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

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**Abstract**

Critics of school choice argue that when private schools compete with public schools, they select the best public school students (cream-skim), increasing socioeconomic segregation. 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 admissions restrictions to capture parents' preferences for different school characteristics and peer composition. I show that ignoring cream-skimming leads to underestimating poor parents' preferences for school quality. My model shows that heterogeneous parental preferences for high-SES peers seem to be the main driver behind socioeconomic segregation. I find that the decrease in cream-skimming induced by Chile's reform led to lower public school enrollment, and that strong preferences for high-SES peers drove increased enrollment in schools that opted out of the reform. Overall, this led to increased segregation, especially in more competitive markets.

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# 1 Introduction

Educational reforms in numerous countries introduce competition between schools by increasing parental choice via school vouchers.[1] In theory, increased competition between educational institutions should result in the provision of better school quality to attract students.[2] However, there is concern that school choice programs may increase social stratification in education systems and weaken public schools if higher-income students migrate to private voucher schools (Manski, 1992; Epple and Romano, 1998; Nechyba, 1999). Indeed, previous studies have shown that private voucher schools ended up serving a wealthier population at the expense of public schools, leading to increased socioeconomic segregation across schools (Gauri, 1999; Hsieh and Urquiola, 2006; 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 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

[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).

[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)

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 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

[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.

[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).

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 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

[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.

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 the paper is organized as follows. Section 2 provides the description of the model for school choice and the mechanisms behind socioeconomic segregation. Section 3 provides institutional background on Chile's educational system and the 2008 reform. Section 4 describes the data. Section 5 provides a descriptive analysis of changes in school enrollment, segregation patterns, and schools' participation decisions. Section 6 describes the demand estimation in the presence of cream-skimming. Section 7 shows the counterfactuals and Section 8 offers a summary and conclusions.

## 2 Model for School Choice

This model integrates decisions of parents and schools at the moment of choosing an elementary school for their children to explain the mechanisms behind student sorting. In many settings where choice is increased, it is observed to increase the level of socioeconomic segregation across schools, even in settings where there is no tuition. Different demand- and supply-side mechanisms could drive these sorting patterns observed in school choice settings. On the supply side, private schools could be selecting students in the admission process. If schools are selecting students based on socioeconomic characteristics this would explain at least part of the sorting. On the demand side, heterogeneous preferences for school characteristics by parents from different socioeconomic background could explain the observed sorting.

The process of applying and registering to elementary schools is not centralized and parents have to apply to each school they are potentially considering, separately through each school admission process.

A market consists of a set of students ($I$) and a set of schools ($J$). Students apply to certain schools, and schools decide whether to admit or reject each applicant. Two types of schools interact in each market, public and private subsidized schools. Public schools admit all students that apply, but private schools have the ability to select students. Most schools are tuition free and financed through government vouchers that are payed directly to each school (both to public and private subsidized) based on student attendance. Private schools are allowed to charge a top-up tuition, most choose not to charge anything and some charge a small amount. I model parents' decisions as a discrete choice of a single school from their market.

Students are characterized by their type $\theta$. The student type is given by their socioeconomic status that will be defined as the education level of the mother.

### Demand Model

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

$$U_{imjt} = \alpha p_{ijt} + X_{jt}\beta_m - \gamma d_{ijt} + \xi_{jt} + \varepsilon_{ijt}$$

where

$$\beta_m = \bar{\beta} + \beta_o \theta_m$$

$X_{jt}$ are school characteristics and the preference parameters on each characteristic $\beta_z$ are allowed to depend on the student type. $p_{ijt}$ is the top-up tuition that school $j$ charges student $i$ and this amount varies across students within each school. $d_{ijt}$ is the distance for student $i$ to school $j$, $\xi_{jt}$ is a year-school specific term that represents unobserved school quality. $\varepsilon_{ijt}$ represents an unobserved idiosyncratic preference of student $i$ for school $j$, distributed independently across schools and students.

Parents choose the school that maximizes their utility within the schools that admit them.

**Student Achievement**

Achievement of student $i$ depend on the student's type $\theta_i$ and school characteristics $X_j$, like class size, teacher quality, type of school, peer quality etc.

$$T_{ij} = f(\theta_i, X_j) \qquad \text{with} \quad \frac{\partial f}{\partial \theta} > 0 \tag{1}$$

Test scores are increasing in type which is supported by the literature[7]. This translates into marginal cost of educating a student decreasing in type.

**Private School Objective Function**

Under a voucher program, public and private subsidized schools compete in each market. All schools (both public and private subsidized) receive a voucher $v$ from the government per student enrolled. Private schools' objective function is likely to differ across different schools. Some schools may be profit-maximizers and some schools are non-profit institutions, but still may care about school rankings that are based on results from nationwide standardized test scores. Private subsidized schools are modeled as Bertrand-Nash competitors that maximize profits by choosing admission thresholds on the students' type. Each private subsidized

[7]

school has an unobserved capacity $q_j$. I assume that public schools admit all students that apply.

The correlation between student type and achievement translates into marginal costs decreasing in the student type, reflecting the fact that increasing student socioeconomic types admitted to a school is an effective way of improving test scores.

This results in both cases, profit maximizers and reputation maximizers, to have a preference for higher type students. Therefore, in admissions there are incentives to select high type over low type students, if the types are observed to the school.

The profit function under the voucher program is given by:

$$\Pi_j = \sum_k P_{kj}(v - mc(\theta_k)) \tag{2}$$

where $P_{kj}$ comes from the demand choice probabilities of student $k$ attending school $j$, $\theta_k$ is student's k type, and $mc$ is the marginal cost that is a function of student's type.

Conditional on the school capacity, admission thresholds adjust endogenously to clear the market, working like prices in a regular supply and demand model.

## 3 Background in Chile

Chile implemented a nationwide school voucher program in 1981 to introduce school choice and decentralize educational services 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.

