

# Approximating the Equilibrium Effects of Informed School Choice

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## Abstract

This paper studies the potential small and large scale effects of a policy designed to produce a more informed consumer demand in the context of the market for primary education. We develop and test a personalized information provision intervention that targets families of public Pre-K students entering the elementary school system in Chile. Using a randomized control trial, we find that the intervention shifts parents' choices toward schools with higher average test scores, higher value added, higher prices, and schools that tend to be further from their home. Tracking students using administrative data, we find that student academic achievement on test scores was approximately 0.2 standard deviations higher among treated families five years later. To quantitatively gauge how average treatment effects might vary in the context of a scaled up version of this policy, we embed the randomized control trial within a structural model of school choice and competition where price and quality are chosen endogenously and schools have capacity constraints. We use the estimated model of demand and supply to simulate policy effects under different assumptions about equilibrium constraints. In counterfactual simulations, we find that capacity constraints play an important role mitigating the policy effect on impact but in several scenarios, the supply-side responses leads to increased quality which contributes to an overall positive average treatment effect. Finally, we show how model estimates using the RCT can be used to inform the design of a large scale experiment such that reduced form estimates can capture equilibrium effects and spillovers.

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# 1 Introduction

The lack of information about product quality can affect consumer behavior and have important effects on equilibrium market outcomes (Akerlof, 1970). In markets for educational services, information and its effects on consumer behavior can have important effects on equilibrium levels of school quality (Andrabi et al., 2017). In addition, lack of information can have distributional effects, given that families from less educated socioeconomic backgrounds may be particularly misinformed and have more difficulty acquiring information (Hastings and Weinstein, 2008; Elacqua and Martínez, 2016).<sup>1</sup> Additionally, poorer families may not have accurate information about the returns to many investments, including underestimating the return to human capital investments (Jensen, 2010; Banerjee and Duflo, 2011). This combination can lead poor families in developing countries to under-invest in human capital by spending less time and energy searching for and acquiring information about what school to choose for their children. In the aggregate, a lower interest in school quality could also lead to an equilibrium with a lower quality schools than would be expected in a market with full information. These concepts are supported by empirical evidence and an emerging consensus that information and marketing interventions in education settings can shift individual choices, although specific effects depend on context, implementation, and design details (Lavecchia et al., 2016). However, with the notable exception of Andrabi et al. (2017), evidence regarding the equilibrium policy effects of large scale interventions are much less common, and evidence of what mechanisms are at play is even scarcer.

In this paper we explore the equilibrium implications of a government policy that provides information to the parents of Pre-K students in Chile. We develop a scalable, policy relevant intervention that consists of a video and a report card. Both provide personalized information about characteristics of nearby schools and a broad message emphasizing the feasibility and importance of searching for a school carefully. The intervention adapts ideas from previous work in other settings and the design accounts for local policy constraints.<sup>2</sup> We use a small-scale randomized control trial to evaluate the impact of our policy intervention on individual household school choices and later academic outcomes. The results from the randomized control trial show that household school choice decisions shift toward schools with higher test scores and higher prices on average. We use administrative data to track students over a five year period and find that the treated group had higher test scores on average, suggesting the intervention increased academic achievement, at least partly due to changes in school choice.

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<sup>1</sup>There is ample empirical evidence of an information-socioeconomic gradient. See Hastings and Weinstein (2008) for evidence of parents in the USA lacking information about schools and their characteristics, and Elacqua and Martínez (2016); Hastings et al. (2016) for additional evidence from Chile.

<sup>2</sup>For example, relevant prior interventions with successful impacts include work by Hastings and Weinstein (2008), and Andrabi et al. (2017), which both provide a report card with school test scores. Jensen (2010) provides middle school children in the Dominican Republic, information on how earnings change by level of education, and Dinkelman and Martinez (2014) show evidence of the effects of providing information about financial aid through videos in Chile.

We quantify the way the policy modifies families' behavior by explicitly incorporating incomplete information into the empirical model of school choice developed in Neilson (2013). The framework directly accommodates evidence from a randomized control trial and administrative data on the choices of the entire student population. Using the estimated empirical model of school choice, we explore how average policy effects change when the policy is implemented nationally, specifically taking into account capacity constraints and heterogeneous market structure across neighborhoods. When capacity constraints are taken into account, the average effect of the policy is still positive, but only half as large, as increased demand for higher quality schools in disadvantaged neighborhoods crowds itself out.

We next study the potential for the policy to generate equilibrium supply side effects in the medium run. We take advantage of recent variation in voucher funding policy together with detailed panel data on the population of schools to estimate a static model of school competition among current providers in the spirit of work in empirical industrial organization such as Berry et al. (1995) and Wollmann (2018). We use the estimated parameters of the cost structure to evaluate the effects that a national policy would have on schools' incentives to provide quality and set prices. We then study the resulting equilibrium distribution of school characteristics induced by the new policy when schools can only adjust prices and quality. We find that the new equilibrium features higher prices and higher quality schools on average. The increase in quality is found to more than compensate for the increased congestion and lack of capacity at higher quality schools. In our preferred model specifications, the effects of the policy on the achievement gap are found to be positive and even higher than the average treatment effects found in the small-scale randomized control trial.

The results from the randomized control trial and the modeling of demand and supply complement each other to provide a policy recommendation. The small-scale randomized control trial shows there is scope for simple information intervention to change behavior. The different simulations of an at-scale implementation highlight the importance of equilibrium considerations such as capacity constraints and the supply side reaction to invest in quality, raise prices, or expand capacity. Taken together, the simulations imply a range of results indicating that low SES test scores would increase, and the SES achievement gap would decrease.

