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TARGETED VOUCHERS, COMPETITION AMONG SCHOOLS, AND THE ACADEMIC ACHIEVEMENT OF POOR STUDENTS

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Abstract

I develop an empirical model of demand and supply with imperfect competition to study the primary school market in Chile. I use this framework to study how voucher policy affects competitive incentives and the equilibrium allocation of school quality. I estimate my model using administrative data, leveraging variation from a policy change that eliminated out-of-pocket fees for approximately 40% of students. The model indicates that schools can increase prices above marginal cost and mark down quality below the perfectly competitive benchmark. Schools in poorer neighborhoods have more local market power and this contributes to inequality in access across socioeconomic groups. I find that a voucher system that provides more resources for poor students would reduce schools' market power and increase school quality. Using the observed policy change, I show that competition increased in the poorest neighborhoods and consequently reduced the inequality of academic achievement.

Keywords: School Choice, School Competition, Targeted Vouchers.

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1. INTRODUCTION

It has been debated whether school choice and competition will be the tide that lifts all boats or whether they will lead to segregation and worse outcomes for the poor.[1] This literature has centered on whether competition betweeen public and private schools can improve outcomes relative to a benchmark of exclusive public provision and limited school choice. However, in many developing countries the private for-profit sector plays a large role in the provision of education services (Baum et al. 2014). These education markets are sparsely regulated, and there is limited public provision since the state fails to adequately provide education. In this context, the relevant policy question is how to make education markets more efficient and equitable, conditional on private provision and limited state capacity. There has been very little research on how governments can incentivize private schools to improve quality and promote more equitable outcomes.

In this paper I address this important public policy question by studying the industrial organization of education markets and explicitly considering the equilibrium supply side response to government policy. I start by developing an empirical model of consumer demand and supply with imperfect competition among schools. I use my model to study how government policy can influence market competition and the distribution of school quality and prices. Specifically, I use my framework to compare flat and targeted voucher policies. I examine how each policy affects schools' market power and the equilibrium distribution of school quality.

On the supply side, the model of school profit maximization highlights the tradeoffs schools make when they choose quality and price, and how these tradeoffs change in response to voucher policy. I can rearrange schools' first order conditions to show how much they will mark down quality as a function of local market power. Local market power crucially depends on how differentiated schools are in terms of prices, distance and quality. It also depends on how sensitive families are to changes in school quality.

[1]See several excellent review papers such as Neal (2002); Hoxby (2007); Rouse and Barrow (2009); Urquiola (2016); Epple, Romano, and Urquiola (2017).

In my model, consumers have heterogeneous preferences over spatially differentiated schools, as in Hastings, Kane, and Staiger (2009). Departing from most of the school choice literature, I include school-level unobservable demand shifter and I implement an empirical strategy that deals with concerns related to the endogeneity of price and quality in this context (Berry and Haile, 2016).

I estimate the model using administrative data on all schools and students in Chile, a country with a large for-profit private education sector. Since 1981 schools in Chile have received a fixed government transfer for each student enrolled. Private schools could also charge an out-of-pocket fee in addition to the goverment transfer. I call this system a “flat voucher policy” with out-of-pocket fees. In 2008, a policy change eliminated out-of-pocket fees for many of the poorest students and signficantly increased transfers to schools. I call this system the “targeted voucher policy”. This policy change provides variation in prices and allows me to create instruments for estimating demand parameters. Additionally, I use the observed new equilibrium to test the model’s predictions and confirm that these match how schools actually responded to the new policy.

My first main result is that schools have significant local market power, and this market power contributes to inequality across socioeconomic groups. Demand estimates indicate that preferences for prices, distance and quality are heterogeneous. In particular, poor households are more sensitive to price and distance. Given the distribution of preferences and households across city blocks, schools in poor neighborhoods have more local market power. With a flat voucher policy, this market power allows for-profit schools in poor neighborhoods to mark down their quality more than schools in more affluent areas. Standard consumer demand heterogeneity and product differentiation lead to significant inequality in the provision of school quality across socioeconomic groups. This inequality is entirely due to differences in competitive pressure and not due to any frictions specific to education markets.

My second result is that a targeted voucher policy increases incentives for schools to compete, and a targeted policy can reduce inequality. My model predicts that moving to a targeted voucher has two direct effects on the incentives for schools to provide quality. First, the targeted voucher reduces market power by eliminating out-of-pocket fees and reducing differentiation due to prices. Second, the targeted policy implemented in Chile increases the marginal revenue from enrolling poor students, raising the optimal quality each school chooses for a given level of market power. Both of these effects are largest in neighborhoods with more eligible students. When all schools have adjusted their prices and quality, more competition can lead to additional equilibrium effects on quality and prices. My demand estimates allow for a detailed analysis of the change in incentives and the drivers of market power on impact, before equilibrium adjustments take place.

The voucher policy change in Chile provides a unique opportunity for evaluating the empirical relevance of my framework. I observe the equilibrium effects of the policy in the data, so it is not necessary to calculate a counterfactual equilibrium under the new policy. I use this observed equilibrium to test the predictions of my model, namely that quality should go up, that inequality should go down, and that schools in more exposed neighborhoods should display larger changes relative to the previous equilibrium under a flat voucher. Empirically, I categorize schools according to the fraction of students living near that school who are eligible for the targeted voucher and assume that this is a measure of exposure to the policy. I then conduct a difference-in-differences analysis of the value added at the school level, comparing across exposure groups. Finally I use data on school-level transfers to study whether the within school variation in resources and exposure to competition are associated with increased quality.

My third result is that, consistent with the model's predictions, increased exposure to the policy is associated with increased school quality. I find similar results for other proxies of school quality. Schools in poor neighborhoods were less likely to be fined for noncompliance to minimal quality standards and had a higher chance of winning a prize for academic excellence (SNED) after the policy change. Prices decrease after the policy change, indicating that competition leads schools to price more aggressively despite increasing their quality and facing a less price-sensitive demand.

These findings are important for several reasons. First, they emphasize that it is important to consider the equilibrium supply side response when studying policy changes in education markets.[2] In this setting, the supply side response can account for the majority of the observed aggregate policy effect. In addition, my framework indicates that comparing student-level outcomes for beneficiaries and non-beneficiaries of the program will fail to appropriately capture the equilibrium effects of the policy.

My analysis also provides specific guidance regarding the design of voucher policy. It suggests that providing targeted vouchers for the poorest students can improve academic achievement and reduce inequality relative to a benchmark of flat vouchers and out-of-pocket fees. Prior work has emphasized that a targeted voucher can help disadvantaged students make the most of a market-oriented education system by expanding access to better schools.[3] This paper shows that in addition to broadening choice, targeted voucher policies can improve equity by increasing competition in neighborhoods where incentives to invest in quality are weakest.

More broadly, I show how modeling supply and demand and using empirical industrial organization tools can be useful for quantitatively studying policy changes in education markets. My framework highlights how the details of the regulatory environment matter for the incentives schools face, and how these details impact the resulting equilibrium. The fact that the model can rationalize the observed changes in school behavior after the policy changed suggests that my empirical framework can be used to conduct ex-ante evaluation of proposed policies in education markets in developing countries.

It is important to note that in the setting I study in this paper I observe the resulting equilibrium under two different voucher policy regimes. I restrict the analysis and

[2]This idea is consistent with recent experimental evidence from education markets such as Muralidharan and Sundararaman (2015); Andrabi, Das, and Khwaja (2017); Andrabi, Das, Khwaja, Ozyurt, and Singh (2018). This supply side response is also emphasized by Hoxby (2000, 2003); Card, Dooley, and Payne (2010); Figlio and Hart (2014).

[3]See Nechyba (2000); Epple and Romano (2008); Bettinger (2011). Early evidence on the positive effects of vouchers leading students to attend different schools includes Rouse (1998) in the U.S. and Angrist, Bettinger, Bloom, King, and Kremer (2002) show evidence in Colombia.

modeling framework to focus on the most salient aspect observed after the change in policy: the broad increase in achievement among the poorest students without a large change in sorting. This focus allows me to ignore potentially important education-specific market frictions such as selection, cream-skimming, peer effects and asymmetric information. While I argue that these are less relevant in this particular application, to tackle a broader set of policy questions and counterfactuals with this framework, future work will need to expand the model in these and other dimensions.[4]

2. THE MARKET FOR PRIMARY EDUCATION IN CHILE

Many developing countries have urban education markets characterized by a significant share of private for-profit providers.[5] Chile has subsidized the private provision of educational services in both primary and secondary schools for almost 40 years.[6] The market for educational services in Chile is characterized by three types of providers: public schools owned and managed by the local municipality (public), privately owned and managed schools that are subsidized by the state (private voucher), and privately owned and managed unsubsidized schools (private non-voucher). Over time, the market share of private voucher schools has risen steadily, and in 2007 68% of students in urban markets attended private voucher schools, 25% public schools, and 7% private non-voucher schools.

[4]There is a growing literature studying education markets. The lack of information and the effects of disclosure policy on equilibrium outcomes is one policy-relevant line of research (see Mizala and Urquiola (2013); Andrabi, Das, and Khwaja (2017); Allende, Gallego, and Neilson (2019)). Gallego and Sapelli (2007); Singleton (2017) have studied cost heterogeneity and the consequences for policy. Advancing toward equilibrium analysis of policies is challenging but an important next step. Dinerstein, Smith, et al. (2014) studies the equilibrium response of private schools to increased public school funding. Sánchez (2018) presents important work on incorporating the extensive margin of supply side participation into voucher policy. Both these papers include the supply side response to education policy. Another important dimension is allowing a role for social interactions in demand and the production function, and seeing how these interactions affect equilibrium considerations in policy counterfactuals (see Allende (2020)).

[5]See Baum, Lewis, Patrinos, and Lusk-Stover (2014) and a discussion in The Economist Magazine titled "The $1-a-week school", published in 2015.

[6]The interested reader is directed to excellent reviews of the initial Chilean voucher reform such as Gauri (1999), de Moura Castro and Espinola (1999) and Beyer, Larraín, and Vergara (2000). Of particular interest is Prieto (1983), which is authored by the minister of education who designed the initial voucher policy, and provides a clear description of the context and arguments that motivated the reforms.

Public and private voucher schools receive a flat subsidy per student depending on the grade level (∼US$1000 in 2007 for first grade). There are several additional vouchers that are based on the geographic location of the school or whether the student has special needs. In the early 1990s, in an effort to increase overall investment in education, private voucher schools were allowed to charge out-of-pocket fees in addition to the flat government voucher. In 2007, 30% of private voucher schools had no out-of-pocket fee, 48% charged less than US$500, and only 6% had fees over US$1000.

From 1990 until 2007, the basic features of the voucher program did not change, but public spending per student increased by 320% in real terms (8.8% annually). In addition, the government made significant efforts to help the most vulnerable schools by investing in infrastructure and materials with targeted programs like the *Programa MECE* and *P-900*, but there is little evidence that these programs raised academic achievement or reduced inequality (Chay, McEwan, and Urquiola, 2005).

The per capita annual government transfer to an average urban school in 2007 was just under US$1000, and the baseline voucher accounted for over 80% of this transfer. Including additional out-of-pocket fees, per capita revenue among private voucher schools was heterogeneous and often much higher, ranging from US$970 to over US$2200. Schools with the highest out-of-pocket fees tended to have students from higher socioeconomic background, students with higher average standardized test scores, and better paid and more qualified teachers (see (Calle, Gallegos, and Neilson, 2019)).

While the introduction of out-of-pocket fees was motivated as a way to increase the investment in education, research has suggested it also has contributed to increased segregation and widened the gap in achievement between rich and poor students.[7]

In 2008, the *Ley de Subvención Escolar Preferencial* (SEP), *Ley 20.248* established a new voucher for the poorest students. This additional voucher eliminated out-of-pocket fees for poorer students and compensated schools by transferring significantly more resources for each eligible student (∼US$ 500 in 2008). The SEP policy was motivated by the notion that a targeted voucher would remove out-of-pocket fees as a barrier for poor students

[7]See for example Hsieh and Urquiola (2006); Anand, Mizala, and Repetto (2009).

(Gallego and Sapelli, 2007). This targeted voucher was seen as a way to help poor students benefit from a market-oriented school system by expanding choice (Nechyba, 2000; Epple and Romano, 2008).

The program was available to approximately the poorest 40% of the population. SEP eligibility was determined in several ways, but the two most common were for the student to be accredited as belonging to the lowest 33% of the income distribution according to the government's ranking of socioeconomic status called *Ficha de Proteccion Social* (FPS) or to belong to the social program for poor families called *Chile Solidario*. These two criteria accounted for 85% of all participants in the SEP program in 2010.

The program is available at all public schools and private voucher schools that signed up. Schools joined the policy in large numbers. By 2011, 85% of schools receiving vouchers had been accredited to participate, including virtually all public schools and two-thirds of private voucher schools.

There are two aspects of the SEP voucher policy that are important to clarify. First, eligible students pay no out-of-pocket fees at participating private voucher schools. Second, schools receive the base voucher and an additional SEP voucher regardless of what the school charges other students. From the schools' perspective, eligible students previously generated income for the school from the baseline flat voucher (US$1000) and their out-of-pocket payment (between US$0 and US$1900). After 2008, these students trigger the additional SEP voucher subsidy so that the school receives a larger subsidy from the government but can not charge students the out-of-pocket fee.[8]

The policy also included measures to increase support and accountability at participating schools (González, Mizala, and Romaguera, 2002). These measures included regulations requiring participating schools to provide a written plan regarding how they would use the additional funds and asked them to set goals for themselves. In theory, the regulator would provide guidance and support to implement these plans as well as threaten to remove a school's SEP funding if they did not meet their goals. It is impossible to know

[8]The same law also introduced an additional subsidy per student for schools that had a high percentage of poor students (over 60%) called the *Subvención por Concentración* (SC). It was much smaller (US$100) than the SEP voucher.

how school administrators actually perceived this increased regulatory pressure when the policy began and whether these aspects played an important role. In practice, virtually no schools were sanctioned for not meeting goals, and the government did not invest in the regulatory capacity necessary to implement the stated accountability policies until the passing of the *Ley General de Educación (LGE), Ley 20.370*.[9] In 2011, the SEP subsidy was further increased by 21%. Additional regulatory changes were implemented in the following years including the creation of the *Agencia de Calidad*, an agency in charge of regulating and monitoring school quality.

3. AN EMPIRICAL MODEL OF SCHOOL CHOICE AND COMPETITION

In this section I develop an empirical model of demand and supply in the primary education market that explicitly incorporates voucher policy. On the supply side, my objective is to characterize how spatially differentiated for-profit schools choose price and quality under different voucher policy regimes. On the demand side, my goal is to characterize how families trade off school distance, school quality, out-of-pocket fees and other school attributes when selecting which school to attend. The challenge is to do this within a flexible model that can capture substitution patterns and accurately describe how families make choices while retaining tractability for the empirical application.