### 3.1 The 2008 Reform: SEP Law

In response to critics of the old voucher system, in February 2008, Chile adopted a new policy creating a targeted schooling subsidy 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.[8]

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

[8]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.

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.

# 4 Data

My empirical analysis rely on data on student enrollment together with school and student characteristics. I use 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.[9] 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.

### 4.1 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 income, public transport quality, weather, etc.

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

Table A1 in the Appendix Tables shows the list of municipalities in each market.

## 5 Stylized Facts

### 5.1 Changes in Enrollment

The SEP reform sought to decrease educational inequality by giving more resources to schools that served a more vulnerable population. However, policy makers did not consider that this would cause a resorting of students and the consequences that this may have on overall segregation.

[9] 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.

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

Average first grade enrollment in different types of school are presented in Figure 3. It provides the coefficients of a regression of average first grade enrollment on school and year fixed effects, so it represents average changes within school.[10]

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

The share of students at public schools steadily declined before and after the reform. In contrast, private subsidized schools increased their share of students around the time of the reform both in SEP and non-SEP schools. The new program 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 for them are unchanged.

Changes in enrollment are not homogeneous across types of students, and they occur at different times. The probability of going to each type of school for different student types across the sample time is shown in Figure 4. The probability of going to a public school dropped significantly for students in the bottom half of the distribution of mother's education, with a correspondent rise of similar magnitude in the probability of going to a private subsidized SEP school.

There is an increase of about 10 percentage points in the probability of going to a private SEP school for students with mothers with fewer than twelve years of education. This increase occurrs in a discrete way, starting in 2008, the first year of the SEP reform. This suggests that private SEP schools started admitting students they had not admitted before, given the rise in the value of the voucher for vulnerable students. Further, it suggests that

[10]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.

the high enrollment, before the SEP reform, in public school of students in the bottom half of the distribution, was likely determined by their inability to meet private schools admission requirements.

Additionally, students in the middle-high part of the distribution are increasingly likely to go to private non-SEP schools 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 is likely to be explained by changes in characteristics in the private SEP schools following the reform. If highly educated parents have preferences for peer quality, the changes in admissions by private SEP schools, admitting more vulnerable students, may have led high-SES parents to stop choosing private SEP schools and enroll instead in private subsidized non-SEP 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.

### 5.2 Segregation Measures

In this section, I define some 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 direction.

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.

Also, I compute disimilarity indices from 2005 and 2012 for disadvantaged students,

students with mothers of less than high-school education.

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

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.

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.

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-type students to opt out of the program, attracting more high-type 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.

### 5.3 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 3. 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 $m$.

$$\mathbb{1}(\underset{jm}{SEP\text{-}School}) = \alpha + \beta X_{jm} + \gamma Z_m + \varepsilon_{jm} \tag{3}$$

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 7.

## 6 School Admissions

In the context of Chile's voucher system, private subsidized schools comprise a heterogeneous group of entities, 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, because of the correlation between achievement and student types, they all have incentives to select students from more educated parents. 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. Yet. most of these schools do not charge any tuition [11].

Aditionally, schools are not allowed to test students on admission and they do not have any information about performance. Therefore, if schools are selecting students, discrimina-

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

tion has to be based on other indicators. One of the easiest being parental education, likely observed through parental interviews.

The SEP reform provides incentives for schools that participate in the program to admit more vulnerable students. The question is whether schools have the means to react given that they don't have any measure of student performance at the moment of admission.

As was introduced in Section 2, the admission process can be modeled as a threshold on the student type that a school is willing to admit. One issue is that these thresholds are unobserved. Using mother's education as a proxy for the student type [12], I show that it does behave as a threshold, and that private schools do, in fact, select students based on socioeconomic characteristics. To show this, I exploit the variation in incentives to schools that participate in the SEP program to lower their admissions threshold, as well as variation in the value of the voucher. Table 1 shows variation in the value of the voucher in the studied period.

First, I take the lowest 1% of mother's education in each school each year, as the 'observed' admissions threshold ($\theta^*_{jt}$), and look at changes in $\theta^*_{jt}$ when capacity increases (when a school adds another classroom) or when the value of the per-student subsidy increases.

I estimate equations 4 and 5 by OLS using school fixed effects, where $v_t$ is the value of the per-student subsidy in year t, and $C_{jt}$ is the number of classrooms at school j in year t.

$$\theta^*_{jt} = \alpha + \beta v_t + \gamma_j + \varepsilon_{jt} \tag{4}$$

$$\theta^*_{jt} = \alpha + \beta C_{jt} + \gamma_j + \varepsilon_{jt} \tag{5}$$

Panel A in Table 6 shows a significant drop in the cutoff values when a school adds a clasroom or when the voucher value increases. This means that when a school increases its capacity or when the voucher program gets more generous, schools are likely to increase its range for admission.

Second, I look at how the threshold changes when schools start participating in the SEP program. I estimate equation 6 by OLS using school fixed effects, and $\mathbb{1}(SEP\text{-}School)_{jt}$ as an indicator for whether school $j$ is participating in the SEP program in year $t$.

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

$$\theta^*_{jt} = \alpha + \beta \mathbb{1}(SEP\text{-}School)_{jt} + \gamma_j + \varepsilon_{jt} \tag{6}$$

Panel B in Table 6 shows the average within-school change in the observed threshold for private subsidized SEP schools, when the school starts participating in the SEP program. The first and second columns show the results for public schools and private subsidized schools, respectively. We see a large drop in a school's admissions threshold after the school enrolls in the reform for private subsidized schools. Yet, 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. To get at this issue, the third column estimates the drop in the threshold using just the sample of schools that did not charge any tuition before 2008. For these schools there is no price effect. 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. These results suggest that schools are effectively able to select students based on socioeconomic characteristics and that mother's education can usefully proxy for schools' selection process in admissions.