Our paper makes two main contributions. First, we provide evidence on the role of a policy-relevant information and marketing intervention in education markets at both the micro and macro level. This distinction is relevant because the difference between partial and equilibrium effects can be important in education contexts as has been noted in Heckman et al. (1998). At the same time, aggregate level ex-ante policy evaluation is difficult, if not impossible in many cases. Building evidence solely on randomized control trials will take time and significant resources to implement at scale evaluations in many applications. These considerations make it difficult to provide quantitative policy advice in a timely way. This is unsurprising since shifting behavior

of many individuals is likely to have nontrivial general equilibrium effects that are difficult to account for in a randomized control trial. One important exception is recent work by Andrabi et al. (2017), which has shown that in Pakistan, providing school report cards in small village markets increased academic achievement without significant student sorting, suggesting that information on school quality and price can lead to changes in the aggregate and that the supply side reactions to information is a relevant margin to consider. While this experimental evidence is a rigorous proof of concept, it is hard to generalize the findings and make policy recommendations in other settings. In fact, some policies that generate signals of quality and are similar in spirit have not provided the same results. One important example is Mizala and Urquiola (2013), where a policy that provided a signal of school quality in Chile seems to not had any effect on school choice. Taken together, the empirical evidence to date indicates that information interventions do have the potential to change behavior but that policy details can matter quite a lot. The evidence presented in this paper shows that the specific policy intervention tested influences how families choose schools. Without an at-scale randomized control trial, we approximate the equilibrium implications of a national policy considering sorting, capacity constraints and schools supply side reaction to the policy. The results point toward a positive partial equilibrium policy effect that is dampened by capacity constraints. However, the equilibrium effects including schools reactions suggest large positive effects across a spectrum of potential assumptions.

Our second main contribution is to present an empirical framework that builds on a small-scale experiment to then approximate the effects of a large scale implementation of the policy. We use both theory and data to build on evidence from a randomized control trial to provide estimates that can be used to consider implementing the policy or whether to proceed and plan for an at-scale experiment to gather more evidence. By explicitly modeling the consequences of changing individual choices on both the demand and the supply side, this empirical framework allows the researcher to quantify the policy implications and provide counterfactual analysis. This approach is one way to provide quantitative policy recommendations when implementing randomized control trials at-scale is infeasible, expensive or just not timely.

The empirical methods used add to a growing body of research that takes advantage of the variation created by RCTs and other credibly exogenous sources of variation. Some papers have used randomized control trials to estimate key parameters or to validate the predictions of a structural model. For example, this approach was famously used to evaluate PROGRESA in seminal work by Todd and Wolpin (2006). Our paper is different because the randomized control trial is not used to validate the model, nor is the structural model used to quantify the effects of changing different features of the policy. In Attanasio et al. (2011), the experimental data both provide variation at scale and a way to identify new parameters associated with the effect of the policy. However, our main objective is to extrapolate the effects of the policy to individuals beyond the experiment and estimate the equilibrium supply side reaction when we do not observe aggregate



policy effects.

In this way, our equilibrium analysis is closer to policy evaluations of potential mergers, where estimating equilibrium responses to changes in demand and supply play a key role in evaluating the impacts of counterfactual policies that could be implemented. This allows the researcher to provide insight on the behavior of families who face different choice sets beyond the experimental sample. We can also explore the consequences of aggregate effects on demand when there are capacity constraints, and then on supply side considerations such as the choice of quality.<sup>3</sup>

Our paper also contributes to the line of work developing structural models of education markets by explicitly adding experimental variation to the modeling of supply and demand. While empirical models of market equilibrium are commonly used to evaluate policy in empirical industrial organization research, these types of models have rarely been applied to education markets and do not usually incorporate experimental variation.<sup>4</sup> In this paper, we argue that using a coherent economic framework to follow the logical implications of changing individual behavior expands the set of questions that researchers can ask. Our framework allows for a range of policy relevant predictions that can be useful for translating evidence and research into policy recommendations in education settings.

## 2 Data and Institutional Setting

We use several data sources for this project. First, we use administrative data on preschools from *Integra*, a preschool education provider, which includes information on the preschool location, enrollment, attendance, socio-economic level (measured as mother's schooling), income, and poverty<sup>5</sup>. Second, we use self-collected data through the baseline and follow up surveys in the preschools included in our experiment, which we discuss in detail in Section 4. These data include contact information, individual identifiers, location of the family, and questions regarding the application process. Then, we match this information with administrative data from the Ministry of Education.

The first source of administrative data are student-by-year matriculation records from the Ministry of Education of Chile (MINEDUC), along with information on grades and some basic demographic information. This also includes individual-level eligibility for the *Subvencion Escolar*

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<sup>3</sup>One interesting application of similar ideas is Lise et al. (2015). They evaluate employment programs taking advantage of experimental variation and their treatment of equilibrium considerations is similar in spirit to what we look to achieve in our paper, although applied to the context of job training and employment.

<sup>4</sup>Some exceptions on work on school choice in education markets include work by Neilson (2013); Dinerstein and Smith (2015); Walters (2018). The model of school choice and competition in this paper builds on prior work in this space by Neilson (2013), and earlier work on school choice in Chile by Gallego and Hernando (2008) and Chumacero et al. (2011).

