.3%)	-1,290 (-77.2%)	-241 (-5.1%)
Entry	18,069	2,210 (52.7%)	7,079 (146.8%)	3,336 (199.6%)	5,444 (115.5%)
Exit	-2,637	-301(-7.2%)	-1,470 (-30.5%)	-375 (-22.4%)	-491(-10.4%)
Total Growth	17.9%	4,191	4,822	1,671	4,712

Note: This table shows a decomposition of enrollment growth between incumbent institutions, new entrants, and institutions that exited during that period for each type of institution. First period corresponds to 2005-2009, and the second period corresponds to 2010-2015. Institutions are classified in four groups: Type 1 corresponds to six elite institutions, private or public that commonly appear in international rankings. Type 2 corresponds to CRUCH public universities that are not in group 1. Type 3 corresponds to CRUCH private universities that are not in group 1. Type 4 corresponds to private non-CRUCH universities that participate in the centralized admission process.

Table 18: Decomposition of Growth in Program Size

	Type 1	Type 2	Type 3	Type 4
Period 1				
Incumbents	8.12	-9.88	1.75	18.80
Entry	-0.53	-7.45	-5.16	-2.73
Exit	0.26	2.50	0.31	1.61
Period 2				
Incumbents	6.15	-0.93	-6.33	12.04
Entry	-2.11	-2.32	-3.37	-14.91
Exit	0.93	0.10	1.24	2.11

Note: This table shows a decomposition of program size growth between incumbent institutions, new entrants, and institutions that exited during that period for each type of institution. Each entry corresponds to the growth measured as the average number of students. For the entrants the size of the new programs is compared to the average size in the previous period and for exit programs, the size is compared to the average size that period. First period corresponds to 2005-2009, and the second period corresponds to 2010-2015. Institutions are classified in four groups: Type 1 corresponds to six elite institutions, private or public that commonly appear in international rankings. Type 2 corresponds to CRUCH public universities that are not in group 1. Type 3 corresponds to CRUCH private universities that are not in group 1. Type 4 corresponds to private non-CRUCH universities that participate in the centralized admission process.

Table 19: Changes in Test Score Thresholds

Year	Type 1	Type 2	Type 3	Type 4
2005	562.8	497.9	488.7	332.7
2006	567.6	498.6	495.3	339.9
2007	578.9	504.3	498.6	328.0
2008	575.2	500.2	502.6	328.6
2009	587.3	504.5	506.0	342.5
2010	582.2	506.6	504.1	563.6
2011	577.1	510.5	503.4	565.7
2012	572.0	496.6	497.7	518.6
2013	558.5	498.2	493.9	519.0
2014	548.4	491.2	492.2	514.7
2015	548.2	492.7	492.0	516.3

Note: This table shows the average math and language score of the last student admitted in each type of institution each year. Institutions are classified in four groups: Type 1 corresponds to six elite institutions, private or public that commonly appear in international rankings. Type 2 corresponds to CRUCH public universities that are not in group 1. Type 3 corresponds to CRUCH private universities that are not in group 1. Type 4 corresponds to private non-CRUCH universities that participate in the centralized admission process.

Table 20: Growth Decomposition

Aggregate Δ Admission Thresholds (2015-2005)				
Aggregate Δ Min PSU	-5.58			
Olley-Pakes Decomposition				
Unweighted average	-2.38			
Covariance	-3.20			

Within Decomposition	Type 1	Type 2	Type 3	Type 4
Aggregate Min PSU	-14.62	-5.21	3.25	4.28
Unweighted Avg	-13.34	0.99	7.24	9.86
Within Covariance	-1.27	-6.20	-3.99	-5.58

Note: This table shows the Olley-Pakes decomposition and the within decomposition in each of the four groups, showing how much of the change in thresholds comes from larger programs relative to the average.