## 7 Demand Estimation

Section 5 established two main patterns of sorting following the SEP reform. (1) More low-SES students enrolled in private subsidized SEP schools instead of publics schools, and (2) more middle-SES students enrolled in private subsidized non-SEP schools instead of private SEP schools. Different demand and supply mechanisms could drive these sorting patterns: changes in schools selection policies resulting from the SEP incentives, changes in tuition from SEP requirements, changes in school characteristics, and peer composition that could drive parents to change their choice of school.

Then, in section 6 I show evidence of private schools' cream-skimming behavior in terms of socioeconomic characteristics, and how this behavior changed following the reform for the participating schools. 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 registers 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, because of the evidence shown in Section 6 about private school cream-skimming behavior, it is important to account for these admission restrictions to low-SES parents to properly recover preference parameters. That is, the choice set may be different for low-SES parents than for high-SES parents. Even if some schools are free, they might not admit some students based on their socioeconomics characteristics. The assumption in the literature that every school is available for every student is not innocuous and it biases the estimation of preferences.

Therefore, it is important to define the choice set of feasible schools for each student. If thresholds were observed, the choice set for each student would be easily defined. In this context, admission criteria in each school is unknown, and this could be different across schools. It has been long discussed in the literature and in politics, that private subsidized school select students using parental interviews.

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

In summary, students type $\theta_i$, is defined as their mothers' education, and 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 $j$, $\xi_{jt}$ is a year-school specific term that represents unobserved school quality. $\varepsilon_{ijt}$ represents an unobserved idiosyncratic preference of student $i$ for school $j$, distributed independently across schools and students.

$X_j$ includes 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.

If we assume that $\varepsilon_{ij}$ 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 $\theta_i$.

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

### 7.1 Estimation and Identification

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 $\theta_i$.

In $X_j$ I include 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 $\boldsymbol{\theta^*}$. 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. To recover the parameters from the utility function, I consider the maximum likelihood estimator assuming the observed vector of $\boldsymbol{\theta^*}$:

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

where

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

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

For the estimation I proceed in two steps. First I obtain $\alpha, \gamma$, and $\beta_0$ that maximize $L$, and following Berry (1994), I estimate $\delta_{jt}$ matching the observed market shares for each school to the estimated shares as a function of the parameters in each iteration. This way, $\delta_{jt}$ (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 $\alpha, \gamma, \beta_0$, and $\delta_j$ 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 $\xi_{jt}$. 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.

### 7.2 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. Table9 shows estimates for the heterogeneity parameters $\alpha, \gamma$, and $\beta_0$ 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).

## 8 Counterfactuals: 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. In both exercises I assume that schools cannot increase capacity beyond their maximum observed enrollment over the data period.

Simulating market outcomes in counterfactual experiments requires computing equilibrium admission thresholds. For this, an allocation mechanism has to be defined to obtain the new thresholds. In a first exercise, I assume a centralized admissions process to efectively eliminate all cream-skimming behavior from schools. To do this, I assume a random serial dictatorship mechanism for assignment. In a second exercise, I change preference parameters to eliminate preference for peer quality. In this case, to do the matching, school preferences over students would need to be known. I assume private subsidized schools maintain their admission policy of prefering higher types to lower types and allow admission thresholds

to adjust given the new preferences. Each school may rank students according to different criteria, but I assume they all rank them based on mother's education. This would generate new equilibrium thresholds.

Table 10 shows the average mother's education in private and public schools and the share of students going to public school in each exercise compared to the actual values in 2007 and 2012. Shutting down parental preferences for peers, increases enrollment in public schools by 8 percentage points on average compared to 2012, and the gap on average mother's education between public and private, decreasing significantly by more than 75%. On the other hand, eliminating school selection, decreases enrollment in public schools by 2 percentage points, and only reduces the gap in mother's education by 30% compared to 2012.

Figure 7 shows the probability of going to public and private subsidized, by type of student when there is a lottery for admissions. The probabilities for low and medium type students is equal for public and private, at around 50%. This is expected given the lottery. High-type students are still disproportionally more likely to go to private than to public, mostly because of prices.

Figure 8 shows the opposite pattern in the probabilities of going to public and private school, when there are no preferences for peer quality. In this case, high type students are as likely to go to public than to private, and low-type students being significantly more likely to go to public school.

## 9 Summary and Conclusions

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

My main results can be summarized in three points. First, I show that private subsidized schools effectively cream-skimmed students based on socioeconomic characteristics. Second, estimates for parents preferences differ when accounting for supply-side selection in admissions. Ignoring these restrictions leads to underestimates of preferences for school 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.

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

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

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

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

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

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

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

Table 3: Number of Schools by Type and Year

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

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

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

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

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

Table 5: 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 Income Students | 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) |
| Proportion 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 Income Students | 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) |
| Proportion 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 | Private Subs. Schools | All Schools |
| Voucher Value | 0.158 | -1.353*** | |
| | (0.099) | (0.104) | |
| Number of Classes | | | -0.368*** |
| | | | (0.038) |
| Constant | 2.281*** | 9.047*** | 6.069*** |
| | (0.225) | (0.239) | (0.064) |
| School FE | X | X | X |
| R-squared | 0.273 | 0.541 | 0.742 |
| N | 13317 | 17474 | 33833 |

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 ($\delta_{jt}$) | | |
|---|---|---|
| | 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 on Preferences by Income and Mother's Education