<sup>5</sup>See Section O-1 in the online appendix for further description of provision of preschool education in Chile.

*Preferencial* (SEP) targeted voucher. The second source of administrative data from MINEDUC is related to students test scores from the SIMCE test and an accompanying survey of the population of 2nd, 4th and 8th grade students. The survey contains detailed information about the household composition, demographics, and income. This data is complemented with data from the Ministry of Health which include all births in the country after 1992 and contains information on the health conditions of a child at birth such as birth weight, length, and gestation. It also contains information regarding the mother and father, such as education level and marital status.<sup>6</sup>

A third source of data available from the Ministry of Education consist of the administrative records on all schools in the country. This source lists each schools's type, matriculation rate by grade level, address, and other school characteristics, such as religious affiliation and tuition. Data on all transfers to schools is also available monthly since 2005<sup>7</sup>. All yearly school expenditures are available since 2014<sup>8</sup>. We associate each school with the markets defined by Neilson (2013) using census track information. We also add data on all the transfers made by the Ministry of Education to public and private voucher schools. We complement this school panel with data on teachers and principals from (Calle et al., 2018). In that paper, college entrance exam scores are matched to each teacher registered by the Ministry of Education.

Our study is focused on urban schooling markets. We use the procedure to define urban schooling markets described in Neilson (2013) and leverages administrative data from the 2002 and 2012 Census with block level shapefiles and geocoded microdata on the population. This data is used to produce the boundaries of urban schooling markets as well as a detailed description of the distribution of the students and schools within markets.<sup>9</sup> After excluding very small markets (with less than five schools), we focus on 74 distinct urban markets that in 2012 contain 3937 schools, 181,000 students which represents 90% of urban students in first grade.

Using the data on students and schools in our sample of interest, we estimate measures of test score value-added at the school level as a proxy of school quality. The data available provide a rich set of characteristics to condition on and in some years, students prior test scores can be used as controls as well. We find that these measures of value added are very correlated with teacher quality as measured by teacher college entrance exams and that controlling for prior test scores provides similar results to not having prior scores when ranking schools by measure of quality. These calculations are presented in the online appendix.

We are interested in studying the differences in choices and access across socioeconomic groups.

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<sup>6</sup>Most of these datasets are described in detail in the online appendix of Neilson (2013), so we refer the reader there for more details.

<sup>7</sup>See Section O-6.1 in the online appendix.

<sup>8</sup>See Section O-6.2 in the online appendix.

<sup>9</sup>We present further details in the online appendix and refer the reader to Neilson (2013).

We divide the population of students into three groups, those whose mother had not completed high school at the time of birth (labeled No HS Mom, 15% of the population), those who had completed only high school (labeled HS Mom, 60% of the population) and those who completed more than a high school education (labeled College Mom, 25% of the population). We divide schools into quintiles of the socioeconomic status of the people who live within 1km of the school. Specifically, we calculate the percent of students who live within 1km that are poor enough to be eligible for a targeted voucher (intended for the 40% poorest students).

In Chile, most students enter primary school in Kindergarten at the age of 5. Prior to entering primary schools, the vast majority of children attend Pre-K institutions where net enrollment rates at ages 3 and 4 are 55% and 87%, respectively (OECD, 2016). Children can attend public or private centers. The two main providers of free public Pre-K are Junji and Fundación Integra, which administer approximately 3,000 and 1,000 centers respectively, and are explicitly tasked with providing access to Pre-K educational services for students all over the country. Of the 3 and 4 year old students enrolled in preschools in 2016, 42% were in Junji, and 18% in Integra.<sup>10</sup> The majority of these students live in urban markets (88% of those enrolled in Junji and Integra) and families tend to send their children to Pre-Ks very close to their homes.<sup>11</sup> We implement our information experiment among Integra centers.

Transiting from a Pre-K institution to a primary school requires parents to apply and sign up for school at some point before the start of the academic year. Until 2016 (i.e., during the our experiment), this process was decentralized and the timing of the application and matriculation process was heterogeneous. In 2016, a pilot version of a centralized application system started working in the southernmost region of the country. In 2017, the system was extended to 5 regions, and it will be implemented in the whole country in 2019.

Primary schools in Chile are either free public schools, private voucher schools or private non-voucher schools. The system features a high degree of choice and a large private sector. In 2016, the market share for first-grade students was 36% for public schools, 55% for voucher schools, and 8% for private schools. Private voucher schools can charge an additional out-of-pocket fee beyond the voucher, but there are some caps and discounts that limit the fee for schools that receive government funds. In 2016, 63% of voucher schools in urban areas are free and 86% have a fee lower than 70 USD (15% of the minimum wage). In addition, several policy changes have modified the transfers schools get per student. In particular, a large change occurred in 2008 when the government introduced a larger voucher for the poorest 40% of students in schools that signed up for the policy. This policy required schools to not charge eligible students any out-of-pocket

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<sup>10</sup>We calculated these numbers by taking the number of enrolled 3 to 4-year-old students (according to the OECD) and then calculating the share of students that are in Junji and Integra centers based on their administrative records. There are few official sources of information on private Pre-K centers. Some of these centers receive public funding and others charge tuition, which is out-of-reach for most lower income families as the ones included in our sample.