3.1. *Demand*

A family is indexed by i and characterized by their income level (low, not low) and the mother's education (less than high school, high school, or more than high school). These two variables define six discrete types of families where $k \in \{1, 2, ..., 6\}$. Each family is located at one of the discrete locations $\text{loc}(i) \in L^m$ within a market m. I model the utility for family i from sending their child to school j as a linear function of the school's observable and unobservable characteristics. The observable characteristics

[9] Muñoz, Irarrázaval, Keim, Gaete, Jiménez, and Quezada (2020) interviews policy makers involved in implementing the SEP policy and reviews a decade of the SEP policy. They conclude that due to the limited investment in regulatory capacity, many of the auxiliary aspects of the policy related to support and accountability were not implemented.

include quality q_j, which is a measure of how much the school increases students' test scores. Distance from a family i to the school j is given by $d_{\text{loc}(i),j}$ and is another dimension that differentiates schools across families within a market. Out-of-pocket fees $op_{k(i),j}$ represent what family i has to pay at school j given the current voucher policy and their type k. Other observable school characteristics include whether the school is religious, for-profit, and whether it has been in operation since 1995 (as a proxy for reputation). To capture additional unobserved reasons families may systematically prefer school j, I model a common preference for a school-specific index ξ_j.

I allow preferences over school characteristics $\left\{op_{k(i),j}, q_j, d_{\text{loc}(i),j}\right\}$ to be heterogeneous across observable family types k. Preferences for quality are also heterogeneous across an unobserved family characteristic ν_i. Families have random iid preference shocks for schools, $\epsilon_{i,j}$.

A family i's utility derived from school j is

$$U_{i,j} = \bar{\beta} x_j + \xi_j + \beta_i q_j - \alpha_i \text{op}_{k(i),j} + \lambda_i d_{\text{loc}(i),j} + \epsilon_{i,j}. \tag{1}$$

The heterogeneity of preferences is given by $\beta_i = \sum_{k=1}^{K} \mathbb{1}(k(i) = k)\beta_k + \beta^u \nu_i$ for quality, $\alpha_i = \sum_{k=1}^{K} \mathbb{1}(k(i) = k)\alpha_k$ for price, and $\lambda_i = \sum_{k=1}^{K} \mathbb{1}(k(i) = k)\lambda_k$ for distance. I assume that the distribution of unobservable preferences ν_i is normal with a zero mean and a variance of σ^2 so that $\nu_i \sim N(0, \sigma)$. I also assume that the distribution of random preference shocks $\epsilon_{i,j}$ has an extreme-value distribution.

Families choose the school with the highest $U_{i,j}$ out of the F^m schools in their market m.[10] Note that there is no outside option, so I choose one school to be the reference for each market and normalize $\xi_{1,m} = 0$ without loss of generality. The share of families of

[10] This assumption requires all schools in the market to be available for the student. This rules out capacity constraints and selection by schools. I argue later in subsection 3.3 that this assumption is reasonable in a developing country education market characterized by private for-profit schools.

type k who live at location loc who will select school j is

$$s_{j,k}^{\text{loc}}(\mathbf{q}, \mathbf{op}) = \int\limits_{\nu} \left(\frac{\exp\left(\bar{\beta} x_j + \xi_j + \beta_k q_j - \alpha_k \text{op}_{j,k} + \lambda_k d_{\text{loc},j} + q_j \nu\right)}{\sum_{\ell=1}^{F^m} \exp\left(\bar{\beta} x_\ell + \xi_\ell + \beta_k q_\ell - \alpha_k \text{op}_{\ell,k} + \lambda_k d_{\text{loc},\ell} + q_\ell \nu\right)} \right) d\nu, \tag{2}$$

where $\mathbf{q}$ represents a vector of length F^m of school quality and $\mathbf{op}$ is a matrix of size $F^m \times K$ representing the resulting out-of-pocket price for each type k given sticker prices and voucher policy.

I calculate the total demand for a school by aggregating across the demand from students of each type k who live at any of the discrete set of L^m locations within the market. The distribution of where the students of type k live is given by the vector w_k^{loc} so that $\sum_{\text{loc}}^{L^m} w_k^{\text{loc}} = 1$, while the total proportion of the students in the market who are of type k is given by Π_k^m so that $\sum_k \Pi_k^m = 1$.

The total market share of students of type k that attend school j is $s_{j,k}$, and the total market share of a given school j is s_j, which is given by the following expression:

$$s_j(\mathbf{q}, \mathbf{op}) = \sum_{k}^{K} \Pi_k^m \sum_{\text{loc}}^{L^m} w_k^{\text{loc}} s_{j,k}^{\text{loc}}(\mathbf{q}, \mathbf{op}). \tag{3}$$

I characterize the average school quality that a group of students attends as

$$\overline{q}^{\text{type}}(\mathbf{q}, \mathbf{op}) = \sum_{j}^{F^m} q_j \cdot s_{j,k}(\mathbf{q}, \mathbf{op}) = \sum_{j}^{F^m} \sum_{\text{loc}}^{L^m} q_j \cdot s_{j,k}^{\text{loc}}(\mathbf{q}, \mathbf{op}) \cdot w_k^{\text{loc}}. \tag{4}$$

I group students by whether they are poor and eligible for the SEP policy, so I can write $k = \mathrm{E}$ for all k that are eligible ($k \in 1, 3, 5$) and $k = \not\mathrm{E}$ for all k that are not eligible ($k \in 2, 4, 6$). Using these groups I can define the gap in school quality across poor and non-poor students as $\Delta\overline{q}^{\not\mathrm{E},\mathrm{E}} = \overline{q}^{\not\mathrm{E}} - \overline{q}^{\mathrm{E}}$ as follows:

$$\Delta\overline{q}^{\not\mathrm{E},\mathrm{E}} = \overline{q}^{\not\mathrm{E}} - \overline{q}^{\mathrm{E}} = \sum_{j}^{F^m} q_j \cdot s_{j,\not\mathrm{E}}(\mathbf{q}, \mathbf{op}) - \sum_{j}^{F^m} q_j \cdot s_{j,\mathrm{E}}(\mathbf{q}, \mathbf{op}) = \sum_{j}^{F^m} q_j \cdot \left[s_{j,\not\mathrm{E}}(\mathbf{q}, \mathbf{op}) - s_{j,\mathrm{E}}(\mathbf{q}, \mathbf{op}) \right]. \tag{5}$$

3.2. *Supply*

I now develop an empirical framework to model the conduct of for-profit schools. The first objective is to derive the optimal equilibrium behavior of schools under a flat voucher policy. I show how market power stems from heterogeneous preferences and product differentiation, and how it can contribute to disparity in access to school quality across social groups. The second objective is to show how incentives and optimal behavior change as a function of voucher policy, specifically contrasting a flat voucher policy with a targeted voucher policy.

I begin by assuming that privately owned and administered for-profit schools choose prices and the quality they provide to maximize profit. The school chooses a sticker price p_j and a quality q_j, which represents the school's ability to increase students' test scores. School j has a fixed cost F_j and, after choosing a quality level q_j, has a marginal cost given by $\text{MgC}(q_j)$.

Government voucher policy affects the school's decisions in two ways. First, it changes the marginal revenue a school gets for each student. It also modifies the demand for each school by changing the out-of-pocket expense that families incur by enrolling at an eligible school. I define voucher policy with two functions. The first function maps the school's chosen price p_j and the student type k to a marginal revenue for the school. The second function maps the price chosen by the school and the type of student to an out-of-pocket cost for families.

When the voucher policy is given by a simple flat voucher, the marginal revenue per student is $v_b^m + p_j$ and the out-of-pocket fee is $\text{op}_{j,k} = p_j$, where v_b^m is the base voucher per student in market m and p_j is the out-of-pocket fee. In this case, the school gets a marginal revenue of $v_b^m + p_j$ for each student independent of their type k, and each student has to pay p_j independent of their type.[11]

[11] In Chile the voucher policy was initially a flat voucher that was the same for all students at the school regardless of type. However it was progressive in the sense that the baseline subsidy v_b^m is reduced as out-of-pocket fees rise based on a step function with four broad fee categories. For simplicity, I assume schools with positive prices are on an interior part of the subsidy step function so that $\frac{\partial v_b^m}{\partial p_j} = 0$. I ignore this aspect of the pricing decision and assume $\text{V}(p_j) = v_b^m$ throughout.

Finally, let F_j represent fixed costs for school j. I can write the profit function for school j as the sum of the net profit derived from each type of student given the sticker price, quality, and voucher policy:

$$\pi_j\ (\mathbf{q}, \mathbf{p}, V) = \mathrm{N} \sum_{k}^{K} \Pi_k^m \sum_{\mathrm{loc} \in L} w_k^{\mathrm{loc}} s_{j,k}^{\mathrm{loc}}(\mathbf{q}, \mathbf{op}) \left[v_b^m + p_j - \mathrm{MgC}(q_j) \right] - F_j. \tag{6}$$

First consider how schools choose prices when the market is in equilibrium. Schools compare the marginal gain from raising the price to the marginal cost of attracting fewer students. For simplicity, assume this problem has an interior solution and that the capacity constraints are not relevant in equilibrium in order to get a simple expression for price and quality.

The first order condition with regard to price is[12]

$$\frac{\partial \pi_j\ (\mathbf{q}, \mathbf{p}, V)}{\partial p_j} = \frac{\partial s_j}{\partial \mathrm{op}_j} \frac{\partial \mathrm{op}_j}{\partial p_j} \left[p_j^* + v_b^m - \mathrm{MgC}(q_j) \right] + s_j(\mathbf{q}, \mathbf{op}) = 0. \tag{7}$$

Note that with the flat voucher $\frac{\partial \mathrm{op}_j}{\partial p_j} = 1$, I can rewrite the expression for price as

$$p_j^* = \underbrace{\left[\mathrm{MgC}(q_j^*) - v_b^m \right]}_{\textbf{Competitive Price}} \underbrace{- s_j(\mathbf{q}, \mathbf{op}) \left[\frac{s_j(\mathbf{q}, \mathbf{op})}{\partial p_j} \right]^{-1}}_{\textbf{Price Markup}\,(\mu_j^p)}. \tag{8}$$

The first term represents the price under perfect competition. Absent market power, the price should be equal to the marginal cost of providing q_j^* minus the subsidy per student v_b^m. The second term represents the "markup" of price over marginal cost that schools can charge because of their local market power. The price markup is smaller if the school's share is more sensitive to its own price changes. Note also that the markup depends on the prices and qualities of all other schools in the market.

Schools have to choose quality by comparing the marginal benefit of attracting more students to the marginal increase in costs of providing higher quality. I specify marginal

[12] I use Equation 3 to simplify this first order condition.

costs to be a linear function of quality and a vector of school and market specific cost shifters that are summarized in the vector ω_j^l, so the marginal cost of school j can be expressed as

$$\text{MgC}(q_j)(q_j) = c^m + \sum_l c_l \omega_j^l + c_q \cdot q_j. \tag{9}$$

I can derive an expression for quality as a function of marginal revenue, marginal costs and market power:

$$q_{j,0}^* = \underbrace{\left[\frac{p_{j,0}^* + v_b^m - c^m - \sum_l c_l \omega_j^l}{c_q}\right]}_{\textbf{Competitive Quality}} - \underbrace{s_j(\mathbf{q}_0^e, \mathbf{op}_0^e)\left[\frac{\partial s_j(\mathbf{q}_0^e, \mathbf{op}_0^e)}{\partial q_{j,0}}\right]^{-1}}_{\textbf{Quality Markdown}\,(\mu_j^q)}. \tag{10}$$

Given a chosen price p_j^*, schools will provide a lower quality when they have more local market power. Schools can provide quality with a "markdown" relative to perfectly competitive quality because they have market power[13]:

$$\mu_j^q(\mathbf{q}_0^e, \mathbf{op}_0^e) = s_j \left[\frac{\partial s_j}{\partial q_{j,0}}\right]^{-1} = s_j \left[\sum_k^K \Pi_k^m \sum_{\text{loc}}^{L_m} w_k^{\text{loc}} \frac{\partial s_{j,k}^{\text{loc}}(\mathbf{q}_0^e, \mathbf{op}_0^e)}{\partial q_{j,0}}\right]^{-1}. \tag{11}$$

For both price and quality, the incentives of the for-profit school depend on their local market power, which stems from the fact that schools are differentiated not only by price and quality, but also by their location. A school's market power depends on the set of competitor characteristics, including price, quality and unobservables ξ. It also depends on the types of students that live near the school and what characteristics they value most.

I define $(\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e)$ as the quality and sticker prices that satisfy each school's first order

[13]Spence (1975) notes that in a situation where firms with market power choose price and quality, it is possible to have an equilibrium with high prices and over provision of quality. The functional forms I use do not do not force quality markdowns to be increasing in market power, but given that empirically I observe low-to-zero prices, a low quality equilibrium seems more consistent with the data. I assume that this is the prevailing equilibrium in the rest of the paper.

conditions under a flat voucher policy V^{flat}. Note that the way the voucher policy maps prices to out-of-pocket fees encodes the voucher policy so that $\mathbf{op}_0^{\text{e}} = \mathbf{op}(\mathbf{p}_0^{\text{e}}, V^{\text{flat}})$ and $\mathbf{op}' = \mathbf{op}(\mathbf{p}_0^{\text{e}}, V^{\text{target}})$.

3.2.1. *Supply Under A Targeted Voucher Policy*

I now describe how the schools' problem changes under a targeted voucher system and define new equilibrium conditions for price and quality. I also use the model to characterize the initial reaction to the change in mapping between sticker prices and out-of-pocket fees and marginal revenue under the new policy before any equilibrium adjustments.

One straightforward way to implement a targeted voucher policy is to provide an additional subsidy v_{sep} for poor students so that out-of-pocket expenses are modified to be $\text{op}_j = 0$ for $k = \text{E}$ and $\text{MgR}(p_j, k) = p_j + v_b^m$ for all k. In this case the schools' first order conditions are unchanged, but the price markups μ_j^p and quality markdowns μ_j^q would be altered for two reasons. First, the policy changes demand by reducing out-of-pocket prices at a subset of schools for a subset of students. Second, the new equilibrium sticker prices and qualities at all schools affect choices.

In this simple targeted voucher policy case when policy changes to V^{target}, "on impact" out-of-pocket fees change instantly leading to a new out-of-pocket fee schedule holding quality and sticker prices fixed as $\mathbf{op}(\mathbf{p}_0^{\text{e}}, V^{\text{flat}}) \rightarrow \mathbf{op}'(\mathbf{p}_0^{\text{e}}, V^{\text{target}})$.