Panel A: Heterogeneity Coefficients

| | $< 8$ 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) |

Panel B: 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 |

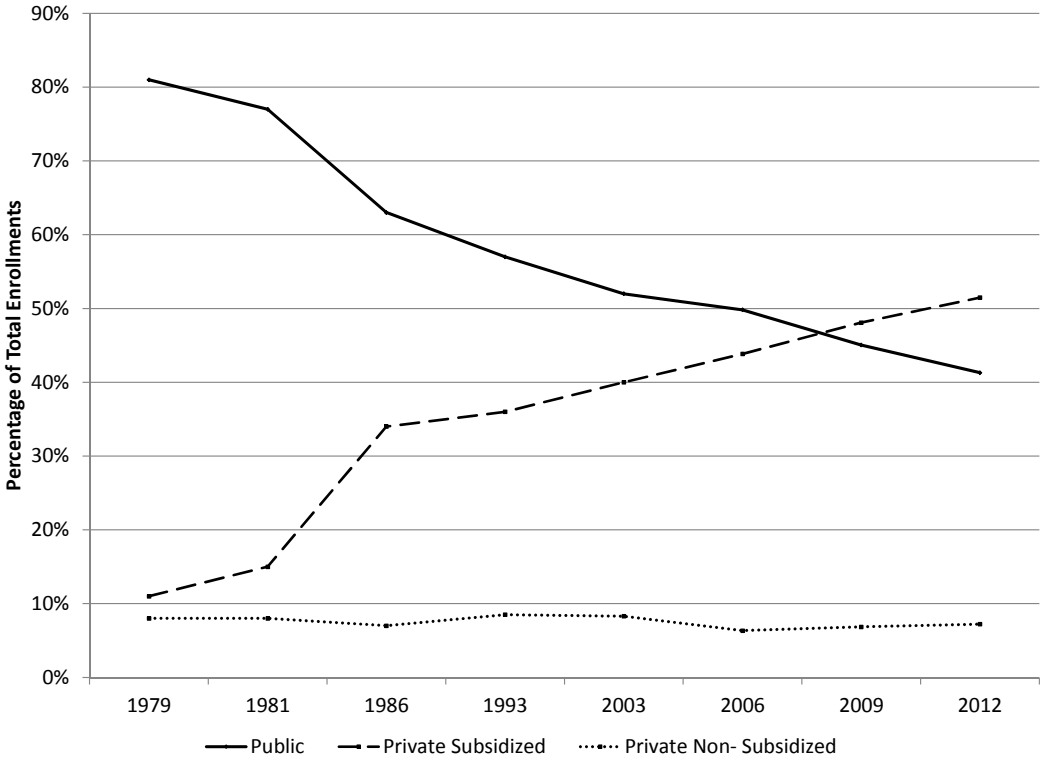
Note: Panel A presents average heterogeneity coefficients across markets weighted by market size. The model allows for heterogeneity in preferences depending on income and mother's education. Income is measured as a continues variable and mother's education as an indicator for being in one of four groups. 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. Panel B 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 10: Counterfactual Comparisons

| | Actual 2007 | Actual 2012 | Lottery for School Selection | No Pref. for Peer Quality |
|---|---|---|---|---|
| Avg M.Ed Private | 0.393 | 0.372 | 0.303 | 0.219 |
| Avg M.Ed Public | 0.335 | -0.203 | -0.073 | 0.096 |
| Share Public Schools | 0.521 | 0.395 | 0.379 | 0.475 |

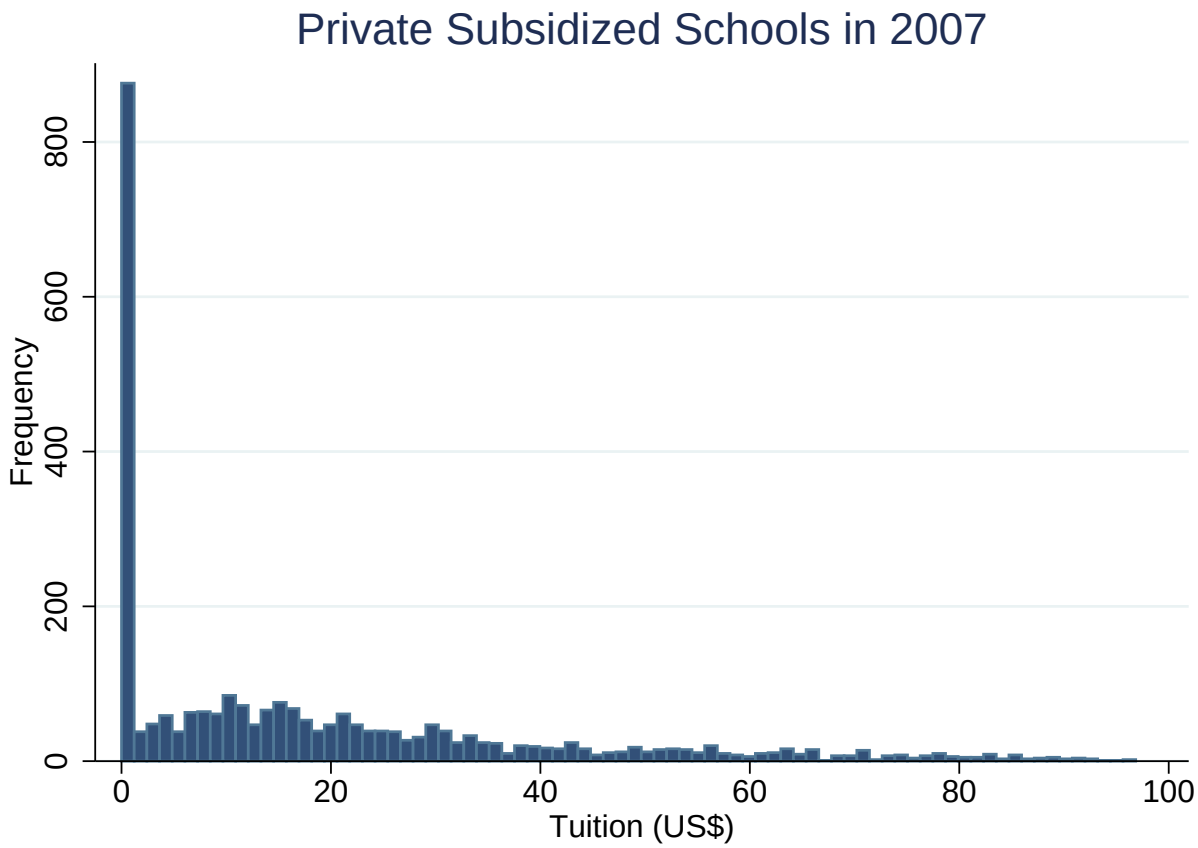
Note: This table presents simulation results assuming two different scenarios: first, that parents have no preference for peers and assuming no cream-skimming. It shows averages across markets for the share of students going to public school and the average mother's education of students in public schools and private subsidized schools.