<sup>11</sup>In our sample of 1800 students, the average distance from their home to the Pre-K is 1.2 kilometers.

tuition fees in exchange for a larger transfer from the government. In practice, this resulted in zero out-of-pocket fees for poor students at all the public schools and the vast majority of the voucher schools (over 80% in 2016). Additional reforms implemented in 2016 froze the prices charged by voucher schools and implemented a gradual plan to completely eliminate fees in voucher schools.<sup>12</sup>

Both public and voucher schools receive the same subsidy per student, and a large portion of private voucher schools have traditionally operated as for-profit.<sup>13</sup> However, it is reasonable to assume that while many private schools maximize profit, public schools face different incentives and different constraints. On one hand, public schools may behave like firms in a competitive market trying to increase revenue, which is proportional to the number of students the school attracts. On the other hand, public schools are administrated at the municipality level where the same administration controls a set of schools, potentially pooling funds across them. As a result, an individual public school can receive additional transfers and cross transfers from the municipality to cover their expenses, independent of their enrollment.<sup>14</sup> Public schools also have less flexibility in how they can spend their money and hire staff because public teacher contracts are highly regulated.

In spite of the variety of schools and choices available, students from poorer families tend to go to schools with lower outcomes in terms of test scores, and lower inputs in terms of teacher quality and overall resources. A series of policy changes have tried to reduce this stratification. Recent changes include implementing larger vouchers targeted for the poor which is studied in Neilson (2013); Mizala and Torche (2013); Elacqua and Santos (2013), among others. The steady increase in the baseline voucher and additional transfers to schools for the poorest students has led to a doubling of the average per pupil government transfer to schools and the differences in resources available to schools with higher and lower socioeconomic backgrounds has all but vanished. The recent introduction of centralized school applications, further expansions of voucher amounts, price caps, and gradual elimination of fees in voucher schools, all seek to increase access to high-quality education for disadvantaged students. While these reforms seem to have helped, the distribution of school inputs and outputs conditional on family socioeconomic status continue to be very different. Figure 1 shows the distribution of estimated school value added for students entering first grade. The figure shows how the type of school chosen differs by socioeconomic status using students mothers' level of education as a simple proxy because it is available for all

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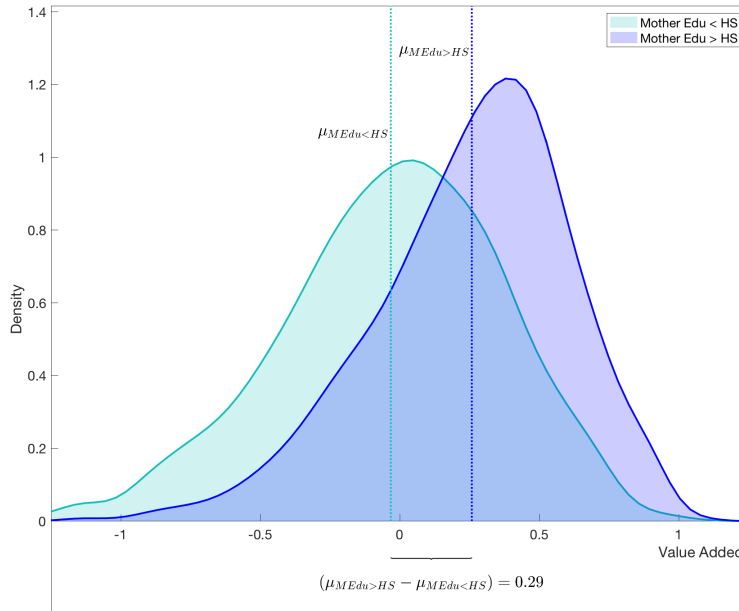
<sup>12</sup>The online appendix describes in detail the sources of income schools have and how they have changed since 2005.

<sup>13</sup>Voucher schools are operated by both for-profit firms and not-for-profit organizations. Aedo (1998) argues that not-for-profit schools behave similarly to for-profit schools as they raise additional funds for operating the school in a relatively competitive market for donations.

<sup>14</sup>Gallego (2013) argues that the fact that public schools receive other transfers different from the voucher implies that they operate under soft budget constraints, where they only partially react to the incentives created by the voucher system.

students from birth records.<sup>15</sup>

**Figure 1: Inequality of School Quality Across SES**



Note: This figure shows the distribution of school value added in 2012 conditional on the students' mothers' education. The population of students is divided into three groups, those whose mother had not completed high school at the time of birth (labeled No HS Mom, 15% of the population), those who had completed only high school (not shown, 60% of the population) and those who completed more than a high school education (labeled College Mom, 25% of the population). The term  $\mu_C - \mu_{NoHS}$  corresponds to the difference in the average school quality for each type presented in Equation 3. Similar graphs showing the distribution of school average teacher quality are presented in the appendix in Figure O-8.

One reason that can explain the lack of convergence across groups even after important investments in access, is that poor families may not know the importance of choosing a high-quality school for very young children. In addition, it is possible that families with less experience with higher equality educational institutions may find it more difficult to accurately assess school quality. These hypotheses would lead poor families to put more weight on the school's proximity or other characteristics when deciding what option to choose. Note that if this is true, even in the case of total equality of access, we can expect differences across SES groups.