Given that families care about out-of-pocket fees and not sticker prices, the change in voucher policy affects market power through the change in $\text{op}(p_j, k; V)$ even though schools have not adjusted their price or quality yet. This change in out-of-pocket fees will only affect the subset of eligible family types ($k = \text{E}$), but the effects on incentives will spill over to all schools with varying intensity depending on how much of the relevant demand is eligible. We can write the difference in quality chosen by a school j as

$$(12) \qquad q_{j,1}^{\text{e}} - q_{j,0}^{\text{e}} = s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}}) \left[\frac{\partial s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}})}{\partial q_{j,0}} \right]^{-1} - s_j(\mathbf{q}_1^{\text{e}}, \mathbf{op}_1^{\text{e}}) \left[\frac{\partial s_j(\mathbf{q}_1^{\text{e}}, \mathbf{op}_1^{\text{e}})}{\partial q_{j,1}} \right]^{-1}.$$

The actual implementation of targeted vouchers in Chile is slightly different, as it introduces a wedge between the additional voucher and the sticker price. Under the SEP policy, out-of-pocket prices are zero ($\mathrm{op}_{i,j} = 0$) for all eligible students independent of the sticker price p_j. However, marginal revenue is fixed at $\mathrm{MgR}(p_j, k) = v_b^m + v_{sep}$ for $k = \mathrm{E}$ and continues to be $\mathrm{MgR}(p_j, k) = p_j + v_b^m$ for all $\not{\mathrm{E}}$. This slight difference in implementation severs the link between the marginal revenue a school gets for each eligible student and p_j given $\frac{\partial \mathrm{op}_j}{p_j} = 0$ for $k = \mathrm{E}$. Once the link between first order conditions and prices is broken, schools have different first order conditions and my model generates different predictions for equilibrium outcomes. I develop the schools' optimization problem in the online appendix and present modified versions for $p_j^*(\mathbf{q}_2^e, \mathbf{p}_2^e, \mathbf{op}_2^e)$ and $q_j^*(\mathbf{q}_2^e, \mathbf{p}_2^e, \mathbf{op}_2^e)$ under the new SEP policy below.

I define the new equilibrium under the SEP targeted voucher policy as the vector of sticker prices and qualities $(\mathbf{q}_2^e, \mathbf{p}_2^e, \mathbf{op}_2^e)$, so that each individual school has adjusted sticker prices and quality to satisfy their first order conditions.

The key difference in the pricing equation is that given $\frac{\partial \mathrm{op}_j}{p_j} = 0$ for $k = \mathrm{E}$, eligible families play no direct role in determining the sticker price at a school:

$$p_{j,2}^* = \left[c^m + \sum_l c_l \omega_j^l + c_q q_{j,2}^* - v_b^m \right] - s_{j,\not{\mathrm{E}}}(\mathbf{q}_2^e, \mathbf{op}_2^e) \left[\frac{\partial s_{j,\not{\mathrm{E}}}(\mathbf{q}_2^e, \mathbf{op}_2^e)}{\partial p_{j,2}} \right]^{-1}. \tag{13}$$

The policy changes prices through a new markup term that is a function only of ineligible families. These families are presumably less price sensitive and thus should push prices upward. Prices might also rise if q_j^* rises given that increasing school quality raises marginal costs. Eventually, prices may go down if the school's local market power falls in the new equilibrium $(\mathbf{q}, \mathbf{op})$, where competitors have higher q_j and it is forced to price more aggressively:

$$q_{j,2}^* = \left[\frac{v_b^m + v_{\mathrm{sep}} - c^m - \sum_l c_l \omega_j^l}{c_q} \right] - \mu_j^q - \left[\frac{v_{\mathrm{sep}} - p_{j,2}}{c_q} \right] \left[\frac{\partial s_{j,\not{\mathrm{E}}}}{\partial q_{j,2}} \right] \left[\frac{\partial s_j}{\partial q_{j,2}} \right]^{-1}. \tag{14}$$

School quality can again be described by a competitive quality minus a markdown. The new competitive quality is determined by $v_b^m + v_{\mathrm{sep}}$, with a correction based on the difference between p_j and v_{sep} that captures the differential in marginal revenue coming from ineligible students when quality improves.

Now comparing across two equilibria, $(\mathbf{q}_0^{\text{e}}, \mathbf{p}_0^{\text{e}}, \mathbf{op}_0^{\text{e}}) \to (\mathbf{q}_2^{\text{e}}, \mathbf{p}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})$, the difference in the equilibrium quality provided at a school j is

$$
\begin{aligned}
q_{j,2}^{\text{e}} - q_{j,0}^{\text{e}} = {} & s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}}) \left[\frac{\partial s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}})}{\partial q_{j,0}} \right]^{-1} - s_j(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}}) \left[\frac{\partial s_j(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})}{\partial q_{j,2}} \right]^{-1} \\
& + \left[\left[\frac{v_{sep} - p_{j,0}^{\text{e}}}{c_q} \right] \left[\frac{\partial s_{j,\mathrm{E}}(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})}{\partial q_{j,2}} \right] + \left[\frac{p_{j,2}^{\text{e}} - p_{j,0}^{\text{e}}}{c_q} \right] \left[\frac{\partial s_{j,\not\mathrm{E}}(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})}{\partial q_{j,2}} \right] \right] \left[\frac{\partial s_j(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})}{\partial q_{j,2}} \right]^{-1} .
\end{aligned}
\tag{15}
$$

The difference in equilibrium quality at school j is driven in part by the change in that school's market power $\mu(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}}) - \mu(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})$, which is shown in the first line of Equation 15 and is the same as Equation 12. Because the policy introduces a wedge between the marginal revenue for an eligible student and an ineligible student, the change also depends on how important each of these groups is for the school.

The model shows how moving from a flat voucher to a targeted voucher (as implemented in Chile) would decrease markdowns, especially in poor neighborhoods, by eliminating out-of-pocket fees and increasing competition. The modification to marginal revenue produced by the policy would also lead to higher transfers and higher quality at poorer schools that previously had low out-of-pocket fees and now get more revenue for each poor student. Both of these effects lead to higher quality, which would likely be reinforced in the new equilibrium since all schools increase quality, again reducing market power as competitor quality rises.

As for prices, the change in policy leads to a change in prices driven partly by the increase in costs due to changes in quality and the changes in market power:

$$
p_{j,2}^{\text{e}} - p_{j,0}^{\text{e}} = c_q \left(q_{j,2}^{\text{e}} - q_{j,0}^{\text{e}} \right) + s_{j,\not\mathrm{E}}(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}}) \left[\frac{\partial s_{j,\not\mathrm{E}}(\mathbf{q}_2^{\text{e}}, \mathbf{op}_2^{\text{e}})}{\partial p_{j,2}} \right]^{-1} - s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}}) \left[\frac{s_j(\mathbf{q}_0^{\text{e}}, \mathbf{op}_0^{\text{e}})}{\partial p_{j,0}} \right]^{-1} .
\tag{16}
$$

The policy leads schools to choose sticker prices considering only the ineligible students. If these families are less price elastic, the new policy will push prices higher. The unambiguously higher quality levels will increase marginal costs, which will push towards higher prices as well. At the same time, a more competitive environment, with smaller markups and markdowns, can lead schools to price more aggressively, leading them to eventually have lower prices. These various channels indicate that the new equilibrium would likely be characterized by higher quality, but the effect on prices is ambiguous. Finally, the model also indicates that relative to richer areas, neighborhoods characterized by a higher concentration of eligible students w_{E} are likely to see decreases in price markups and smaller quality markdowns.

3.3. *Modeling Limitations*

I have made several assumptions in order to derive my empirical model of school choice and competition. Some of these simplifying assumptions fail to capture important components of real education markets, such as what information families have about product attributes, the scope of residential sorting, selection by schools, the role of peer composition in production/demand and capacity constraints. However, I argue that in this particular application these assumptions are less problematic and allow for a parsimonious model that provides useful insights.

One important assumption is that unobservable preferences for quality are not correlated with residential location. Empirically I estimate the model using data before and after the SEP policy change, and I require the slightly less stringent assumption that families chose their location prior to knowing about the policy and do not sort significantly across markets or within markets following the policy. I find empirical support for this assumption, at least during the period under study.[14]

A second important assumption is that families are fully aware of all the schools in the market and their characteristics. In this application I avoid conducting welfare analysis and instead use the empirical demand model to quantify the tradeoffs parents are making

[14] I do not find any evidence of residential sorting changing with the policy, suggesting that at least during the time frame I study, residential sorting is not a first order concern. I explore the evolution of market size as well as the number of students in a smaller political unit of *Comuna* and find a null or negative correlation between average school quality and market size (-0.2). My findings are the same when I focus on students eligible for SEP (-0.2). These findings are consistent with the assumption that residential sorting is not changing with the policy and is not a first order concern in this setting.

about variables schools can choose, such as prices and quality. A lack of awareness is likely to downward bias the estimated preferences for true school quality, but my approach will accurately capture the tradeoffs schools face when they decide to invest in quality as long as the informational environment does not change.[15]

A third important assumption is that, after considering prices and distance, families can attend any school they want. This assumption rules out the possibility that schools select students and that schools can turn students away due to capacity constraints. While some schools may have excess demand and reject or select students, this is not a widespread feature of the Chilean education market for three reasons. First, while elite, private, unsubsidized schools may select students, it is illegal for public and private voucher schools to select students at the primary level. In addition, in the data I see limited evidence that capacity constraints or selection are affecting school choice for a significant part of the market. Instead, prices, distance and academic achievement are the biggest drivers of school choice.[16] Finally, in a market characterized by private and for-profit schools that can eliminate excess demand by raising prices or lowering quality, and over time can expand or open new locations, it is unlikely that a significant amount of schools will have excess demand in equilibrium. Of course, this assumption is much more restrictive following a large policy change. In my estimation I avoid using data from years immediately after the introduction of the new voucher, when schools may still be making adjustments.

[15]See work on the role of information and school choice in the U.S. context by Hastings and Weinstein (2008) and in the Chilean context by Mizala and Urquiola (2013); Allende, Gallego, and Neilson (2019).

[16]While the legal class size limit is 45 students (established in *Decreto 8144, 1980*), this cap binds in only 2% of urban primary schools. At the same time, parents do not report being displaced from their school of choice. In 2009 the population of parents of students in fourth grade were asked the main reasons why the chose their current school. Table VII in the appendix presents the results and shows that only 2% of parents mention they chose their school because they were turned away from another school they preferred more. In the same question, parents overwhelmingly (40% or more) mentioned prices, quality and distance as the main reasons they chose their school.

4. DATA, MARKETS AND MEASURES OF SCHOOL QUALITY

4.1. *Schools and Students*

I use administrative records from the Ministry of Education of the Chilean government (MINEDUC) on all schools in the country from 2005 to 2016. These data provide information on aggregate matriculation by grade level, the address of each school, and other school characteristics such as the type of administration. In this paper, I study only urban schools that have first grade students.

I use data on government transfers to public schools and voucher schools. These data indicate the source of funding and the amount transferred to each school for each month. Since voucher transfers depend on school characteristics, these data also include information on the average out-of-pocket price charged to non-SEP students, whether the school is a recipient of the SNED achievement prize, and whether the school has been fined for noncompliance with minimal quality and safety regulations. Other government transfers include, for example, resources for teacher training programs.

I use administrative panel data from 2005 to 2016 on all students in Chile. These data record the school each student attended each year, as well as information on grades and basic demographics. They also include individual level data on students' eligibility for the SEP targeted voucher starting in 2008. This dataset contains address information for a subset of students for the years 2010 and 2011, which I geocode to the nearest census block.

I also have student birth records from the Ministry of Health. This database covers all births in the country after 1992 and includes 97% of all students enrolled in first grade during my sample period. These data contain information on the health conditions of a child at birth such as birth weight, birth length and gestation. They also include demographic information about the child's parents, as well as administrative education information on the mother, such as her college entrance exam scores. My final source of student data is test scores from the SIMCE test.[17]

[17] Student birth record data is described in detail in Bharadwaj, Loken, and Neilson (2013); Bharadwaj, Eberhard, and Neilson (2017). Data on college entrance exams prior to 2000 was originally collected from

I define a discrete set of family types based on whether they are poor as defined by eligibility for the SEP targeted voucher (44% Poor, 56% Not Poor for first grade students in 2011) and the highest level of education their mother had achieved when she gave birth (21% less than high school, 58% high school, 21% more than high school for first grade students in 2011). This classification generates six types of students.

4.2. *Urban Markets in Chile*

Accurately characterizing urban education markets is challenging for two reasons. First, defining market boundaries is a difficult task in the sprawling urban settings common among education markets in developing countries. Studies of retail markets have typically used political or administrative boundaries to define markets, such as zip codes or counties (see for example Davis (2006)). This approach works well if education markets are small, isolated communities, such as the villages in Pakistan studied by Andrabi, Das, and Khwaja (2017). In larger urban settings, families close to the border of a political unit or school district may choose schools across these boundaries. A second challenge is carefully characterizing the heterogeneity of both families and schools across geographic space.

In this application, I define education markets using a combination of aggregate administrative data on schools, microdata on the population of students, and individual level census block data.

I define an urban education market by six features. Each market has a geographic boundary (a polygon) described by B^m. I join all areas classified as urban by the Chilean Census that are two kilometers apart or less at their closest point. The union of all connected urban areas is defined as one market under the assumption that students could feasibly travel within this set of urban areas. I add a one-km buffer zone around the edge of each market since some schools locate at the edge of urban areas to lower costs. The second feature is a set of schools F^m that are located within the market boundary defined by

archival records as part of the *Proyecto 3E* (Beyer, Hastings, Neilson, and Zimmerman, 2015; Hastings, Neilson, and Zimmerman, 2015), a joint research effort with DEMRE, the institution that administers the college entrance exam in Chile.

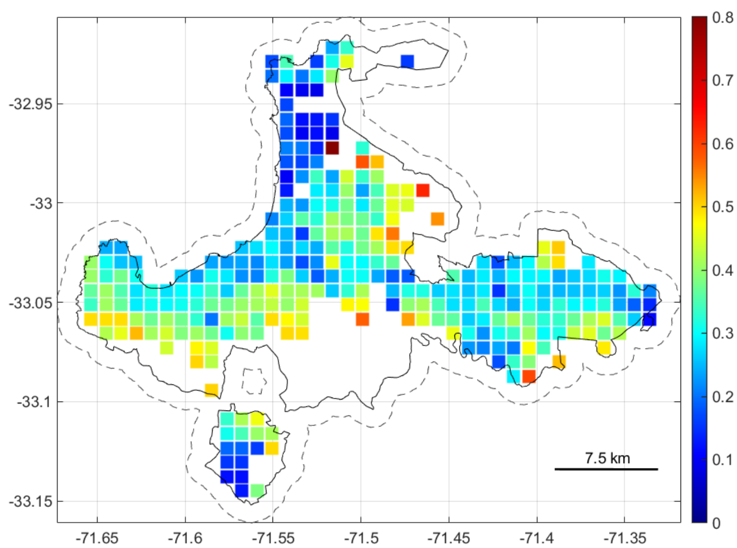
B^m. I divide each market into a set of locations L^m spread evenly within the boundaries B^m of the market at five block intervals. These locations help capture the heterogeneity within the market by aggregating the census block level data to a fixed grid of locations. I define the student population in each market as a set of S^m students of K observable types. Students can live at any of the L^m locations inside the market. I assign students to a market based on the school they attend (which is included in the administrative data for all students). Each market has a vector $\Pi^m = \{\Pi_1, \Pi_2, ..., \Pi_K\}$ of length K that contains the shares of each type of student, and $\sum_k^K \Pi_k^m = 1$ for each market m. I calculate these shares from the microlevel population data for all students in each market each year.