Figure 1: Changes in Enrollment by Type of School



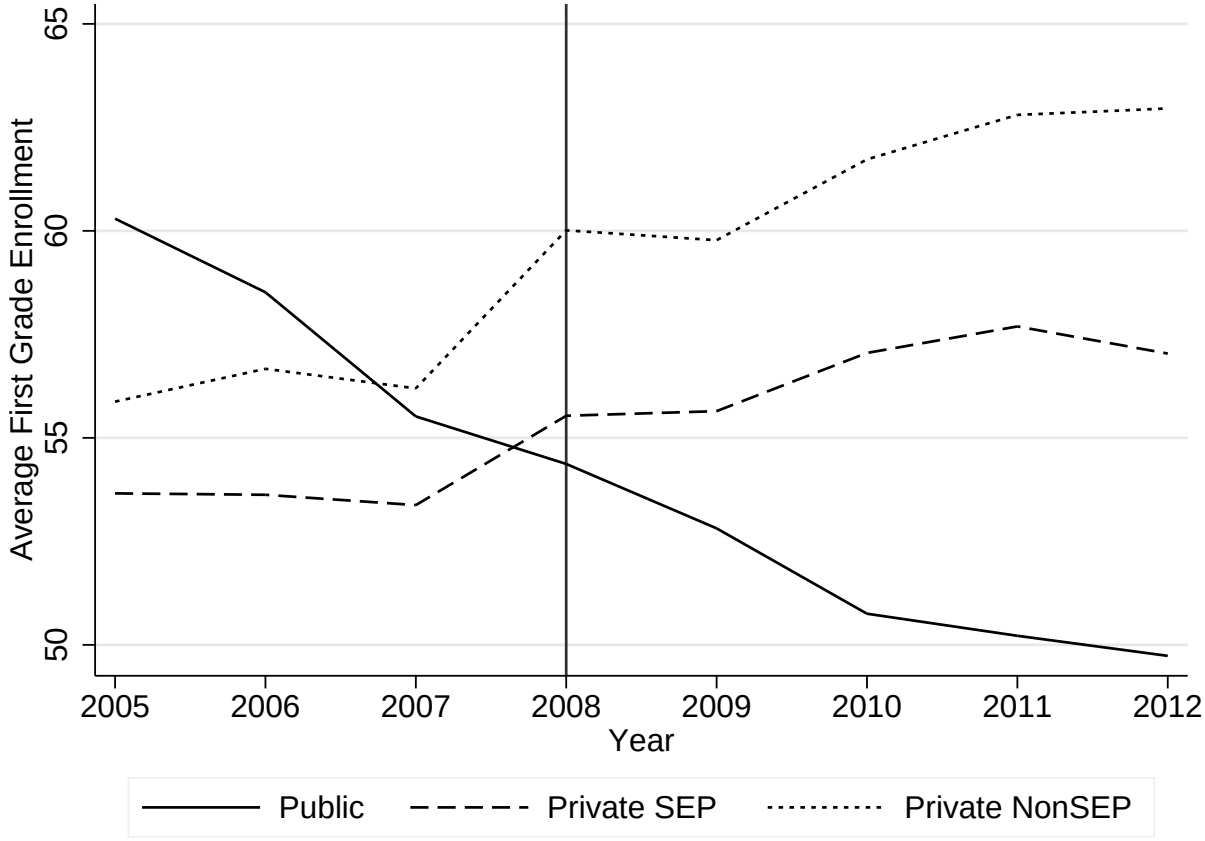

Note: This figure shows the evolution on the share of students that is enrolled in each type of school from the beginning of the voucher system in Chile.