Policy makers in Chile have been trying to promote the production and dissemination of in-

<sup>15</sup>The online appendix presents similar information showing differences in the teacher quality at the schools attended by different types of students. Spending on teachers is shown to represent over 70% of total school expenditures (Tables O-11 and O-10). It is also highly correlated with estimated school value added.

formation for many years. Standardized tests have been universally administered since 1987, and government web sites have posted school test scores for many years. For instance, in 2010 the government of Chile pushed an agenda called "*Más Información, Mejor Educación*" (More information, Better Education) showing interest in the idea of providing information<sup>16</sup>. Evidence from other countries and contexts such as the US and Pakistan suggests that there may be scope for an information provision policy to improve outcomes (see eg., Hastings and Weinstein (2008), and Andrabi et al. (2017) for a discussion on this issue in two different contexts) .

This paper builds on a project that began in 2009, and the randomized control trial was implemented in the second half of 2010. The objective was to study the effects of increasing information provision through government policy, so our research design and intervention were shaped by concerns of policy feasibility. The goal of the design was to accommodate scalability and policy feasibility, while rigorously evaluating effectiveness at a small scale, eventually arriving at a quantitative recommendation relevant for policymakers.

### 3 Conceptual Framework

#### 3.1 Framework for Policy Analysis

In this section we provide a general framework to analyze the effects of an information provision policy. We are interested in how this policy might change individual behavior and specifically how it might change the quality of the schools chosen. We are also interested in how applying the policy at-scale might result in different effects in the short and long run (when firms can adjust their quality). The challenge is to incorporate enough institutional background into our empirical model so that we can make sense of the data while keeping it simple enough to be tractable. We need to incorporate institutional details about schools and families but at the same time restrict the set of possible responses to the policy changes to have any hope of approximating what reactions are likely to occur in equilibrium.

The model specifies the behavior of families and schools together with a notion of equilibrium. Each make choices to maximize their objective function subject to financial and other regulatory constraints.<sup>17</sup> A notion of short and long run determine what variables are under the control of schools.

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<sup>16</sup>"Más Información, Mejor Educación" or MIME it's a platform where families and students can find relevant information about any school on the country. Among other things, they can find schools general description, educational programs, standardized tests scores, teachers evaluation, information about selection processes and geographic location.

<sup>17</sup>Several papers have studied school demand systems in the context of Chile, notably Gallego and Hernando (2008) and (Neilson, 2013). Very few studies include supply side considerations in education context. One recent exception is Sanchez (2017), which takes the supply side seriously and models the extensive margin of voucher program participation of schools in Chile.

### 3.2 Families

When a student  $i \in \{1, \dots, N\}$  is entering school, the family must choose a school  $j \in J_i^m$  where  $J_i^m \subset J^m$  is the set of schools that are available to student  $i$  and  $J^m$  is the set of all schools in a market with  $\#J^m = N_j$  the number of schools in market  $m$ . Families might differ in the set of schools that are available to them so that  $J_i^m$  is not the same for all  $i$ . Families can also differ by their socioeconomic status  $\text{type}_i \in \{1, \dots, T\}$  and location node  $n_i$  across an urban market  $m$ . Families can have heterogeneous preferences for school characteristics such as out of pocket price  $p_j$ , quality  $q_j$  and distance to their location  $d_{ij}$ . Government voucher policy  $v_{ij}$  determines the out-of-pocket expenses for different families  $i$  at potentially different schools  $j$ .

The value the family gets by choosing  $j$  is given by  $U_{ij}(\omega)$  where  $\omega \in \Omega$  is a state of the world indicating the price, quality and distance of all schools as well as government policy and how important school quality is for future outcomes of the children. Families have an information set  $\mathcal{I}_i \in \mathcal{I}$  so that, at the time of choosing a school, the perceived value of a school, given the information set the family has, is given by Equation 1.

$$U_{ij}^{\mathcal{E}}(\mathcal{I}_i) = \mathcal{E}(U_{ij}(\omega) | \mathcal{I}_i) \quad (1)$$

We further assume that families choose the school that provides the highest perceived value conditional on their information set so that  $j_i^* = \operatorname{argmax}_{j \in J_i^m} U_{ij}^{\mathcal{E}}(\mathcal{I}_i)$ . Having defined the latter, we can sum over all such choices to write the share of families of each SES type that choose school  $j$  as in Equation 2. The average school quality for each type can be written as the weighted average in Equation 3.

$$s_j^{\text{type}}(U, \mathcal{I}, J^m) = \frac{1}{N_{\text{type}}} \sum_{i=1}^{N_{\text{type}}} \mathbf{1}(j = j_i^* | U_{ij}^{\mathcal{E}}(\mathcal{I}_i), J_i^m) \quad (2)$$

$$\mu_q^{\text{type}} = \sum_{j=1}^{N_j} q_j \cdot s_j^{\text{type}}(U, \mathcal{I}, J^m) \quad (3)$$

With this very basic framework we can conceptually decompose the differences in school quality attended by students of low and high socioeconomic status as a composite of several forces. Part of the difference can be due to heterogeneity in the schools available. This could be driven by differences across markets or due to selection on the part of schools that make some options unfeasible to some families. Differences in location of a family within a market also changes the value of the available options due to preferences for distance. Another reason is differences in choices can be driven by heterogeneity in preferences for school characteristics. Finally differences could arise due to differences in the information sets available to different types of families, which lead

them to make different choices due to different beliefs about school characteristics and also how important school quality can be.