Finally, the sixth aspect that defines a market is the distribution of student types across nodes within each market described by w_k^{loc}, which indicates what share of students of type k live at a specific location. The Chilean census provides detailed block-level data on every urban area and thus on every market in my analysis. I approximate the distribution of student characteristics on this grid by aggregating the block level census information. I use the 2012 census together with a sample of geocoded students to estimate the joint distribution of poverty (SEP eligibility) and mother's education based on census block characteristics. The share of each type k in a market that lives at each location loc is given by w_k^{loc}, where $\sum_{\text{loc}\in L^m} w_k^{\text{loc}} = 1$. I fix this within market distribution of types over time.

This way of describing markets is useful for several reasons. First, this micro level structure does not require knowing where all families live, just the joint distribution of family types conditional on block characteristics. Second, aggregating at the level of equidistant nodes instead of unevenly sized blocks keeps the estimation step manageable by reducing the dimensionality and making the results easier to interpret. Finally, this structure allows for a very detailed characterization of the within market heterogeneity and local market conditions schools and students face. This heterogeneity can be very important; in particular, if households are very sensitive to distance, then competition will be extremely local.

One important aspect of within market heterogeneity is the number of SEP eligible students that live in each part of the city. Figure 1 uses the market characterization described above to show how different areas of a market are differentially exposed to the SEP policy due to existing patterns of residential segregation. The figure shows the main elements I use to characterize education markets. Dashed lines denote market boundaries B^m, squares indicate the grid of L^m locations, and the colors indicate the percent of the students that are poor (SEP eligible). The colormap shows that these values vary drastically: in some neighborhoods, only 10% of students are eligible, while in others up to 80% of students are eligible.

Figure 1: Within Market Heterogeneity of % $k=$ E (eligible)



Note: This is a map of an arbitrarily chosen market to illustrate the structure of a market and the variation across space in the concentration of SEP eligible students. This market contains 300 schools and approximately 100,000 first grade students. Dashed lines denote urban boundaries B^m, squares indicate the grid of Loc^m locations, and the colors indicate the percent of students that are poor (SEP eligible). The colormap indicates that these values vary drastically: in some neighborhoods, only 10% of students are eligible, while in others up to 80% of students are eligible.

I use this variation in the percent of eligible students to generate a variable that captures the degree of exposure to the SEP policy for each school. Specifically, I calculate the percent of SEP eligible students that are within 1.5km of the school. I use this exposure variable to classify schools into quintiles. The locations categorized with the highest exposure quintile have an average of 70% of students who will become eligible for the new voucher and will pay no out-of-pocket prices once the policy is in place. The schools located in areas with the least exposure quintile have an average of 20% of students who will become eligible for the SEP voucher.

I determine the final sample by focusing on urban markets with 1) at least five elementary schools 2) at least 500 students in the first grade and 3) at least one private school. This leads to 74 markets that contain 4,266 schools and around 90% of all urban students in first grade. The resulting school-year level database contains first grade market shares, average out-of-pocket prices, per-student government transfers, and the number and characteristics of teachers from 2005 to 2016.

The resulting student-year level dataset of first grade students contains almost 2 million student-year observations. I use this dataset to calculate market shares and characterize student choices. I use the same panel dataset to track students from first grade through fourth grade (when they take standardized tests). This fourth grade test score dataset contains 1.5 million observations and covers 90% of all students. 97% of these observations have a full set of covariates based on birth record family demographics, employment and health. Health records include birth weight, birth length, weeks of gestation, type of hospital, and the type of birth. Demographics recorded at birth include parents' age, parents' education levels, and employment status of the mother and father, the marital status of parents, number of older siblings, and location (*Comuna*) of residence. They also include whether the mother took the college entrance exam and her scores in math, language and GPA. The online appendix describes how I construct markets, the firm-level dataset and these two student-level datasets in detail.

4.3. *Estimating Measures of Quality*

I define the relationship between test scores y_{ijt}, student characteristics, and each school's ability to increase test scores, q_{jt}, in Equation 17:

$$y_{i,j,t} = q_{j,t} + X_{i,t}\gamma + e_{i,j,t}. \tag{17}$$

X_{it} is a large vector of observable individual student characteristics and e_{ijt} is a random iid shock to test scores. Student characteristics include health information at birth, demographic composition of the families, parents' employment and educational levels as well as mothers' math and language college entrance exam scores. The estimated value of $q_{j,t}$ represents the school fixed effect and is the component of the average test score for each school that is not explained by the individual characteristics of the students. This term will capture school inputs such as teacher quality, infrastructure, and any other school specific characteristics that raise the average test score. To the extent that the demographic composition of the schools' students matters for test scores, these effects will also be captured by the estimated school value added. I present the results from estimating Equation 17 in Table V in the Appendix .

Both parents' education levels have significant and large coefficients. Students whose mother took the college entrance exam did significantly better, scoring almost 3 standard deviations higher on the standardized test. Children whose mothers who did better on the college entrance exam scored better on their 4th grade evaluations. My results conform with prior research showing that health at birth is an important predictor of later life outcomes.[18] Birth weight, birth length and weeks of gestation are all significantly related to test scores, even after controlling for school and year fixed effects as well as many other demographic characteristics.

The school and year level fixed effects ($q_{j,t}$) estimated from Equation 17 represent the school value added. Consistent with prior results from the literature on school quality in

[18] See Behrman and Rosenzweig (2004), Currie and Almond (2011), and Almond and Currie (2011) for examples. Bharadwaj, Loken, and Neilson (2013) and Bharadwaj, Eberhard, and Neilson (2017) show that health outcomes at birth are systematically correlated with academic outcomes in Chile.

Chile (see Drago and Paredes (2011) for a summary), voucher schools have consistently higher estimated value added than public schools, and private non-voucher schools have much higher quality than either. Private voucher schools tend to have higher estimated value added than publics but there is some overlap. 15% of private voucher schools had lower value added than the median public school. In 65 of 74 markets, the median private voucher school had higher value added than the median public school. An additional result that is less emphasized in the literature is that estimated school quality is very heterogeneous within each type of school. In 2007, the difference between the 25th and 75th percentile of the estimated school value added was 1.04σ among public schools and 1.23σ for private voucher schools. This heterogeneity is partially explained by observable school inputs. In the Online Appendix I present evidence that the estimated school value added is significantly correlated with school inputs such as spending on teachers, measures of teacher quality, and measures of principal human capital. After conditioning on the poverty of a neighborhood, schools with higher estimated value added are also more likely to have other features associated with higher quality such as being awarded a SNED prize, and they are less likely to be fined for noncompliance with minimal quality standards.

5. ESTIMATING DEMAND FOR SCHOOLS

I estimate parameters $\theta = \{\alpha, \beta, \lambda, \sigma, \xi\}$ using a method of moments estimator following Berry (1994); Berry, Levinsohn, and Pakes (1995); Nevo (2001); Petrin (2002); Berry, Levinsohn, and Pakes (2004). I estimate my model with data from the pre-policy period in 2007 and the post-policy period in 2011.

The empirical model of demand has two features that pose a challenge for identification. First, consumers have heterogeneous preferences due to unobserved tastes for quality. Second, the demand model accommodates school level unobservable characteristics ξ that are correlated with price and quality. This framework is common in the empirical industrial organization literature. Berry and Haile (2014) describe nonparametric identification results using only aggregate data, and these results carry over to the case with microdata (Berry and Haile, 2016). The main requirement for identification is instruments that are independent from ξ and provide independent variation in the endogenous variables price, quality and market share.

The first type of instrument I use are variables that shift labor costs at schools. Specifically, I instrument for teacher labor costs at the regional level with the average earnings of other college graduates excluding teachers. I interact this aggregate cost shifter with school characteristics such as type of administration because local costs are likely to have different effects on public and private schools. A second instrument that shifts prices and quality independently of ξ is the value of the base voucher paid by the Ministry of Education v_b^m for schools in each market. This transfer varies over time and across markets by a factor Δ^m that ranges from 0 to 110%. The baseline voucher for a school in market m in period t is given by $v_{b,t}^m = \overline{v}_t \cdot (1 + \Delta^m)$. A third type of instrument is the exogenous characteristics of competing schools in the market. These are the same school characteristics that are predetermined and influence demand in Equation 1. These instruments shift shares, as well as prices and quality, and are valid instruments in my demand and supply model (see Berry, Levinsohn, and Pakes (1995) for a formal argument).

The instruments I use provide the variation needed to identify the parameters of the demand system. I add an additional instrument that builds on the change in voucher policy. The model of demand and supply describes how switching from a flat voucher to a targeted voucher generates variation that shifts the endogenous variables independently of ξ. The change in policy shifts markups and markdowns and modifies first order conditions by shifting how marginal revenue is determined. Importantly, the model shows that the degree to which the policy shifts prices, quality and market shares depends on the distribution of eligible students within the market, which I assume is exogenous to ξ and the timing of the policy. Specifically, I use the fraction of eligible students that live within 1.5km of the school as the measure of policy exposure. I interact this measure of policy exposure with the timing of the policy change.

Table I presents linear regressions of the endogenous variables (price, quality and shares), on the exogenous variables, including the excluded instruments. I include two columns for each endogenous variable; one column runs the regression on the entire panel and the other only uses the estimation sample (i.e. years 2007 and 2011). In both cases I obtain high F-statistics, but the estimated coefficients are difficult to interpret because I am controlling for endogenous variables that are jointly determined with the omitted endogenous variables.

I define the micro moments of interest to be the expected quality, out of pocket fees, and distance each type of family chooses in each market in each period. Finally, I use market shares as additional aggregate moments as in Berry, Levinsohn, and Pakes (1995).

TABLE I

Regression of Endogenous Variables on Instrumental Variables

	Quality		Price		Shares	
Exogenous School Characteristics	(1)	(2)	(1)	(2)	(1)	(2)
For Profit	-0.084***	-0.086***	0.050***	0.056**	-0.009***	-0.009***
	(0.000)	(0.000)	(0.000)	(0.027)	(0.000)	(0.000)
Religious	0.027***	0.024*	0.026***	0.034	0.002***	0.001
	(0.000)	(0.070)	(0.006)	(0.109)	(0.001)	(0.177)
Private Voucher	0.254***	0.267***	NA	NA	0.000	0.000
	(0.000)	(0.000)	(.)	(.)	(0.968)	(0.904)
Private Non Voucher	0.466***	0.472***	4.587***	4.614***	0.014***	0.014***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Has High School	0.157***	0.142***	0.244***	0.234***	0.006***	0.006***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Traditional x Private Voucher	0.022***	0.016	-0.120***	-0.110***	0.004***	0.004***
	(0.000)	(0.259)	(0.000)	(0.000)	(0.000)	(0.000)
Traditional x Private Non Voucher	0.194***	0.173***	0.547***	0.537***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.781)	(0.910)
Instruments						
Base Voucher v_b^m	0.224***	0.174**	0.718***	0.733***	0.038***	0.039***
	(0.000)	(0.039)	(0.000)	(0.000)	(0.000)	(0.000)
Earnings of Non Teacher Professionals	-567.673***	-877.076***	167.995	118.891	-19.948***	-14.854
	(0.000)	(0.000)	(0.359)	(0.811)	(0.003)	(0.417)
Earnings of Non Teacher Professionals^2	101710***	165682***	-28567	-17439	2636*	1301
	(0.000)	(0.003)	(0.504)	(0.879)	(0.096)	(0.759)
% Poor within 1km	-0.101***	-0.095***	-0.175***	-0.177***	0.008***	0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
% Poor within 1km x SEP Policy	0.043***	0.052***	-0.014	-0.012	-0.001**	-0.001
	(0.000)	(0.000)	(0.149)	(0.522)	(0.027)	(0.175)
Instruments : Other Nearby Schools Charateristics						
ForProfit Nearby	-0.201***	-0.183***	-0.051	-0.069	-0.039***	-0.040***
	(0.000)	(0.005)	(0.394)	(0.604)	(0.000)	(0.000)
Religious Nearby	-0.166***	-0.186***	-0.061	-0.051	0.031***	0.030***
	(0.000)	(0.002)	(0.241)	(0.659)	(0.000)	(0.000)
Private Voucher Nearby	-0.393***	-0.419***	-0.662***	-0.656**	-0.099***	-0.122***
	(0.000)	(0.002)	(0.000)	(0.014)	(0.000)	(0.000)
Private Non Voucher Nearby	-0.221**	0.048	2.146***	2.191***	-0.100***	-0.117***
	(0.014)	(0.815)	(0.000)	(0.000)	(0.000)	(0.000)
Has High School Nearby	0.005	0.033	0.280***	0.274***	0.021***	0.020***
	(0.774)	(0.425)	(0.000)	(0.001)	(0.000)	(0.000)
Traditional x Public Nearby	-0.372***	-0.374***	-0.357***	-0.369*	-0.083***	-0.106***
	(0.000)	(0.001)	(0.001)	(0.098)	(0.000)	(0.000)
Traditional x Voucher Nearby	-0.015	0.003	0.024	0.008	-0.048***	-0.043***
	(0.548)	(0.959)	(0.614)	(0.940)	(0.000)	(0.000)
Traditional x Private Non Voucher	-0.507***	-0.830***	-0.979***	-1.035***	-0.094***	-0.099***
	(0.000)	(0.000)	(0.000)	(0.005)	(0.000)	(0.000)
Constant	0.761***	1.244***	-0.097	-0.090	0.141***	0.155***
	(0.000)	(0.000)	(0.668)	(0.878)	(0.000)	(0.000)
Only 2007 and 2011		✓		✓		✓
R^2	0.247	0.258	0.890	0.892	0.261	0.271
F-statistic, Excluding Instruments	123.2	28.2	335.2	67.2	907.1	191.1
N Obs	38852	7775	25176	5033	38852	7775