Figure 2: Distribution of Average Tuition in 2007



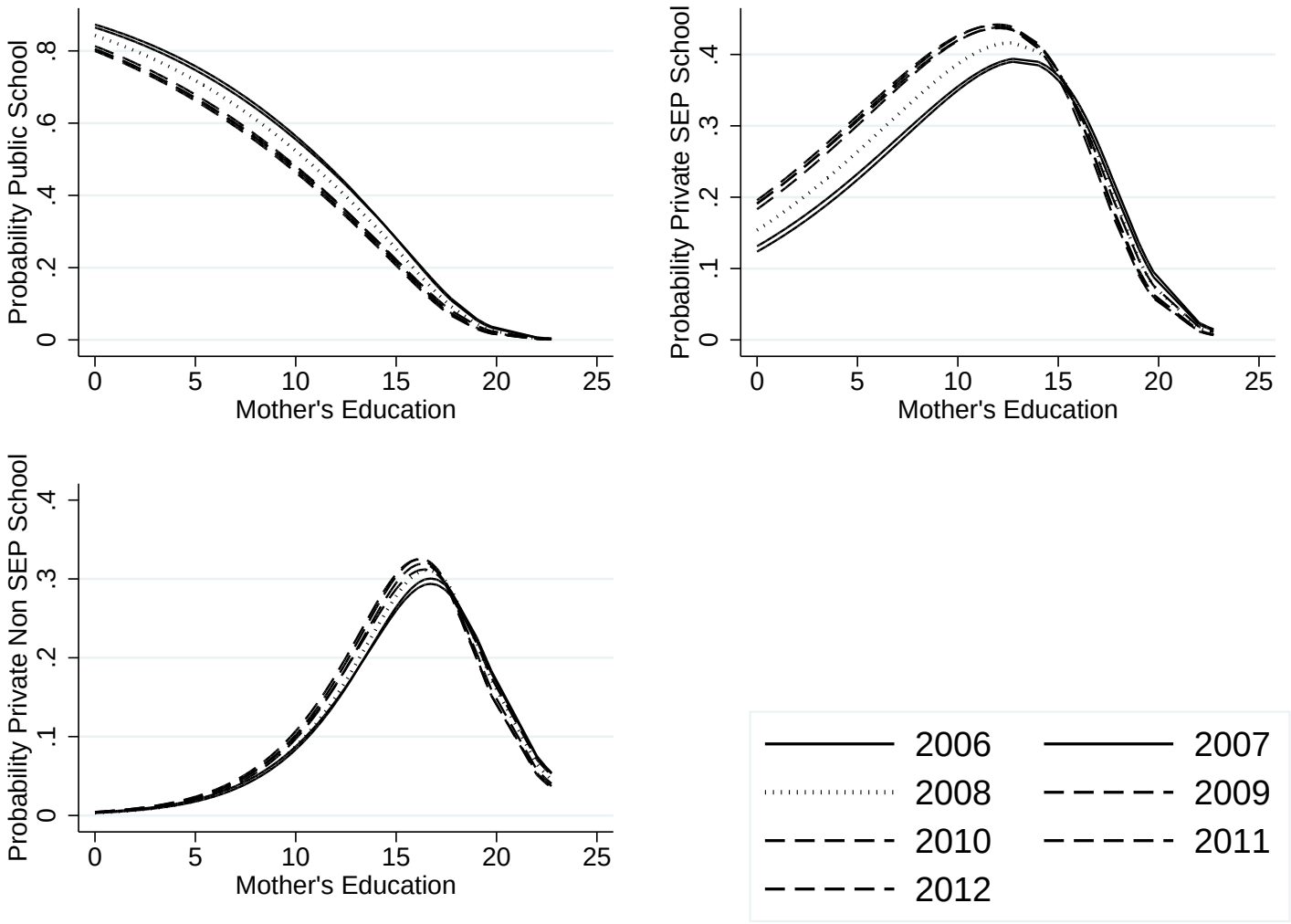

Note: This figure shows the distribution of average tuition charged by private subsidized schools in US$ in 2007, before the program started. More than half of the schools did not charge any tuition.

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



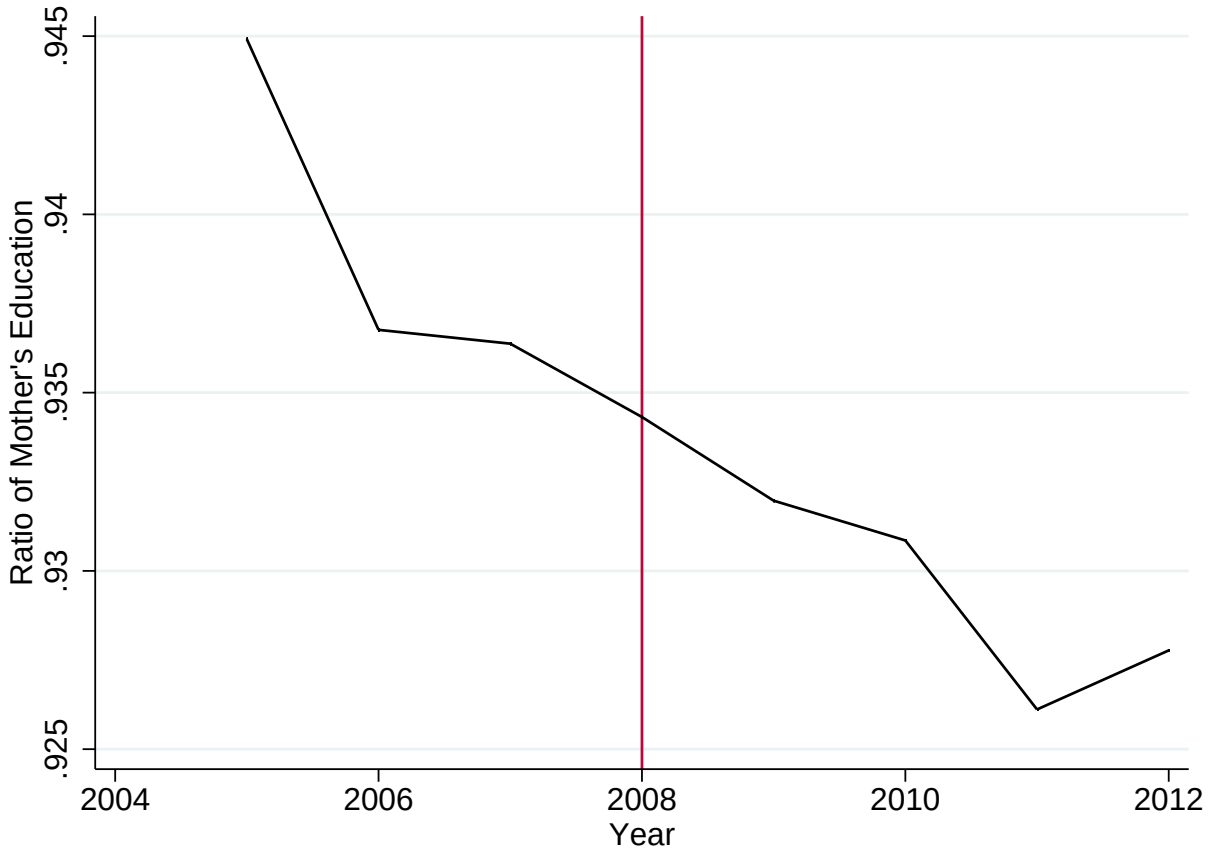

Note: This figure shows changes in average first grade enrollment within schools. It shows coefficients from a regression of enrollment on year and school fixed effects.