### 3.3 Schools

An elementary school  $j \in J^m$  can be public or private and is located at a node  $n_j$  in an urban market  $m$ . The school can potentially choose to make investments and exert effort to adjust their quality<sup>18</sup>,  $q_j$ , and over time possibly their capacity  $k_j$  as well. Private schools can also choose a price  $p_j$ , possibly subject to restrictions given by policy. Schools can also differ in their ability to mix inputs to generate quality so that their cost structure is heterogeneous  $C_j(q)$ . This could reflect that some schools may be run more or less efficiently or they can have access to cheaper inputs. This would allow schools to differ in the cost of providing a given level of quality and capacity. Schools receive a student-level transfer  $v_{ij}$  that is potentially different for different students at different schools.

Given the choice of individual families described above, it follows that the demand a school can expect to get given the government policy, quality, price and location of other schools also depends on the information structure that partially determines decisions of families and thus can potentially influence quality and prices.

$$s_j(U, \mathcal{I}, J^m) = \frac{1}{N} \sum_{\text{type}=1}^T N_{\text{type}} \cdot s_j^{\text{type}}(U, \mathcal{I}, J^m) \quad (4)$$

Schools maximize some combination of profit and quality weighted average, subject to a set of financial and technological constraints. Thus, conditional on capacity, quality and price are chosen endogenously as a function of government policy, own costs/productivity, objectives and local market conditions.

$$(q_j^*, p_j^*) = \operatorname{argmax}_{(p,q)} \Pi(C_j(q), v_j, s_j(U, \mathcal{I}, J^m)) \quad (5)$$

This setup highlights that schools quality, price and other valued attributes are endogenous to a series of environmental factors. The heterogeneity in school quality in a particular market can be due to government policy, differences in costs, differences in objectives and differences in market structure and competitive pressure. Importantly for this paper, the quality and price chosen by schools can also depend on the information structure of local families given that this can affect the demand ( $Ns_j$ ) faced by schools.

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<sup>18</sup>For simplicity, note that quality is assumed to be the same for all students at the school and, while potentially chosen with some uncertainty, it is not a function of what students attend. This rules out peer effects and other more complicated school-student match effects.



### 3.4 Equilibrium and Potential Policy Effects

In equilibrium, schools will have chosen quality and prices, and families have chosen what school to attend, such that there is no excess demand for any particular school given school capacities. Due to fixed costs and the zero lower bound on prices, there may exist excess capacity at some schools. Schools can expand capacity, and raise or reduce quality over the medium term.

Given the above, the average school quality chosen by different types of family defined by Equation 3 is due to demand, supply, and government policy. The model can be used to decompose the factors that define that average and the gap between any particular groups such as rich and poor. The policy of providing information takes an aim at shifting the information set families use when making school choices. At the individual family level, such a policy directly affects the optimal school choice, assuming the choice set  $J_i^m$  and the characteristics of all schools in that set are unchanged. A small scale randomized control trial is an approximation to this situation and helps identify the effect of the policy on families' optimal school choice. Given that the treatment changes the information set to  $\mathcal{I}'$ , and defining  $\Delta_{(\cdot)}(\cdot)$  as a conditional post-treatment difference operator, such that  $\Delta_{\mathcal{A}}x := x|_{\mathcal{A}'} - x|_{\mathcal{A}}$  for any  $x$  and  $\mathcal{A}$ , then

$$\Delta_{\text{Treat}}\mu_{q, \text{small}}^{\text{type}} \approx \sum_{j=1}^{N_j} q_j^* \cdot \Delta_{\mathcal{I}S_j}^{\text{type}} \quad (6)$$

A larger, scaled version of the policy could induce additional reactions that could affect the average quality chosen. To simplify, assume the policy is implemented to all families in the short run, but schools are unable to adjust prices, quality or capacity. We would have that average quality that a particular type of family chooses is now affected by the changing information set, but also due to a change in the schools available. Unexpected shifts in demand could lead to excess demand at some schools and crowd out some of the families' demand.

$$\Delta_{\text{Treat}}\mu_{q, \text{scale, sr}}^{\text{type}} \approx \sum_{j=1}^{N_j} q_j^* \cdot \left( \Delta_{\mathcal{I}S_j}^{\text{type}} + \Delta_{J^m S_j}^{\text{type}} \right) \quad (7)$$

In the medium term, a large scale policy that shifts demand for schools by shifting information sets could have additional effects through the supply side, as schools may adjust their quality and price as a function of changing demand.

$$\Delta_{\text{Treat}}\mu_{q, \text{scale, mr}}^{\text{type}} \approx \sum_{j=1}^{N_j} \left[ \frac{\partial q_j^*}{\partial s_j} \cdot \Delta_{\text{Treat}}s_j \cdot s_j^{\text{type}} + q_j^* \cdot \left( \Delta_{\mathcal{I}S_j}^{\text{type}} + \Delta_{J^m S_j}^{\text{type}} \right) \right] \quad (8)$$

In the long run, schools are expected to adjust capacity and re-optimize price and quality to

maximize their objective function, given local market conditions. Entry and exit margins are likely to be relevant and a series of dynamics can be of interest as well. Without going into further details, this framework suggests that there could be meaningful adjustments on both the demand and the supply side once equilibrium constraints are imposed on the policy effects. The relevance of these adjustments depends on the quantitative importance of particular mechanisms. The first is that the policy affects individual decisions in a meaningful way. Secondly, the changing demand could make capacity constraints binding and limit the adjustments in demand in the short run. The third important aspect that links supply side reactions is whether schools change their behavior as a function of changing demand and local market conditions. These three aspects and their implications are explored quantitatively in the following sections.