6. RESULTS AND ANALYSIS

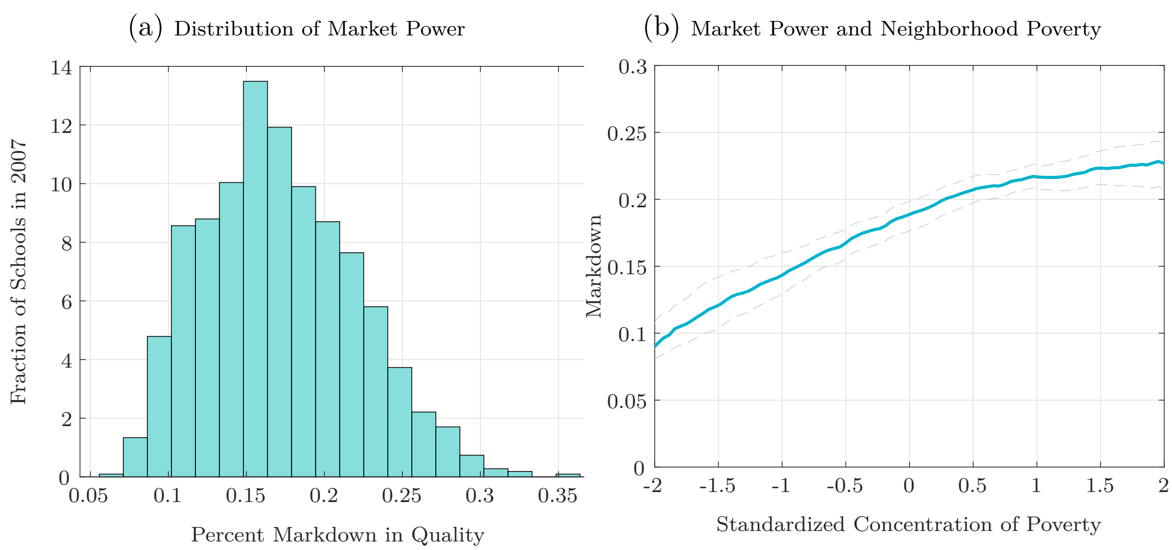
6.1. *Quantifying Heterogenous Demand*

I present the estimated demand parameters in Table VIII. I find that preferences are heterogeneous across socioeconomic groups, which is consistent with prior work on school choice (see for example Hastings, Kane, and Staiger (2009); Gallego and Hernando (2010); Carneiro, Das, and Reis (2016)). I find that poorer and less educated families value school quality, but they are very price sensitive and dislike distance more than richer and more educated families. These results suggest out-of-pocket prices and distance are contributing to the observed inequality in access to higher quality schools. These patterns in preferences are consistent with the original motivation for the targeted voucher policy, since out-of-pocket fees are indeed a barrier to access for poorer families (see Hsieh and Urquiola (2006); Mizala and Romaguera (2000); Anand, Mizala, and Repetto (2009)). While there is substantial heterogeneity in preferences across observable family characteristics, I do not find an important role for unobserved heterogeneity in preferences for quality since the coefficient on σ is small and insignificant. In part, this is not surprising given that I have already included significant heterogeneity and have modeled families down to the block level within a city. Since I do not have data on repeated or ranked choices, it is infeasible to drill down further to get at additional unobserved heterogeneity (see Berry, Levinsohn, and Pakes (2004); Agarwal and Somaini (2019)).

6.2. *Market Power and Unequal Access to Quality*

The supply side model of for-profit school behavior under a flat voucher policy suggests that heterogeneous preferences combined with segregated neighborhoods can lead to differences in the provision of quality through the quality markdown term $\mu_j^q = s_j \left[\sum_k^K \Pi_k^m \sum_{\text{loc}}^{L_m} w_k^{\text{loc}} \frac{\partial s_{j,k}^{\text{loc}}(\mathbf{q}, \mathbf{op})}{\partial q_j}\right]^{-1}$. This term is determined solely by the distribution of families across the city and the demand parameter estimates in Table VIII, which allows me to empirically quantify markdowns at the school level. I first evaluate markdowns in 2007, in the flat voucher policy equilibrium given by $\mu^q(\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e)$. Markdowns vary substantially across schools. While at some voucher schools the markdown is calculated to be 25% (90th percentile), at others voucher schools it can be as low as 10% (10th percentile). The second interesting aspect of the distribution of markdowns is that the heterogeneity has an important spatial component where markdowns are significantly correlated with the fraction of poor students living nearby.

Figure 2: Estimated School Quality Markdowns



Note: This figure shows the distribution of schools' market power in Panel (a) and its positive correlation with the fraction of poor students living nearby in Panel (b). Both graphs correspond to the pre-policy year of 2007.

The relationship between market power and poverty is important because when schools in poor neighborhoods reduce the quality provided due to imperfect competition, not only does it have an effect on efficiency, but also on inequality in the education system.

6.3. *Predicted Effects of Moving from Flat to Targeted Vouchers*

The targeted voucher policy was promoted as a way to provide more resources to poorer students, expanding the set of schools they could afford. To evaluate whether the policy succeeded in this respect, I use the estimated demand model to quantify the potential sorting that would result if out-of-pocket prices were eliminated and the supply side did not react at all, $(\mathbf{q}_0^{\mathrm{e}}, \mathbf{p}_0^{\mathrm{e}}, \mathbf{op}_0')$. I characterize the difference in average school quality between eligible and ineligible students as

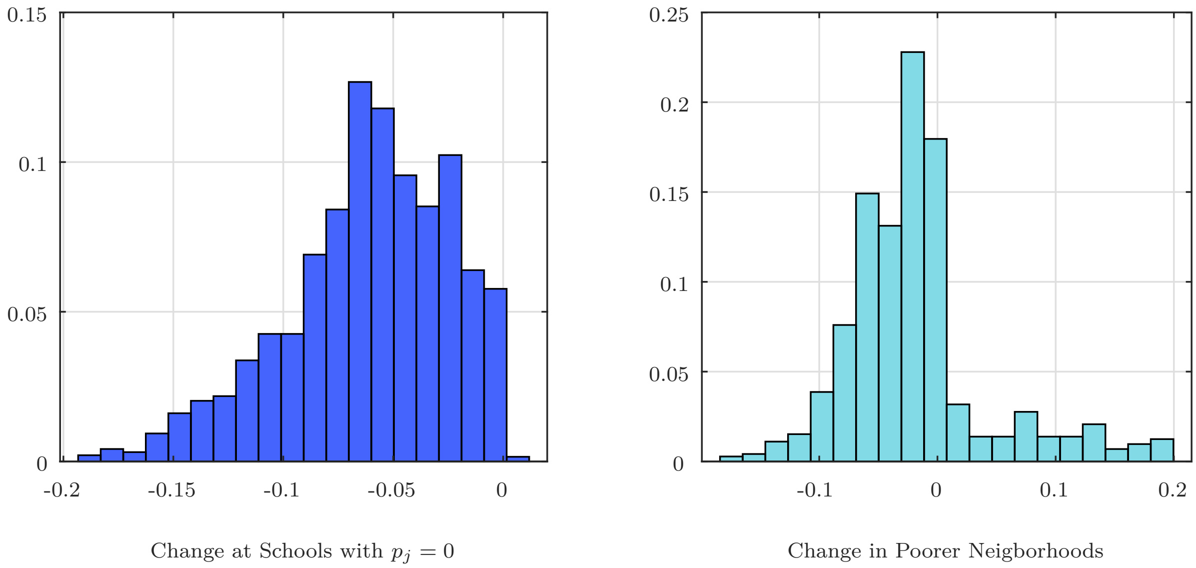
$$\Delta\overline{q}^{\not{\mathrm{E}},\mathrm{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{p}_0^{\mathrm{e}}, \mathbf{op}_0^{\mathrm{e}}, \mathbf{op}') = \sum_{j}^{F_m} q_{j,0}^{\mathrm{e}} \cdot \left[s_{j,\mathrm{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{op}') - s_{j,\mathrm{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{op}^{\mathrm{e}}) \right]. \tag{18}$$

I fix sticker prices and quality in 2007, but implement the targeted voucher policy eliminating the out-of-pocket fees for eligible students. I simulate student choices assuming no capacity constraints and quantify the sorting implied by the estimated model. School market shares change varying from a loss of -15% of matriculation at the 10th percentile to 10% increase in market share at the 90th percentile. This counterfactual leads to an increase in average test scores of 0.08σ for students in the poorest 40% of the distribution which is approximatly one third of the total effect observed by 2011.

A second channel that I emphasize in this paper operates through the supply side. My model of supply and demand indicates that the policy change would alter school incentives in several ways. First, my model suggests that the targeted voucher policy can reduce quality markdowns by eliminating differentiation due to out-of-pocket fees. To quantify the importance of supply side considerations, I use the estimated demand parameters to evaluate the change in market power due to the elimination of out-of-pocket fees for eligible students. Given the demand estimates, changing to a targeted voucher policy would immediately reduce quality markdowns for schools with zero out-of-pocket prices with varying intensity depending on their local market competition. In general schools will be differentially affected depending on how many families are affected nearby and whether the change affects their demand positively or negatively.

These changes in market power can increase quality and also reduce inequality. Schools with lower fees lose market power as higher performing, more expensive schools, become more affordable. The median reduction in markdowns is 8% at schools with zero out-of-pocket. I also find that there are larger reductions in quality markdowns at schools in neighborhoods with a higher concentration of eligible students (median reduction of 5%), where families are more price sensitive before the policy change.

Figure 3: Change in Markdowns



Note: This figure shows the distribution of the change in schools' markdown. On the left panel the graph shows the change for schools who had zero-out-of-pocket fees. On the right panel, the graph shows the change for schools located in poorer neighborhoods (5th quintile of neighborhood poverty). Both graphs correspond to the pre-policy year of 2007, with out-of-pocket fees induced by the targeted voucher policy before schools adjust price or quality.

The actual implementation of the SEP policy induced an additional effect by introducing a wedge between the marginal revenue schools get for eligible students and ineligible students. The change in quality is described in Equation 15 which shows that, in addition to changing market power, the change in quality will also depend on the change in marginal revenue. This comes from the difference between the new subsidy and the old out-of-pocket fee $(v_{\text{sep}} - p^{\text{e}}_{j,0})$ and the demand coming from eligible families, $\left[\frac{\partial s_{j,\text{E}}(\mathbf{q}^{\text{e}}_2, \mathbf{op}^{\text{e}}_2)}{\partial q_{j,2}}\right]$. This mechanism indicates that schools with low or zero price who are located near more eligible students will also be more affected as these students will contribute a higher marginal revenue relative to the pre-policy period.

6.4. *A New Equilibrium Under Targeted Vouchers*

I now document the evolution of student level academic achievement and school value added during the period of study. There are two main stylized facts associated with the evolution of student achievement, and two regarding the evolution of school quality. The first stylized fact is that official state-mandated test scores improved in the aggregate, in 2008 and in subsequent years, breaking with many years of stagnation.

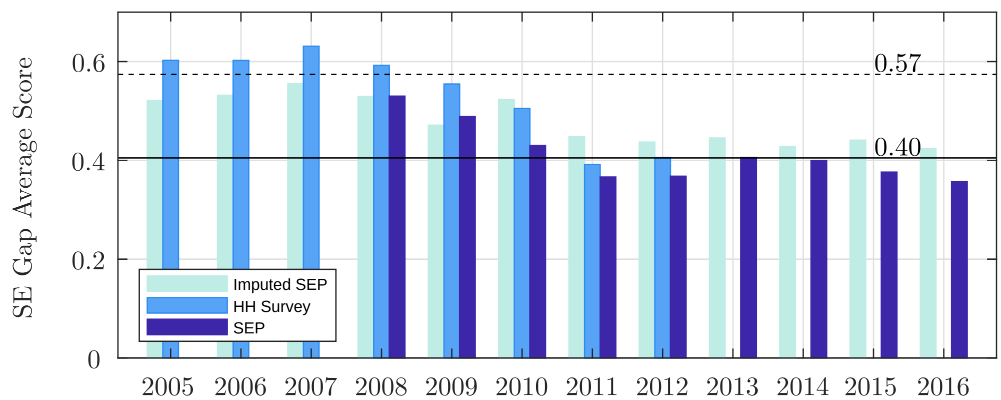
From 1999 to 2007, the growth in the average test score was negligible, while the five years from 2008 to 2012 saw growth of almost 0.3σ. In the five years between 2012 and 2016, test scores remained higher but did not improve substantially. Table IV shows average test scores for students in 4th grade (averaged over both math and language).

The second relevant fact is that the large gap between the academic achievement of students from different socioeconomic backgrounds narrowed starting in 2008. Prior to 2008, the average test score of students from the poorest 40% of households ranged between -0.2σ and -0.3σ depending on the year and the exact definition of poor.[19] The average student in the richest 60% had an average ranging between 0.3σ and 0.4σ over the same period. Since 2008, these differences have narrowed by approximately one third of the original gap. Figure 4 shows the evolution of the achievement gap between the bottom 40% and the top 60% of the SES distribution under three different measures of low SES.[20]

[19] Deciding how to divide rich and poor is arbitrary, and different definitions of income will have different coverage and yield different magnitudes for the evolution of average test scores. In this paper poverty status is determined in three ways. The first approach uses eligibility for the SEP voucher, but this measure is not available before 2007. A second approach is to impute eligibility status by predicting eligibility and labeling the 40% of students who are most likely to be eligible based on the model. A third way is to calculate household per capita income percentile using data collected from household surveys filled out by student test-takers' parents. This measure is not possible after 2012 and has varying levels of coverage across years and schools. Regardless of how I define poor students, these students increased their scores and caught up with their richer counterparts during the period under study.

[20] One definition is given by eligiblity to the SEP voucher (SEP). This compares roughly the 40% poorest students to the richer 60% and is available starting in 2008. To get a longer time series I impute eligiblity for students based on their observable characteristics using data from 2008 to 2016 (Imputed). I also use income per capita reported in household surveys (HH Survey) taken by the parents of test taking students (HH); this measure is only available until 2012.

Figure 4: Evolution of the Gap in Academic Achievement High-Low SES



Note: This figure shows the difference in average standardized test scores between students in high SES and low SES categories. Test scores are comparable across years and are standardized relative to the benchmark set in 1999. The average test score indicates the average across math and reading test scores of all students in the 74 markets in the study. There are three groups considered in the comparison. The first comparison denominated (SEP) is the difference between the ineligible students and the eligible students for the SEP voucher. The eligible group roughly represents the 40% with the lowest SES, and this measure is available starting in 2008. A second comparison imputes eligibility for students based on their observable characteristics (Imputed SEP). Finally, I use income per capita reported in household surveys (HH Survey) taken by the parents of test taking students. This measure is only available until 2012 when the questions required to calculate household income per capita were discontinued. The average test score over the population 0.05σ in 2007, 0.29σ in 2011, and 0.33σ in 2016. The average gap across SES groups from 2005 to 2007 was 0.57σ (dotted line), while from 2011 to 2016 the average was 0.39σ (continuous line). Table IV in the Appendix reports average test scores for all schools, and average scores differentiated by group.

These aggregate effects have been documented by a growing literature studying the SEP policy. A series of papers document the increase in academic achievement and the reduction in inequality.[21] Murnane, Waldman, Willett, Bos, and Vegas (2017) and Mizala and Torche (2017) argue that both additional funding and additional regulation and support have improved outcomes. In contrast, a few papers including Aguirre (2017); Feigenberg, Yan, and Rivkin (2019), present a dissenting point of view from the rest of the literature.[22] A recent review after ten years of the policy is presented in Muñoz, Irarrázaval, Keim, Gaete, Jiménez, and Quezada (2020).

[21]See early academic work by de Políticas Públicas (2012); Henriquez, Lara, Mizala, and Repetto (2012); Mizala and Torche (2013); Valenzuela, Villarroel, and Villalobos (2013); Correa, Parro, and Reyes (2014); Raczynski, Muñoz, Weinstein, and Pascual (2013) and government publications such as de Estudios MINEDUC (2012). Examples from the popular press include *La Nacion, 04/11/2012* and *La Tercera, 04/14/2012*.