Table 21: Preference Parameters

		Coefficients	Std. Error
Intercept	Gender	0.581^{*}	0.122
	Education of parents	0.009	0.009
	Income/Family size	-0.118^{*}	0.028
Relative admission score		-0.459	0.359
|Ability-Avg Peer Ability|		-2.471^{*}	0.080
Science weight $\times$ Math score		11.519^{*}	1.245
Science weight $\times$ Gender		-1.376^{*}	0.291
Distance		-0.315^{*}	0.048
Different region		-2.396^{*}	0.085
Price - Public	Intercept	-2.899^{*}	0.222
	Test score	0.540^{*}	0.037
	Income/Family size	0.016	0.009
Price - Private	Intercept	-1.969^{*}	0.212
	Test score	0.408^{*}	0.036
	Income/Family size	0.028^{*}	0.007
LLF/N		-1.65	

Note: This table presents the estimated parameters and standard errors for the sorting model. Gender is an indicator variable equal to one for females and zero for males. Education of parents is measured in years of education, income in millions of pesos per year. Admission score is measured in thousands of points (same as ability, which is just the average of math and language test scores). Distance is measured in hundreds of miles, and different region is an indicator variable equal to one if the program is located in a region different to the student's home region. Prices are measured as out of pocket tuition after considering government grants and loans, in millions of pesos per year.

Table 22: Business Substitution when Quality Increases

Own Peer Ability	Outside Option	Rival Peer Ability			
		$(\bar{a}_{\min}, \bar{a}_{.25})$	$(\bar{a}_{.25}, \bar{a}_{.5})$	$(\bar{a}_{.5}, \bar{a}_{.75})$	$(\bar{a}_{.75}, \bar{a}_{1})$
$(\bar{a}_{\min}, \bar{a}_{.25})$	0.55	0.14	0.18	0.10	0.03
$(\bar{a}_{.25}, \bar{a}_{.5})$	0.48	0.11	0.20	0.16	0.06
$(\bar{a}_{.5}, \bar{a}_{.75})$	0.36	0.06	0.16	0.24	0.18
$(\bar{a}_{.75}, \bar{a}_{1})$	0.20	0.01	0.05	0.13	0.61

Note: Programs are classified in four groups according to the average student ability. Each cell is the average fraction of new students going to *row* schools that come from the *column* schools, when a *row* school marginally increases its quality using the results from the estimation.

Table 23: College Quality Decomposition - First Stage

	Average Peer Ability		
Share of programs in region/category	-4.998***	-3.290**	-4.404***
	(1.181)	(1.113)	(1.166)
New programs in category	1.876***		-2.273**
	(0.537)		(0.852)
Share of top ten programs in region		-5.463**	-5.450**
		(1.678)	(1.671)
Share of old institutions in the region		-17.914*	
		(7.691)	
Ranking $\times$ New Programs in Region			0.285***
			(0.046)
F-test	11.60	8.70	17.72

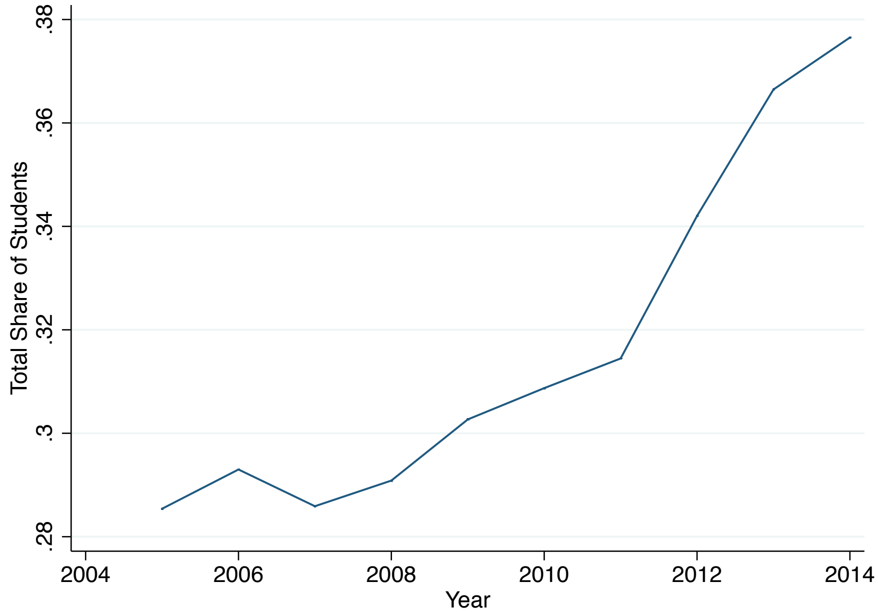
Note: This table presents the first stage estimation using different sets of instruments for average peer ability in the program.