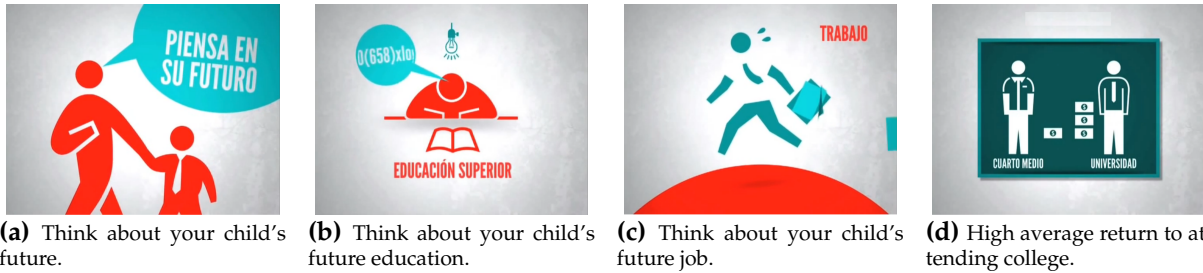
We first quantify the effects of the policy on individual choices using a randomized control trial. We estimate average treatment effects on the characteristics of the schools chosen and students' later outcomes. Once we verify potential meaningful effects on individual choices, we lay out an estimation strategy to recover how the treatment changes the way families choose, even if the econometrician does not observe information sets. We then propose an empirical strategy to recover estimates of the schools' cost structures and how to use these to recover new equilibrium behavior of all schools.

## **4 The Policy and Randomized Control Trial**

### **4.1 Design of the Randomized Control Trial**

The main objective of the intervention was to encourage parents to invest in the process of choosing a school for their child. The intervention tried to increase the awareness of neighborhood schools characteristics and the perceived returns to school quality. The intervention was designed to have a low marginal cost and be easily scalable by government agencies that provide Pre-K services. We collaborated with the network of *Integra* preschools that provide Pre-K education to 25,229 students in the cohort of 3 to 4 years (30% of public Pre-K enrollment) to test the intervention. The information provision treatment consisted of a session during regular parent-teacher meetings. Parents were shown a video that emphasized the returns to investing in school quality and choosing a school carefully. The video urged parents to think about how their choice today could affect their child's future. One segment of the video asked parents to think about what kind of job their child might have and what opportunities higher education could provide them. The video then explained that higher education is associated with more job opportunities and higher earnings. The video placed a special emphasis on the idea that going to a good school can be very important in helping a child prepare for higher education and a good job.

**Figure 2:** Choosing a school carefully is important for your child's future



To reinforce the idea that school choice is important for a child's future, the video included testimonials from students and parents. The video shows that there are good schools in poor neighborhoods and that going to these schools can improve future opportunities, showing real-life examples of two students and one parent from neighborhoods that are well-known to be low income.

**Figure 3:** Message Conveyed Through Relatable Role Model Testimonials



The video explains that to get into higher education, students need to do well on standardized tests. So they should make sure to check how well students are doing on standardized tests when comparing schools. Parents received a report card that highlights test scores and prices of schools in the neighborhood. A discussion with parents provided space for asking questions about the school choice process. We refer the reader to the Online Appendix for more details on the treatment design. The overall message is reiterated with a plea for parents to invest in getting information and comparing options to be able to choose well.

**Figure 4:** To choose well, get information and compare options



We conducted our study in three of the largest regions of Chile: Valparaíso, Biobío, and Santiago. To be included in the sample, schools had to be located in urban areas (according to *Integra's* classification), in areas with at least 10 schools within 1.2 miles and with the ratio (primary schools<sub>*m*</sub>/preschools<sub>*m*</sub>)  $\geq 2$ .

We randomly assigned preschools to control (C) and treatment (T) arms, stratifying by region, number of grades the preschools offer, and the "school competition", as measured by the number of primary schools within 1.2 miles. We chose to work with only the highest grade in each preschool so that the enrollment decision was more likely to be exogenous. The initial design of the experiment additionally included two subgroups within the treatment arm. One subgroup was to receive the full treatment of both the video and report card, and the other was to receive only the report card. However, implementation difficulties led to imperfect tracking of which schools within the treatment arm received the more and less intense versions the treatment. The online appendix describes the design in detail. Our final research design looks at the feasibility of a generic information provision policy. While we can't be certain which schools received which materials, they were all designed with the same explicit goal of providing accurate information to parents. Pooling the data means that we cannot identify which media (e.g. brochures vs. videos) are most effective, but we can still evaluate the class of information provision policies, both in this context and writ large.

The experiment was implemented between August and December 2010 by trained staff who participated in the parents' meeting scheduled by the preschools. In the 133 preschools that agreed to participate, a total of 1,832 parents signed the informed consent and answered a baseline survey. Parents took this survey before staff handed out any information and it included contact information and questions regarding the application process. We asked parents whether they had decided to send their child to primary school in 2011, if they had already chosen a specific school, and whether they had already enrolled their child. Parents were also asked if they had any other children already enrolled in primary school. After the survey, parents in treatment schools re-

ceived the school choice intervention (see the treatment description above). Parents did not know about the intervention before the meeting, to prevent self-selection due to a special interest in the enrollment process or preferences toward quality and demand for information. Most of the staff were hired by the surveying firm, and they had a similar background to the preschool parents.

Between May and July 2011, we conducted a follow-up survey asking parents about their enrollment decisions. Of the 1,832 who received information, we were able to survey 1,611 (87%). In addition, we were able to match 1,795 out of 1,832 (98%) in our original sample to administrative records using individual student identifiers.