[22]Feigenberg, Yan, and Rivkin (2019) and Cuesta, Gonzalez, and Larroulet (2017) cite evidence of selective testing and gaming as a potential issue that generates bias in student test scores (repeating similar concerns from the U.S. literature on vouchers (Rouse, Hannaway, Goldhaber, and Figlio, 2013)). I attempt to take these issues into account in robustness exercises presented in the appendix and discussed further in the online appendix.

International evaluations such as the PISA and TIMSS evaluations show evidence that is consistent with these findings. Comparing TIMSS and PISA tests prior to 2008 and after 2011 shows that academic achievement grew substantially, and the gap across socioeconomic groups declined. Specifically, TIMSS scores in Science and Math averaged close to 405 in 1999 and 2003, but rose to 435 in 2011 and 2015, making Chile one of the countries with the highest growth during that period.[23] PISA international test scores also grew faster from 2006 to 2015 in Chile (3.4%) than in the rest of Latin America (2%) or the OECD (0%). A publication by the OECD in 2017 shows that, when comparing 2006 and 2015, Chile was one of the countries that most improved in both levels of achievement and also in measures of equity. In particular, Chile had the second highest improvement in equity as measured by PISA (See PISA 2015 Table I.6.17). The online appendix describes the evolution of international test scores over the time period under study. Overall, the evolution of these international measures of academic achievement are broadly consistent with observed increases in learning and academic achievement, and a decline in inequality in Chile during this period.

6.5. *Interpreting The Observed Change in Equilibrium*

The model indicates that the overall effect of the policy on inequality will be a combination of both student sorting and schools adjusting. Eligible students will potentially sort into higher quality schools given the reduction in out-of-pocket fees. Schools may improve quality due to more resources and increased competition. The change in policy leads to a change in equilibrium previously defined by $(\mathbf{q}_0^{\mathrm{e}}, \mathbf{p}_0^{\mathrm{e}}, \mathbf{op}_0^{\mathrm{e}}) \rightarrow (\mathbf{q}_2^{\mathrm{e}}, \mathbf{p}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}})$. I group students by SEP eligibility and write the differences-in-differences of average student achievement using the characterization described in Equation 5. Letting $\Delta\overline{q}^{\not{\mathrm{E}},\mathrm{E}}(\mathbf{q}_2^{\mathrm{e}}, \mathbf{p}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}}) = \Delta\overline{q}_2^{\not{\mathrm{E}},\mathrm{E}}$ and

[23]When comparing 8th grade TIMSS results for science and math in 2011 to the previous evaluation in 2003, students from Chile had the 2nd and 4th highest growth out of over fifty countries evaluated (the official policy brief from MINEDUC is *Presentacion Resultados TIMSS, 2011*)

$\Delta\overline{q}^{\not{E},\mathrm{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{p}_0^{\mathrm{e}}, \mathbf{op}_0^{\mathrm{e}}) = \Delta\overline{q}_0^{\not{E},\mathrm{E}}$,

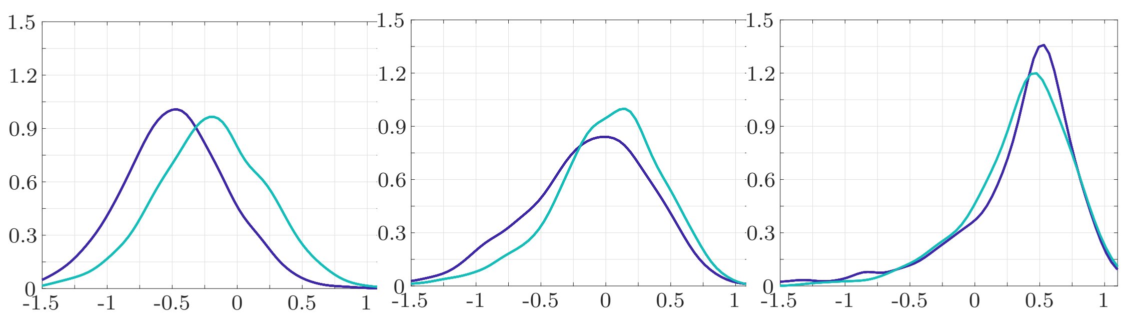
$$\Delta\overline{q}_2^{\not{E},\mathrm{E}} - \Delta\overline{q}_0^{\not{E},\mathrm{E}} = \sum_{j}^{F_m} \left[q_{2,j}^{\mathrm{e}} \left[s_{j,\not{E}}(\mathbf{q}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}}) - s_{j,\mathrm{E}}(\mathbf{q}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}}) \right] - q_{0,j}^{\mathrm{e}} \left[s_{j,\not{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{op}_0^{\mathrm{e}}) - s_{j,\mathrm{E}}(\mathbf{q}_0^{\mathrm{e}}, \mathbf{op}_0^{\mathrm{e}}) \right] \right]. \tag{19}$$

Figure 4 documented a fall in the gap in student-level test scores across ineligible and eligible students of approximatly 0.18 standard deviations. A similar trajectory is observed for the gap in school value added. In 2007 $\Delta\overline{q}_0^{\not{E},\mathrm{E}} = 0.31$ and in 2011 $\Delta\overline{q}_2^{\not{E},\mathrm{E}} = 0.19$ for students in 4th grade who are taking the test. We can use Equation 19 to decompose this difference into changes in shares across groups as well as changes in school quality.First, I hold fixed the school quality of the pre-policy period (2007), but use the shares observed in the post-policy period data (2011) and find that there is a reduction in the gap in school value added of -0.04. Second, I hold shares observed in the pre-policy period (2007) but take the post-policy estimated school quality to recalculate the differences and find a change in the gap in value added of -0.10. Given the total effect in the reduction of the gap across types of students is approximately 0.12, this exercise suggests that while there is some sorting, the majority of the observed effects in academic achievement observed by 2011 are driven by changes to school quality and not by students sorting to different types of schools. These findings are consistent with Figure 7 which shows overall there are minimal changes to the share of eligible students in 4th grade at each school in 2007 and in 2011.

In the prior section, I calculated how differently students would be expected to sort in a counterfactual where out-of-pocket fees changed but quality did not. Those results indicated an expected reduction in the school quality gap of -0.08, which is higher than the effect due to more sorting when schools cannot adjust their quality in response to the policy. Taken together, these results suggest that the observed equilibrium adjustment by the supply side is a crucial mechanism. Not only have schools played a large role, but had they not improved, students would still not have sorted enough to produce the observed results even when out-of-pocket prices are eliminated.

Since my results highlight the importance of the supply side response, I now focus on the evolution of estimated school value added. Figure 5 plots the distribution of value added conditional on the type of school for 2007 and 2011. On average, value added increases at both public schools and private voucher schools, but there is no change in the non-voucher private sector, which did not participate in the SEP policy. Public schools improved evenly across the distribution, while lower performing voucher schools improved the most. Public schools improved their student-weighted average quality by 0.16σ. Private voucher schools increased their quality by 0.12σ on average, with the largest changes coming from the bottom of the quality distribution.

Figure 5: Distribution of Estimated School Quality



(a) Public Voucher (b) Private Voucher (c) Private Non Voucher

Note: This figure shows the distribution of quality estimated for schools in 2007 (in dark blue) and 2011 (in light blue) using Equation 17 with estimated school quality on the x-axis. Regression coefficients are presented in Table V.

The model of demand and supply indicates that the shift in policy will lead to a new equilibrium with higher quality where all students and schools will be affected, not just the eligible students or participating schools. Students that are not eligible will be affected through several channels. The schools they attend will get more resources, and different schools will make price and quality decisions in different ways given their exposure to the change in incentives created by the policy. For these reasons comparing the evolution of individual-student-level test scores for poor and non poor students, or for eligible and ineligible students, is a purely descriptive exercise.

The model suggests that an appropriate empirical strategy for evaluating the effects of the policy is to consider a school as the unit of observation and evaluate the effects of exposure to the policy based on the preexisting distribution of families across city blocks. Specifically, Equation 15 indicates that schools in neighborhoods with more eligible students that have lower sticker prices will be most affected by the policy. I categorize a school's exposure to the policy based on the concentration of eligible students according to the same process I described earlier.

I run a difference-in-differences regression, exploiting time and cross-sectional variation across schools in neighborhoods with the highest fraction of eligible students and schools in neighborhoods with the lowest fraction of eligible students (see Section section 4). Specifically, I keep schools in the top and bottom quintile of exposure to SEP eligible students and estimate the difference-in-differences model

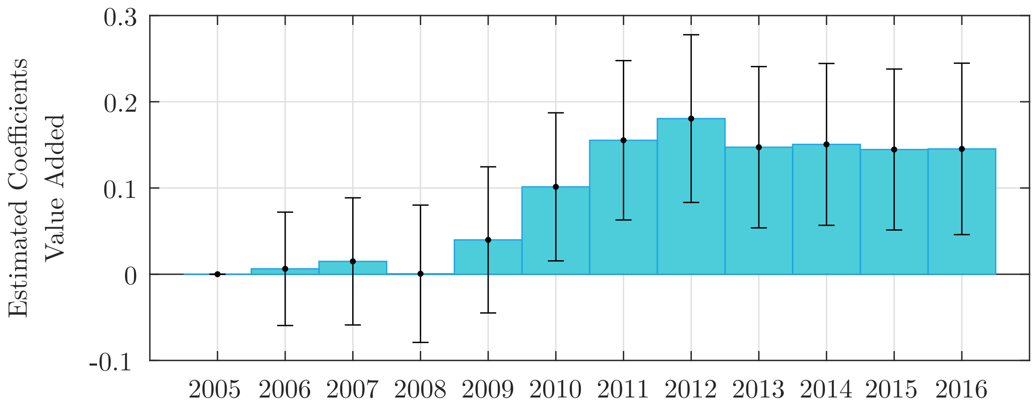
$$\hat{q}_{j,t} = \sum_t \text{High Exposure}_j \beta_t + \gamma_t + \varepsilon_{j,t}, \tag{20}$$

where 2005 serves as the baseline year, and the coefficients γ denote year fixed effects. The dummy variable Exposure_j takes the value 1 if school j is in the top quintile and 0 if school j is in the bottom quintile (I don't include schools in the middle 3 quintiles).

I estimate the model on school value added and find significant effects after 2007. I present these results in Figure 6, and in the first column of Table VI in the Appendix. Reassuringly, there are no observable pre-trends before SEP is in place and there are significant effects on school quality in the poorest neighborhoods relative to the richest ones.

To assess the role of student sorting across schools I perform the same analysis using fitted test scores based on students' observables $X_i\gamma$ estimated on the pre-policy period. This index variable captures the change in student characteristics weighted by their contribution to test scores. I present the results in the fourth column of Table VI in the Appendix.

Figure 6: Differences in Differences Estimates by Policy Exposure



Note: This figure shows the estimated coefficients from a difference-in-differences estimation on school quality $\widehat{q}_{jt}$ (Value Added). The treatment group corresponds to the highest quintile of school level exposure to eligible students, and the control group corresponds to the lowest quintile. The measure of exposure to the policy is calculated as the share of SEP eligible students that live within a 1.5 km radius of the school. Table VI in the Appendix show the details of this regression compared to the same regression over predicted test scores $X_i\gamma$ as an index of student characteristics.

While school value added estimates are large and significant after the policy, estimates for the predicted test score index are very small. I conclude that student characteristics do not change across schools in these differentially exposed neighborhoods. In a complementary analysis, I show in Figure 7 the relationship between the share of poor students at each school in 2007 and 2012. While there are some differences, there are no large changes in the distribution of poor students across schools, again suggesting a minimal role for sorting across schools leading to changes in $s_{j,\not{t}}$.

The previous exercise shows that schools in poorer neighborhoods improved their estimated school value added relative to schools in richer neighborhoods after the SEP policy was implemented. Part of the improvement can be attributed to increased funding, and part of it can potentially be attributed to increased competitive incentives.

I now study the effects of exposure to the policy distinguishing between additional funding and increased competition using a school fixed effects model and a series of measures of school quality. Since revenue from enrollment is endogenous to the school's reaction to the policy, I use the composition of the school in 2007 and adjust the values of the transfers each school would recieve over time to account for changes in resources. Taking into account the simulated revenue over time, I estimate a school level fixed effects model where policy exposure is interacted with time.

I present the results in Table II for measures of quality including school value added, an indicator for SNED prize for academic achievement, and an indicator for whether the school was fined. The results show evidence that resources and exposure to competitive incentives from the policy both increase several measures of school quality and reduce prices.

TABLE II
INCOME AND EXPOSURE TO POLICY - SCHOOL FE

	Private Voucher				Public		
	(1)	(2)	(3)	(4)	(1)	(2)	(3)
	Quality	Has Fine	Has SNED	Price	Quality	Has Fine	Has SNED
% Poor within 1km x SEP Policy	0.015*** (0.003)	-0.011* (0.079)	0.032*** (0.000)	-0.029*** (0.000)	0.013* (0.056)	-0.029*** (0.001)	0.006 (0.483)
Income per Student (Simulated)	0.027*** (0.000)	0.008** (0.036)	-0.003 (0.440)	0.008*** (0.000)	0.007 (0.245)	0.033*** (0.000)	-0.012 (0.102)
Income per Student^2 (Simulated)	0.001** (0.029)	-0.001*** (0.002)	0.001 (0.110)	0.000 (0.128)	0.001*** (0.002)	-0.002*** (0.000)	0.001** (0.015)
Constant	-0.128*** (0.000)	0.156*** (0.000)	0.341*** (0.000)	0.225*** (0.000)	-0.315*** (0.000)	0.178*** (0.000)	0.310*** (0.000)
Year FE	x	x	x	x	x	x	x
School FE	x	x	x	x	x	x	x
R^2	0.674	0.242	0.449	0.929	0.515	0.267	0.359
N Obs	25331	25331	25331	25331	17426	17426	17426

Note: This table shows the results for the exposure to the policy on quality measures and price at schools grouped by the geographic exposure of schools to SEP eligible students. Specifically, I calculate the share of SEP eligible students that live within a 1.5 km radius from the school, to construct an exposure-to-policy measure for schools. The regressions account for simulated income received by schools from out-of-pocket fees and vouchers. The specific simulation is to fix the student composition in 2007 and obtain values of transfers and payments for each year using this fixed enrollment but updating with current voucher values.

Beyond the neighborhood level effects of competition and resources, the model indicates that at the school level, market power and resources will influence prices and quality. I test the predictions of the model by doing three different analysis. The first is to evaluate whether the change in markdowns documented in the counterfactual excersize when out-of-pocket prices are eliminated but schools cannot react. Then I use Equation 15 to evaluate whether the measured markdowns under each policy and the change in marginal revenue across policies is related to the observed change in quality. I present the results of these regressions in Table III. All coefficents have signs that are consistent with the empirical models predictions and lend support for competitive pressure to play some degree of importance in this market.