Figure 4: Probabilities of Enrollment by Type of School



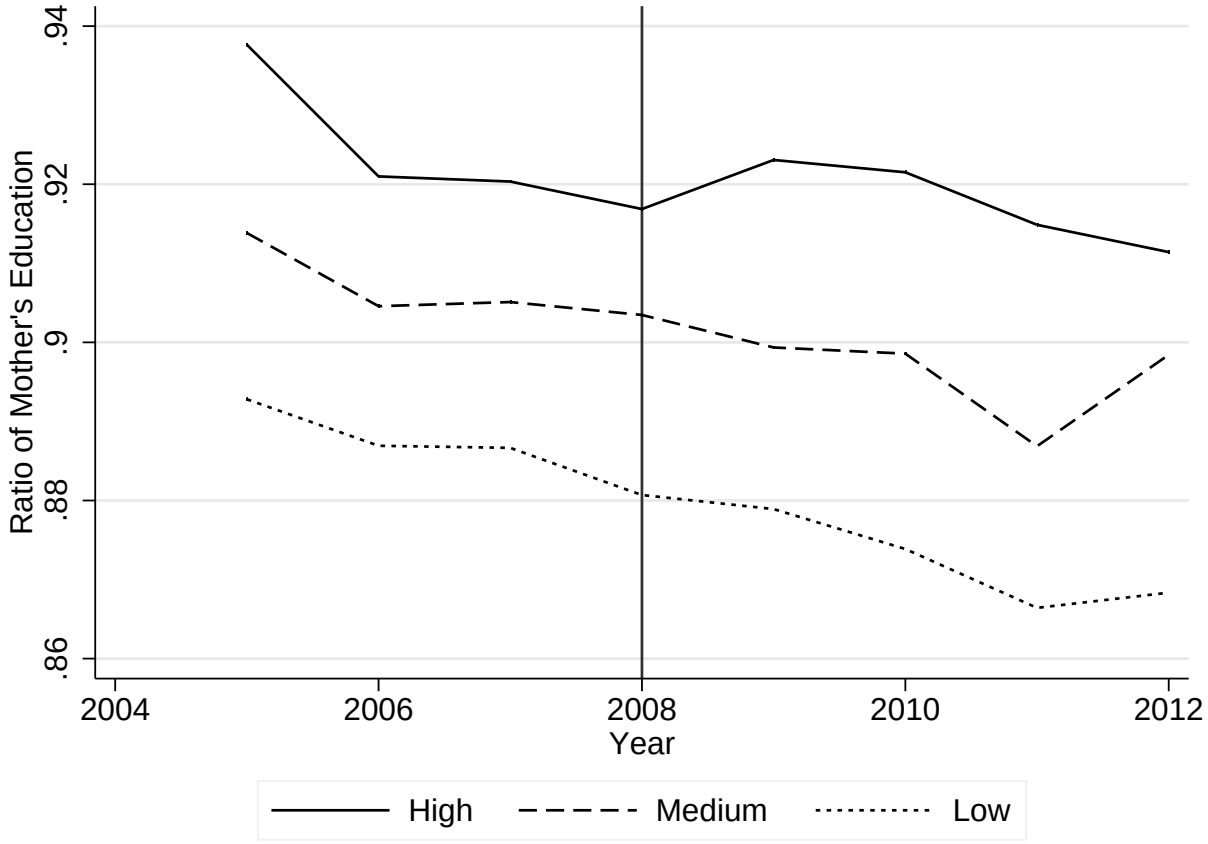

Note: Each graph shows the probabilities for each level of mother's education of enrolling in different type of school each year. The probabilities are calculated based on the coefficients from a multinomial logit model where a student has the option of enrolling in four types of schools: public, private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