Table 24: College Quality Decomposition

VARIABLES	(1) OLS	(2) IV 1	(3) IV 2	(4) IV 3
Avg. Peer	0.009***	0.035**	0.021	0.020*
	(0.001)	(0.013)	(0.012)	(0.009)
2006	-0.183***	-0.101	-0.147**	-0.146**
	(0.044)	(0.058)	(0.056)	(0.048)
2007	-0.031	-0.166	-0.096	-0.089
	(0.044)	(0.088)	(0.077)	(0.064)
2008	-0.181***	-0.311***	-0.235**	-0.233***
	(0.044)	(0.084)	(0.075)	(0.063)
2009	0.196***	-0.043	0.087	0.093
	(0.044)	(0.136)	(0.123)	(0.098)
2010	0.336***	-0.023	0.177	0.190
	(0.044)	(0.195)	(0.174)	(0.135)
2011	0.467***	0.156	0.331*	0.343**
	(0.044)	(0.176)	(0.152)	(0.123)
2012	0.300***	0.166	0.240**	0.249**
	(0.043)	(0.105)	(0.091)	(0.080)
2013	0.547***	0.421***	0.490***	0.479***
	(0.043)	(0.105)	(0.095)	(0.086)
2014	0.816***	0.745***	0.782***	0.769***
	(0.043)	(0.096)	(0.087)	(0.083)
Program FE		X	X	X
Weak IV		9.623	5.668	10.045
J-test (p-value)		0.668	0.106	0.065

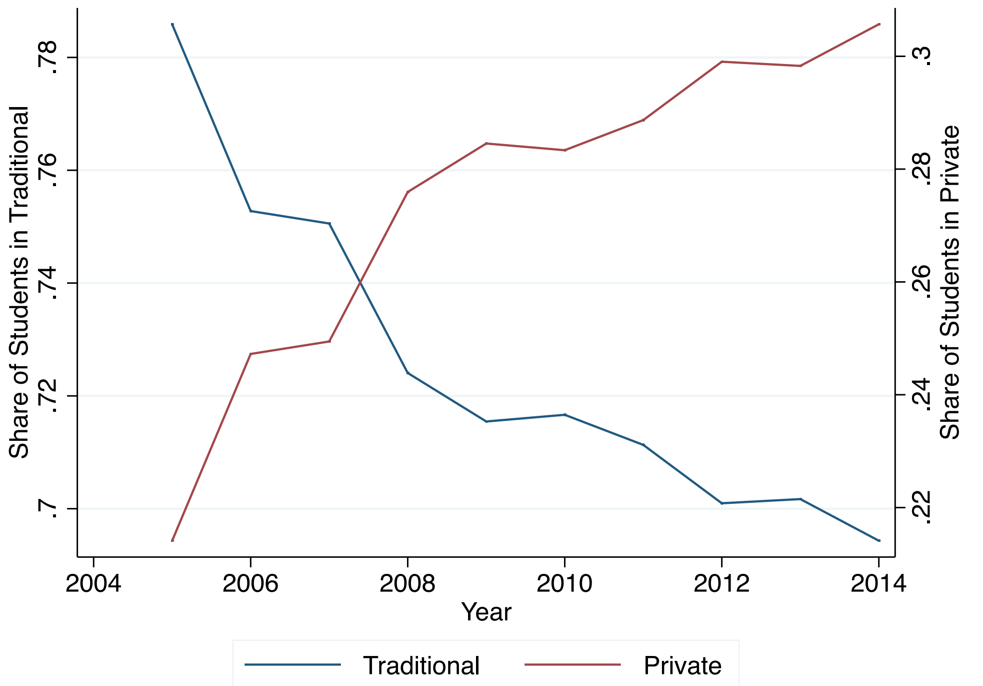
Note: This table presents the quality decomposition by OLS and using the three different IV specifications shown in Table 23

Figure 10: Growth in College Enrollment in Chile 2005-2014



Note: This figure shows the total share of high-school graduates attending some type of higher education program each year from 2005 to 2014.

Figure 11: Growth in Enrollment by Type of Institution



Note:This figure shows the share of students in higher education attending a traditional institution and the share attending a private institution, each year from 2005 to 2014.

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