TABLE III

QUALITY MARKDOWN AND THE CHANGE IN SCHOOL QUALITY

Δ School Quality and Baseline Markdowns $\mu^q((\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e))$		
Constant	-0.0303**	-0.0241**
Quality Markdown in 2007 $\mu^q((\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e))$	1.1807**	1.1835**
Market FE	✓	
Δ School Quality vs Δ Counterfactual Markdowns in 2007		
Constant	0.1649**	0.1474**
Δ Quality Markdown in Counterfactual		
$\mu^q((\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}')) - \mu^q((\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e))$	-0.5048**	-0.5118**
Market FE	✓	
Δ School Quality and Δ Estimated Markdowns and MgRevenue		
Constant	0.2236**	0.2312**
Quality Markdown 2007 $\mu^q((\mathbf{q}_0^e, \mathbf{p}_0^e, \mathbf{op}_0^e))$	0.5184**	0.5386**
Quality Markdown 2011 $\mu^q((\mathbf{q}_2^e, \mathbf{p}_2^e, \mathbf{op}_2^e))$	-0.5874**	-0.5840**
Δ MgRevenue	0.0232**	0.0516**
Market FE	✓	

Note: This table presents the results of three regressions. The top panel presents the results of regressing the estimated mark down for schools in 2007 and the quality estimates in the same year. The middle panel presents the results of regressing the difference in school quality and the difference in estimated markdowns from the counterfactual presented above. The bottom panel I present the results of the regression of Equation 15. The change in marginal revenue represents $\Delta\text{MgRev} = \left[\left[\frac{v_{sep} - p^{\mathrm{e}}_{j,0}}{c_q}\right]\left[\frac{\partial s_{j,\mathrm{E}}(\mathbf{q}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}})}{\partial q_{j,2}}\right] + \left[\frac{p^{\mathrm{e}}_{j,2} - p^{\mathrm{e}}_{j,0}}{c_q}\right]\left[\frac{\partial s_{j,\cancel{\mathrm{E}}}(\mathbf{q}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}})}{\partial q_{j,2}}\right]\right]\left[\frac{\partial s_j(\mathbf{q}_2^{\mathrm{e}}, \mathbf{op}_2^{\mathrm{e}})}{\partial q_{j,2}}\right]^{-1}$.

7. CONCLUSION

In this paper I study how different voucher policies affect student choices, school incentives, and the equilibrium distribution of school quality. To this end, I develop an empirical model of consumer demand and supply with imperfect competition among schools. On the demand side, the model estimates indicate that preferences for school characteristics are heterogeneous across socioeconomic groups, in particular with regard to out-of-pocket prices and distance. On the supply side, modeling schools' choice of price and quality reveals that schools mark down their quality as a function of their local market power. Combining the two sides of my model, I show that schools located in neighborhoods with a large concentration of poor families, who are more sensitive to price and distance, have more local market power and tend to provide lower quality under a flat voucher system. I show that a voucher system with out-of-pocket fees and a flat subsidy per student contributes to inequality across socioeconomic groups due to heterogeneous demand and imperfect competition, even in the absence of additional education specific market failures.

Introducing a larger subsidy for poor students through a targeted voucher policy does two main things to ameliorate the inequality generated by the flat voucher policy. First, it makes a larger set of schools affordable for poorer families, allowing them to enroll in more desirable and potentially higher quality schools. The policy also changes incentives for schools. On the one hand, the policy provides more resources for each poor student and eliminates out-of-pocket fees. This generally increases the marginal revenue schools receive from poor students, especially at schools that originally had low out-of-pocket fees. On the other hand, the policy diminishes schools' local market power by eliminating out-of-pocket fees as a dimension of differentiation and increasing competition.

I use my model estimates to quantify the heterogeneity in market power under a flat voucher and show how moving to a targeted voucher system would expand access and change competitive incentives. I show that eliminating out-of-pocket fees would allow families to choose better schools. However, since these families also value distance and other school attributes, the effects of the policy would be limited without a supply side response. I then show that the change in out-of-pocket fees induced by the targeted voucher policy would increase competitive incentives and, together with the additional resources, would likely lead to an increase in school quality, especially in the poorest neighborhoods.

I use the observed policy change to test the empirical predictions from my model. Guided by the model, I divide the schools into groups depending on the fraction of students that live within 1.5 km of the school that will become eligible for the additional voucher once the policy is changed. I use this differential exposure to the policy together with administrative data on individual school level transfers to show that the policy led to increased quality and lower prices by increasing competition, in addition to the implied increase in resources. Using several different measures of school quality, I show that schools in the poorest neighborhoods increased their quality and that this supply side reaction contributed to higher achievement and lower inequality.

This paper presents one of the first empirical analyses to explicitly consider both demand and supply in a market-oriented school choice system. This framework, taken from the empirical industrial organization literature, is useful for quantifying the different mechanisms behind the large policy impact of the SEP program. My model can also be used to further study how other sets of rules and regulations can affect market allocations.To develop this empirical model, I took advantage of the fact that I can observe the two equilibria of interest to make several simplifying assumptions regarding the educational production function and how families choose what school to attend. Given that aggregate improvements in school quality accrued to the poorest half of the population without any evidence of large scale reshuffling of students, it is unlikely that my results are being driven by assumptions regarding peer effects or selection. However, future work should enrich the model to include these industry specific features in order to develop counterfactual predictions for a wider range of policy questions and situations.

REFERENCES

Agarwal, N., and P. J. Somaini (2019): "Revealed Preference Analysis of School Choice Models," Working Paper 26568, National Bureau of Economic Research.

Aguirre, J. (2017): "Can progressive vouchers help the poor benefit from school choice? Evidence from the Chilean voucher system," .

Allende, C. (2020): "Competition under Social Interactions and the Design of Education Policies," .

Allende, C., F. Gallego, and C. A. Neilson (2019): "Approximating the Equilibrium Effects of Informed School Choice," Working Paper 628, Industrial Relations Section, Princeton University.

Almond, D., and J. Currie (2011): "Killing Me Softly: The Fetal Origins Hypothesis," Journal of Economic Perspectives, 25(3), 153–72.

Anand, P., A. Mizala, and A. Repetto (2009): "Using School Scholarships to Estimate the Effect of Private Education on the Academic Achievement of Low-income Students in Chile," Economics of Education Review, 28(3), 370–381.

Andrabi, T., J. Das, and A. I. Khwaja (2017): "Report cards: The impact of providing school and child test scores on educational markets," American Economic Review, 107(6), 1535–63.

Andrabi, T., J. Das, A. I. Khwaja, S. Ozyurt, and N. Singh (2018): "Upping the Ante: The

Equilibrium Effects of Unconditional Grants to Private Schools," World Bank Policy Research Working Paper, (8563).

Angrist, J., E. Bettinger, E. Bloom, E. King, and M. Kremer (2002): "Vouchers for Private Schooling in Colombia: Evidence from a Randomized Natural Experiment," American Economic Review, 92(5), 1535–1558.

Baum, D., L. Lewis, H. Patrinos, and O. Lusk-Stover (2014): What matters most for engaging the private sector in education: A framework paper. World Bank.

Behrman, J. R., and M. R. Rosenzweig (2004): "Returns to Birthweight," Review of Economics and Statistics, 86(2), 586–601.

Berry, S. (1994): "Estimating Discrete-Choice Models of Product Differentiation," The RAND Journal of Economics, pp. 242–262.

Berry, S., and P. Haile (2016): "Identification in differentiated products markets," Annual review of Economics, 8, 27–52.

Berry, S., J. Levinsohn, and A. Pakes (1995): "Automobile Prices in Market Equilibrium," Econometrica: Journal of the Econometric Society, pp. 841–890.

——— (2004): "Differentiated Products Demand Systems from a Combination of Micro and Macro Data: The New Vehicle Market," V Journal of Political Economy, 112(1), 68.

Berry, S. T., and P. A. Haile (2014): "Identification in differentiated products markets using market level data," Econometrica, 82(5), 1749–1797.

Bettinger, E. (2011): "Educational Vouchers in International Contexts," 4.

Beyer, H., J. S. Hastings, C. A. Neilson, and S. Zimmerman (2015): "Connecting Student Loans to Labor Market Outcomes: Policy Lessons from Chile," American Economic Review, 105(5), 508–513.

Beyer, H., F. Larraín, and R. Vergara (2000): "Entre la autonomía y la intervención: las reformas de la educación en Chile," La transformación económica de Chile, pp. 644–708.

Bharadwaj, P., J. Eberhard, and C. A. Neilson (2017): "Do initial endowments matter only initially? The persistent effect of birth weight on school achievement," forthcoming Journal of Labor Economics.

Bharadwaj, P., K. V. Loken, and C. A. Neilson (2013): "Early Life Health Interventions and Academic Achievement," American Economic Review, 103(5), 1862–91.

Calle, F., S. Gallegos, and C. A. Neilson (2019): "Screening and Recruiting Talent At Teacher Colleges," Discussion Paper 143.

Card, D., M. Dooley, and A. Payne (2010): "School Competition and Efficiency with Publicly Funded Catholic Schools," American Economic Journal: Applied Economics, 2(4), 150–76.

Carneiro, P. M., J. Das, and H. Reis (2016): "The value of private schools: Evidence from Pakistan," Discussion paper.

Chay, K. Y., P. J. McEwan, and M. Urquiola (2005): "The central role of noise in evaluating interventions that use test scores to rank schools," American Economic Review, 95(4), 1237–1258.

Correa, J. A., F. Parro, and L. Reyes (2014): "The Effects of Vouchers on School Results: Evidence from Chile's Targeted Voucher Program," Journal of Human Capital, 8(4), 351–398.

Cuesta, J. I., F. Gonzalez, and C. Larroulet (2017): "Distorted quality signals in school markets," Manuscript.

Currie, J., and D. Almond (2011): "Human Capital Development Before Age Five," Handbook of Labor Economics, 4, 1315–1486.

Davis, P. (2006): "Spatial Competition in Retail Markets: Movie Theaters," The RAND Journal of Economics, 37(4), 964–982.

de Estudios MINEDUC, C. (2012): "Impacto de la Ley SEP en SIMCE: una mirada a 4 años de su implementación," Discussion Paper 8, Ministerio de Educación de Chile.

de Moura Castro, C., and V. Espinola (1999): Economía política de la reforma educacional en Chile: la reforma vista por sus protagonistas. Banco Interamericano de Desarrollo.

de Políticas Públicas, C. (2012): "Evaluación de los primeros años de Implementación del Programa de Subvención Escolar Preferencial, de la Secretaría de Educación," Discussion paper.

Dinerstein, M., T. Smith, et al. (2014): "Quantifying the supply response of private schools to public policies," Discussion paper.

Drago, J. L., and R. Paredes (2011): "The Quality Gap in Chile's Education System," CEPAL REVIEW, 141.

Epple, D., and R. Romano (2008): "Educational Vouchers and Cream Skimming," International Economic Review, 49(4), 1395–1435.

Epple, D., R. E. Romano, and M. Urquiola (2017): "School vouchers: A survey of the economics literature," Journal of Economic Literature, 55(2), 441–492.

Feigenberg, B., R. Yan, and S. Rivkin (2019): "Illusory Gains from Chile's Targeted School Voucher Experiment*," The Economic Journal.

Figlio, D., and C. Hart (2014): "Competitive effects of means-tested school vouchers," American Economic Journal: Applied Economics, 6(1), 133–56.

Gallego, F., and C. Sapelli (2007): "El financiamiento de la educación en Chile: una evaluación," Revista de Pensamiento Educativo, 40(1), 263–284.

Gallego, F. A., and A. Hernando (2010): "School choice in Chile: Looking at the demand side," Pontificia Universidad Católica de Chile Documento de Trabajo, (356).

Gauri, V. (1999): School Choice in Chile: Two Decades of Educational Reform. University of Pittsburgh Pre.

González, P., A. Mizala, and P. Romaguera (2002): "Recursos diferenciados a la educación subvencionada en Chile," Documentos de Trabajo 150, Centro de Economía Aplicada, Universidad de Chile.

Hastings, J. S., T. J. Kane, and D. O. Staiger (2009): "Preferences and Heterogeneous Treatment Effects in a Public School Choice Lottery," NBER Working Papers 12145, National Bureau of Economic Research, Inc.

Hastings, J. S., C. A. Neilson, and S. Zimmerman (2015): "The Effects of Earnings Disclosure on College Enrollment Decisions," NBER Working Papers 21300.

Hastings, J. S., and J. M. Weinstein (2008): "Information, School Choice, and Academic Achievement: Evidence from Two Experiments," The Quarterly Journal of Economics, 123(4), 1373–1414.

Henriquez, F., B. Lara, A. Mizala, and A. Repetto (2012): "Effective schools do exist: low-income children's academic performance in Chile," Applied Economics Letters, 19(5), 445–451.

Hoxby, C. M. (2000): "Does Competition among Public Schools Benefit Students and Taxpayers?," American Economic Review, 90(5), 1209–1238.

Hoxby, C. M. (2003): "School choice and school productivity. Could school choice be a tide that lifts all boats?," in The economics of school choice, pp. 287–342. University of Chicago Press.

Hoxby, C. M. (2007): The Economics of School Choice. University of Chicago Press.

Hsieh, C.-T., and M. Urquiola (2006): "The Effects of Generalized School Choice on Achievement and Stratification: Evidence from Chile's Voucher Program," Journal of Public Economics, 90(8-9), 1477–1503.

Judd, K. L., and B. Skrainka (2011): "High performance quadrature rules: how numerical integration affects a popular model of product differentiation," CeMMAP working papers CWP03/11, Centre for Microdata Methods and Practice, Institute for Fiscal Studies.

Mizala, A., and P. Romaguera (2000): "School Performance and Choice: The Chilean Experience," Journal of Human Resources, pp. 392–417.

Mizala, A., and F. Torche (2013): "Logra la subvención escolar preferencial igualar los resultados educativos?," Discussion paper.

——— (2017): "Means-Tested School Vouchers and Educational Achievement: Evidence from Chile's Universal Voucher System," The ANNALS of the American Academy of Political and Social Science, 674(1), 163–183.

Mizala, A., and M. Urquiola (2013): "School Markets: The Impact of Information Approximating Schools Effectiveness," Journal of Development Economics.

Muñoz, N., I. Irarrázaval, D. Keim, L. Gaete, H. Jiménez, and D. Quezada (2020): "Subvención Escolar Preferencial: Gestión y uso de los recursos en sus 10 años de implementación.," Discussion paper, Centro UC Politicas Publicas.

Muralidharan, K., and V. Sundararaman (2015): "The aggregate effect of school choice: Evidence from a two-stage experiment in India," The Quarterly Journal of Economics, 130(3), 1011–1066.

Murnane, R. J., M. R. Waldman, J. B. Willett, M. S. Bos, and E. Vegas (2017): "The Consequences of Educational Voucher Reform in Chile," Working Paper 23550, National Bureau of Economic Research.

Neal, D. (2002): "How Vouchers Could Change the Market for Education," Journal of Economic Perspectives, 16(4), 25–44.