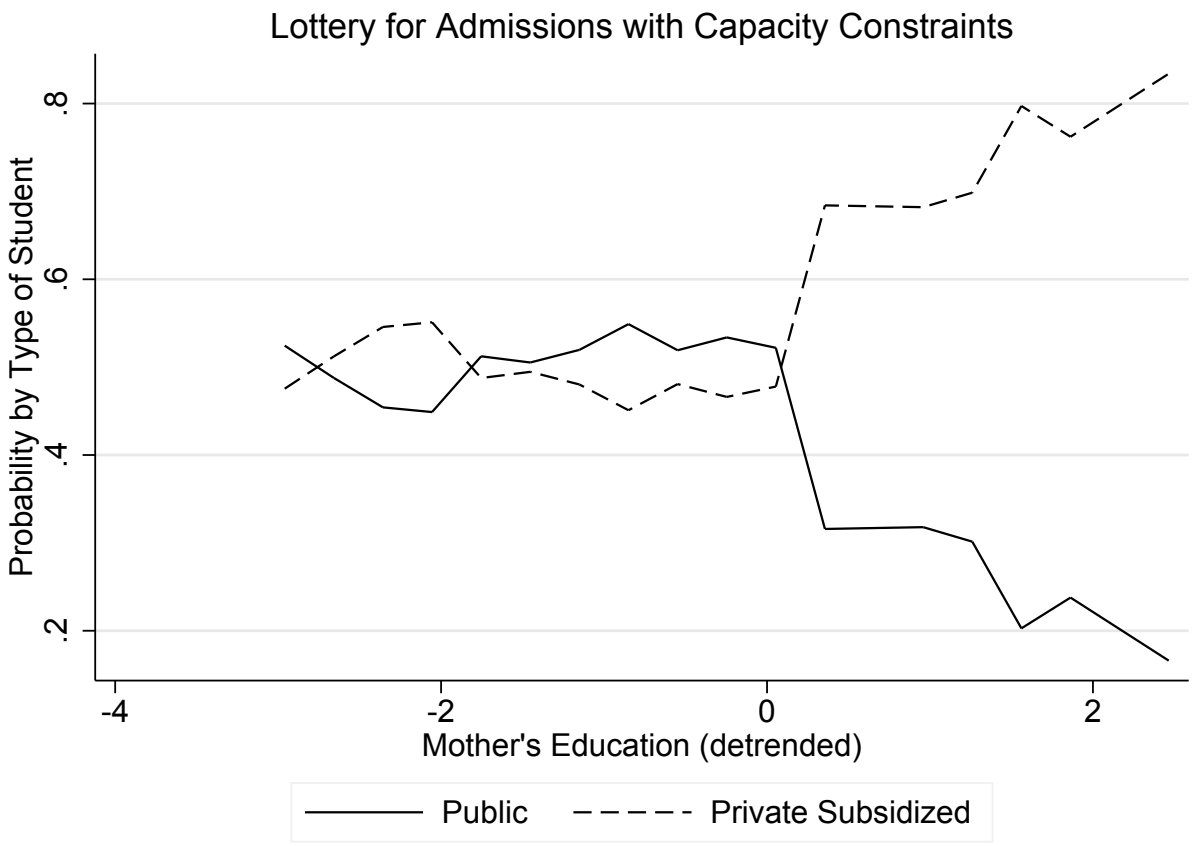

Note: This figure shows average within market changes in the integration measure. The ratio is constructed as the average student type in public schools over the average student type in the market where the public schools operate. Higher values mean more integrated markets where public schools have a 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



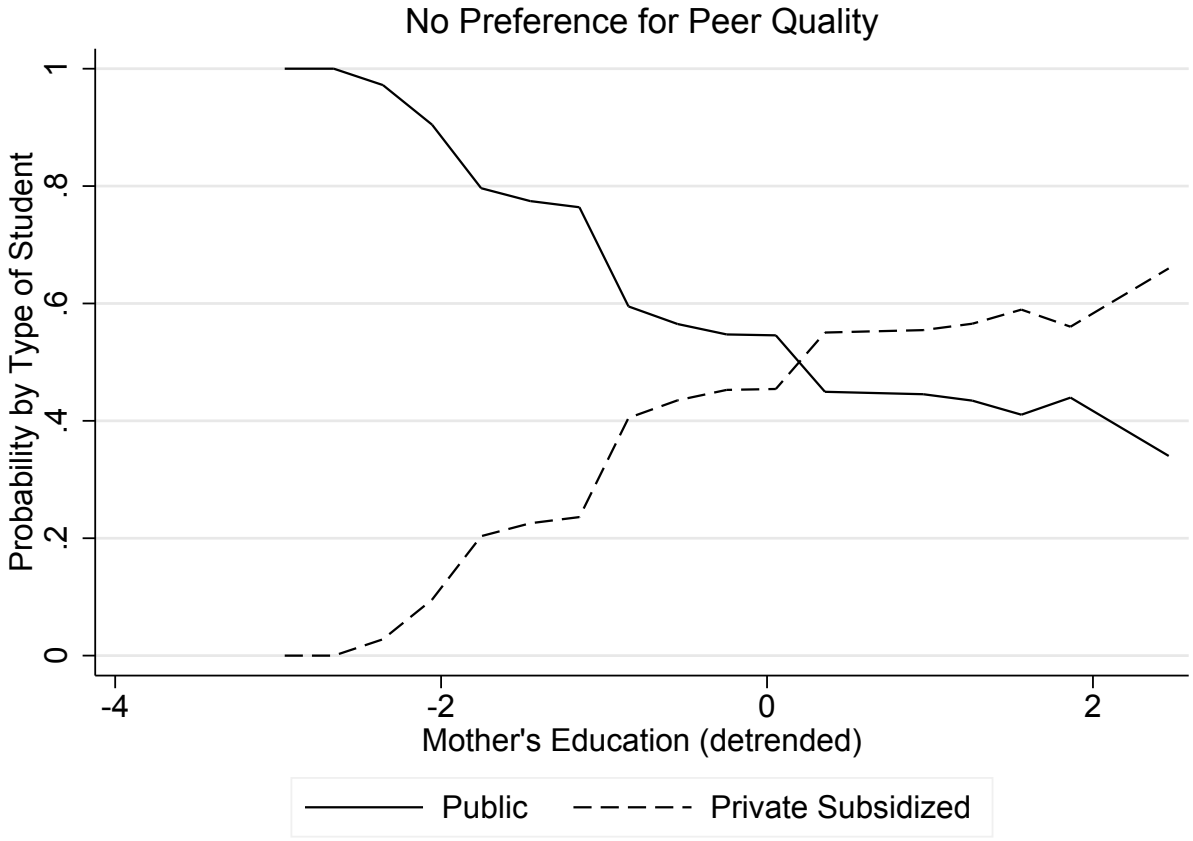

Note: This figure shows average changes in the ratio of mother's education within market for three groups of markets depending on the level of concentration. Concentration in each market was calculated as the Herfindahl Index, which is equal to the sum of the squares of the shares of each school in the 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: Counterfactual-No Cream-Skimming




Note: This figure shows average probability of attending public or private subsidized schools when no selection from private schools is allowed. I assume a lottery for admissions, with a random serial dictatorship allocation mechanism. I assume that school capacities cannot increse beyond the maximum observed enrollment during this time period.

Figure 8: Counterfactual-No Preferences for Peers




Note: This figure shows average probability of attending public or private subsidized schools when preferences for peer quality is shut down. I assume schools still prefer high type to low types and allow thresholds to adjust. I assume that school capacities cannot increse beyond the maximum observed enrollment during this time period.

Table A1: 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 |

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

Table A1: Continuation - Municipalities by Market

| 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.