Nechyba, T. J. (2000): "Mobility, Targeting, and Private-School Vouchers," American Economic Review, 90(1), 130–146.

Nevo, A. (2001): "Measuring market power in the ready-to-eat cereal industry," Econometrica, 69(2), 307–342.

Petrin, A. (2002): "Quantifying the Benefits of New Products: The Case of the Minivan," Journal of Political Economy, 110(4), pp. 705–729.

PISA (2017): "Where did equity in education improve over the past decade.," Discussion Paper 68, OECD.

Prieto, A. (1983): La Modernización Educacional, vol. 1. Universidad Catolica de Chile.

Raczynski, D., G. Muñoz, J. Weinstein, and J. Pascual (2013): "Subvención Escolar Preferencial (SEP) en Chile: un Intento por Equilibrar la Macro y Micro Política Escolar," REICE. Revista Iberoamericana sobre Calidad, Eficacia y Cambio en Educación, 11(2), 164–193.

Rouse, C. E. (1998): "Private school vouchers and student achievement: An evaluation of the Milwaukee Parental Choice Program," The Quarterly journal of economics, 113(2), 553–602.

Rouse, C. E., and L. Barrow (2009): "School Vouchers and Student Achievement: Recent Evidence and Remaining Questions," Annual Review of Economics, 1(1), 17–42.

Rouse, C. E., J. Hannaway, D. Goldhaber, and D. Figlio (2013): "Feeling the Florida Heat? How Low-Performing Schools Respond to Voucher and Accountability Pressure," American Economic Journal: Economic Policy, 5(2), 251–81.

Sánchez, C. (2018): "Understanding school competition under voucher regimes," Discussion paper.

Singleton, J. D. (2017): "Putting dollars before scholars? Evidence from for-profit charter schools in Florida," Economics of Education Review, 58, 43–54.

Spence, A. (1975): "Monopoly, Quality, and Regulation," Bell Journal of Economics, 6(2), 417–429.

The Economist (2015): "The $1-a-week school," The Economist Magazine.

Urquiola, M. (2016): "Competition among schools: Traditional public and private schools," Handbook of the Economics of Education, 5, 209–237.

Valenzuela, J., G. Villarroel, and C. Villalobos (2013): "Ley de Subvención Escolar Preferencial (SEP): algunos resultados preliminares de su implementación [Preferential School Subsidy Law (SEP): some preliminary results of its implementation]," Revista Pensamiento Educativo, 50(2), 113–131.

8. APPENDIX

TABLE IV

Average Standarized Test Scores by Measures of Socioeconomic Status

	Avg. Standarized	By Imputed SES					By SEP Eligibility		By SES from HH Survey	
Year	Test Score (AVE)	20% lowest	40% lowest	60% highest	40% highest	20% highest	Eligible	Ineligible	40% lowest	60% highest
2005	0.105	-0.321	-0.234	0.291	0.460	0.774	-	-	-0.242	0.353
2006	0.060	-0.362	-0.277	0.247	0.410	0.713	-	-	-0.227	0.366
2007	0.053	-0.384	-0.291	0.250	0.416	0.730	-	-	-0.297	0.322
2008	0.126	-0.277	-0.175	0.353	0.551	0.829	-0.206	0.311	-0.211	0.367
2009	0.198	-0.172	-0.057	0.423	0.596	0.836	-0.073	0.408	-0.132	0.411
2010	0.281	-0.117	-0.033	0.469	0.602	0.835	0.032	0.450	0.030	0.522
2011	0.289	-0.045	0.019	0.445	0.562	0.786	0.075	0.435	0.078	0.454
2012	0.326	-0.011	0.060	0.479	0.602	0.809	0.114	0.473	0.116	0.508
2013	0.231	-0.109	-0.039	0.386	0.511	0.720	0.030	0.429	-	-
2014	0.232	-0.091	-0.026	0.383	0.510	0.709	0.026	0.416	-	-
2015	0.283	-0.061	0.013	0.438	0.566	0.760	0.077	0.445	-	-
2016	0.325	-0.019	0.061	0.477	0.611	0.801	0.126	0.478	-	-

Note: This table shows average test scores over time and broken down by different definitions of socioeconomic status. The first column considers all students and schools in the study sample. The next five columns show averages by the imputed poverty index (Imputed SES). The following two show average scores by SEP eligibility and the last two use household income per capita measured from a household survey. A subset of these statistics are used to calculate gaps in achievement that are presented in Figure 4.

TABLE V

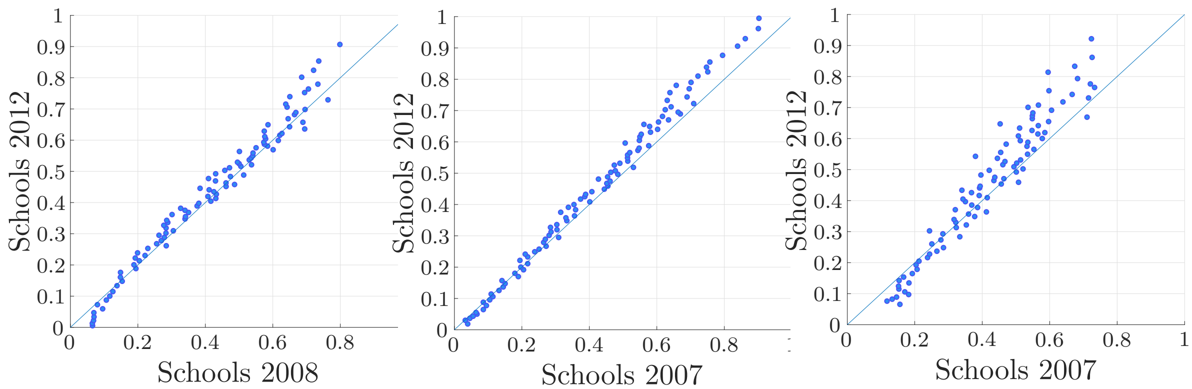
Estimates of the production function coefficients

	(1) AVE 2005-2016	(2) AVE 2005-2007 & 2010-2012	(3) AVE 2005-2007	(4) AVE 2005-2011
Mother High School	0.202***	0.208***	0.226***	0.211***
Mother More than High School	0.276***	0.271***	0.304***	0.279***
Male	-0.064***	-0.052***	-0.036***	-0.054***
Parents Married	0.056***	0.072***	0.065***	0.055***
Single Birth	0.054***	0.058***	0.060***	0.063***
First Born Child	0.056***	0.074***	0.090***	0.069***
Constant	-0.092***	-0.151***	-0.319***	-0.180***
FE by varios health and family demographics†	✓	✓	✓	✓
School by Year FE	✓		✓	✓
School by Group Year FE		✓		
R^2	0.31	0.28	0.31	0.31
N Obs	2,164,812	1,108,152	563,073	1,282,807

Note 1: This table shows the regression coefficients of the estimated production function with different subsamples of data. The first two columns show the estimation of value added by school by year fixed effect considering all years, and by school by group of years fixed effects, considering only two periods 2005-2007 and 2010-2012. Columns (3) and (4) repeat these estimations for different subsamples of years. All listed coefficients are statistically significant and have $\sigma = 0.000$.

Note 2†: The total number of covariates is 50, where many sets of fixed effects are included such as mother's college entrance exam score groups for math and language tests (10 groups and 9 covariates each), mother and father occupation categories, birth conditions groups, considering length, weight and gestation (5 groups and 4 covariates each); location of birth group (3 groups and 2 covariates); and region of birth (12 groups and 11 covariates).

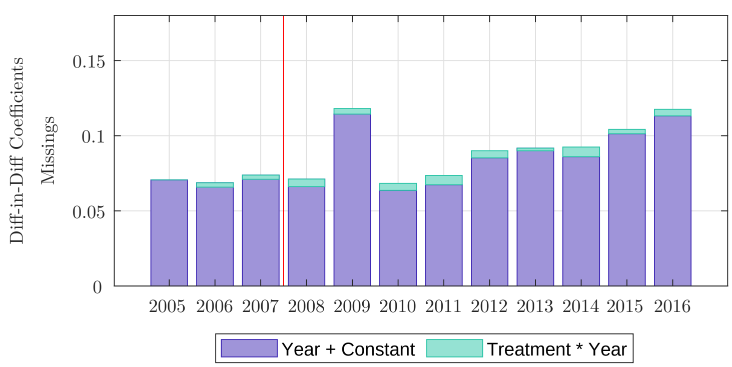
Figure 7: Share of poor students by school before and after the policy



(a) SEP Eligible (b) Imputed Eligibility (c) HH Survey

Note: This figure shows three binscatter plots comparing shares of poor students before and after the policy, considering three different measures. Panel (a) shows the share of priority students in 2008 and 2012 by school. Panel (b) shows the share of students with imputed priority in 2007 and 2012. Panel (c) shows the share of poor students measured in the HH survey as the 40% poorest families in the income distribution, in 2007 and 2012. The imputed priority is the predicted poverty status obtained with a logit estimation of being a priority student over a large vector of individual student level characteristics and fixed effects by market. I categorize as imputed priority student the one that belongs to the poorest 40% of the predicted distribution each year. The vector of variables is the same shown in Table V.

Figure 8: Difference-in-differences estimation for Missings Test Scores



Note: This figure shows diff-in-diff estimates for missings test scores. The dependent variable of the estimation is dichotomic and takes the value 1 if the test is missing on the data, and there is not an excused absence reported. The treatment group corresponds to the highest quintile of school-level exposure to eligible students, and the control group corresponds to the lowest quintile. The measure of exposure to the policy is calculated as the share of SEP eligible students that live within a 1.5 km radius from the school.

TABLE VI

Differences in Differences Estimates by Policy Exposure

	(1)		(2)		(3)		(4)	
			Robustness Imputations					
	$\widehat{q}_{jt}$		Lowest 25		All		$X_i\widehat{\gamma}$	
	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err	Coef.	Std.Err
Q5 % Poor within 1km (T)	-0.423***	(0.000)	-0.443***	(0.026)	-0.442***	(0.026)	-0.196***	(0.000)
Q5 % Poor within 1km (T) ×2006	0.006	(0.709)	0.009	(0.017)	0.009	(0.017)	0.001	(0.679)
Q5 % Poor within 1km (T) ×2007	0.015	(0.428)	0.020	(0.019)	0.021	(0.019)	-0.005**	(0.026)
Q5 % Poor within 1km (T) ×2008	0.001	(0.979)	0.003	(0.020)	0.003	(0.020)	-0.006**	(0.022)
Q5 % Poor within 1km (T) ×2009	0.040*	(0.065)	0.033	(0.022)	0.038*	(0.021)	0.002	(0.560)
Q5 % Poor within 1km (T) ×2010	0.101***	(0.000)	0.091***	(0.022)	0.094***	(0.022)	-0.009***	(0.009)
Q5 % Poor within 1km (T) ×2011	0.155***	(0.000)	0.145***	(0.023)	0.149***	(0.023)	-0.007*	(0.074)
Q5 % Poor within 1km (T) ×2012	0.181***	(0.000)	0.169***	(0.025)	0.173***	(0.025)	-0.006	(0.141)
Q5 % Poor within 1km (T) ×2013	0.147***	(0.000)	0.143***	(0.024)	0.145***	(0.024)	-0.005	(0.200)
Q5 % Poor within 1km (T) ×2014	0.151***	(0.000)	0.146***	(0.024)	0.149***	(0.024)	0.016***	(0.000)
Q5 % Poor within 1km (T) ×2015	0.145***	(0.000)	0.136***	(0.024)	0.137***	(0.024)	0.001	(0.829)
Q5 % Poor within 1km (T) ×2016	0.145***	(0.000)	0.132***	(0.025)	0.135***	(0.025)	0.019***	(0.000)
Constant	0.186***	(0.000)	0.213***	(0.019)	0.205***	(0.019)	0.339***	(0.000)
Year FE	✓		✓		✓		✓	
R^2	0.175		0.400		0.177		0.180	
N Obs	778,899		856,486		856,486		778,899	

Note: This table shows the estimated coefficients from a difference-in-differences estimation on school quality $\widehat{q}_{jt}$ (Value Added) and the predicted test scores $X_i\gamma$ as an index of student characteristics. The treatment group corresponds to the highest quintile of school level exposure to eligible students, and the control group corresponds to the lowest quintile. The measure of exposure to the policy is calculated as the share of SEP eligible students that live within a 1.5 km radius from the school. Column (1) shows the main results for value added and Column (4) shows the results for the predicted test scores. Columns (2) and (3) perform robustness checks to the estimation in Column (1) with imputed data on missings scores. I estimate 100 imputations for each missing score in each school, and use the averages of the lowest 25 imputations and the average of all the imputations. After including imputations, the results remain similar to the first estimation, reassuring that differences-in-differences are robust to considering imputations. An extended version of this procedure is presented in the Online Appendix.

TABLE VII

School Choice Survey - 2009

		Quintiles				
Reason	Total	1	2	3	4	5
Close to home	52%	65%	65%	62%	59%	50%
School infrastructure	23%	18%	22%	26%	31%	36%
Friends are there	10%	12%	12%	12%	11%	10%
Values of the school	29%	23%	28%	32%	38%	47%
Academic Excellence (SIMCE)	31%	25%	31%	37%	41%	49%
Had a technical area	3%	4%	4%	3%	3%	2%
It was the cheapest	21%	34%	32%	27%	21%	12%
Only school in the area	4%	7%	6%	4%	4%	3%
Was not accepted at others	2%	2%	2%	2%	2%	1%
Siblings went there	22%	29%	29%	26%	23%	21%
Bilingual School	5%	2%	3%	3%	4%	10%
Other reasons	26%	25%	29%	31%	33%	33%

Note: This table presents the results from a parent survey of 4th grade SIMCE test-taking students regarding the most important reasons they chose their school. They could choose three reasons. Per capita household income is used to calculate income quintiles.

TABLE VIII

Demand Model Estimates

Parameter	Coef.	Std. Error
Quality	1.07	0.06
Forprofit	-0.54	0.031
School Religion	0.04	0.025
School Private Voucher	0.11	0.034
School Private No Voucher	-0.18	0.098
Private Voucher X Existed 1995	0.08	0.017
Private Non Voucher X Existed 1995	0.41	0.073
Has High School	0.27	0.018
Quality x HS Mom	0.34	0.077
Quality x College Mom	2.33	0.064
Quality x SEP	-0.74	0.047
Price x NHS Mom	-8.31	0.762
Price x HS Mom	-0.53	0.024
Price x College Mom	-0.01	0.01
Price x SEP	-0.73	0.097
Distance x NHS Mom	-1.19	0.044
Distance x HS Mom	-0.52	0.005
Distance x College Mom	-0.58	0.007
Distance x SEP	-0.37	0.024
Sigma Preference - Quality	0.54	0.034

Note: Integration over unobserved heterogeneity induced by v_i^q is done using a seven point Gaussian-Hermite quadrature as described in Judd and Skrainka (2011). A nested fixed point algorithm was used in calculating the estimates presented in this table. Data is from 2007 and 2011.