The characteristics at the pre-school level come from *Integra's* administrative data and include total enrollment, mean attendance, and measures of SES proxied by mothers' education, income quintile and poverty status for children in each pre-school. We see no difference in the characteristics between the treatment and control pre-schools.<sup>19</sup> Family characteristics were self-reported in the baseline and follow-up surveys and also show no systematic differences across treatment and control groups for a host of characteristics, including SES characteristics (household size, possession of durable goods, whether the family owns the dwelling, whether the mother is the head of the household and measures of the mother's education), baseline information about the school (whether the child is already enrolled in a school or the parents have an older child that is already going to school), and an indicator for whether the child will start school in the following year (2011) or later.

The intervention was implemented during the time period that parents were enrolling their children into schools. The treatment should have a much smaller impact on school choice decisions for families who have already made their decisions prior to receiving the intervention. It is possible that the timing of matriculation could be correlated with the characteristics of the family.<sup>20</sup> Matriculating early does seem to be correlated with some observable characteristics associated with slightly higher SES (possession of durable goods), but we see no difference between groups in other SES family characteristics (except for a marginally higher probability of being born at a hospital) that can affect school choice, or with other background characteristics of the children that affect academic achievement (Almond and Currie, 2011; Bharadwaj et al., 2017). There are no systematic differences across treatment and control groups when we look at subsamples that either were enrolled or were not enrolled at the baseline.<sup>21</sup> This is because treatment and control groups are balanced across time by design. We present results for the pooled sample as well as for the sample that has not yet matriculated.

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<sup>19</sup>Table A1 presents the coefficients and standard errors for regressions of each school characteristic on treatment status. Table O-2 shows the coefficients and standard errors for regressions of each characteristic of the families in our sample on treatment status.

<sup>20</sup>Table A2 shows the coefficients and standard errors for regressions of each characteristic of the families in our sample on enrollment status at baseline.

<sup>21</sup>See Table O-2

The experiment is designed to compare the school choices of families in treated groups to the choices of control groups. In the short run, we look at the characteristics of schools that are chosen: their price, distance, inputs and outputs. In the long run, we look at students' standardized test scores in fourth grade and compare the treated students to the control students.

## 4.2 Results of the Randomized Control Trial

Table 1 shows a summary for the main results of the effect of the treatment on the characteristics of the schools chosen by families. Table 2 shows the analysis for the students achievement four years after the experiment took place. The specifications include market characteristics such as the number of schools nearby, the average, the standard deviation and percentiles 25, 50 and 75 of test scores of schools nearby, and municipality fixed effects. These are our most preferred specifications which include controls for randomization units. We present subsample analyses by matriculation status at the time of treatment.<sup>22</sup> The online appendix explores a series of alternative specifications with expanded controls, including a list of variables measuring family socioeconomic status and student health.

**Table 1:** Effects on Characteristics of Schools Chosen One Year After Treatment

	Distance (1)	Positive Price (2)	Lang 2nd (3)	Lang 4th (4)	Math 4th (5)	V. Added (6)
<i>Panel A: Full Sample</i>						
Treatment	0.1371** (0.0595)	0.0438 (0.0354)	0.0108 (0.0224)	0.0107 (0.0275)	0.0147 (0.0293)	0.0274 (0.0273)
N obs.	1,378	1,775	1,758	1,752	1,752	1,752
<i>Panel B: Already enrolled at the time of the PreK visit</i>						
Treatment	-0.0843 (0.1234)	0.0091 (0.0522)	-0.0123 (0.0430)	-0.0097 (0.0489)	-0.0348 (0.0570)	-0.0320 (0.0496)
N obs.	487	596	589	590	590	590
<i>Panel C: Not enrolled at the time of the PreK visit</i>						
Treatment	0.2390 <sup>†</sup> (0.0658)	0.1198 <sup>†</sup> (0.0399)	0.0591** (0.0268)	0.0377 (0.0323)	0.0658* (0.0386)	0.0718** (0.0345)
N obs.	780	975	967	961	961	962

Note: Randomization controls are used, which include market characteristics of schools (number and test scores mean, standard deviation and percentiles 25, 50 and 75.). <sup>†</sup> indicates significance at 0.01 confidence level, while \*\* and \* indicate 0.05 and 0.1 levels respectively.

<sup>22</sup>Note that from the original 1,832 students in our sample, we only have enrollment status at the time of the intervention for 1,612 students. That is why the number of observations in the pooled regression and the sum of the observations separated by enrollment do not coincide.

Column 1 in Table 1 shows the impact of the treatment on the distance between treated families and their schools. If we look at the full sample in panel A, we see that treated families travel 0.13 additional kilometers (km) to attend school, a significant treatment effect of approximately 0.1 standard deviations. However, as we see in panel C, most of this effect comes from a significant and positive treatment effect for families that were not enrolled in the baseline, with a magnitude of 0.2 standard deviations. In this analysis we exclude families that appear to have moved.<sup>23</sup> As a robustness check, we look at the treatment effect on distance for several maximum distance restrictions in Figure O-6.

Column 2 in Table 1 shows the impact of the treatment on whether the family went to a school that would charge them a positive price beyond the voucher. Treated students are slightly more likely to attend schools that charged additional out-of-pocket fees than students in the untreated group. Columns 3-6 show the impact of the treatment on the test scores of the schools chosen by families, measured using the mean math and language test scores for the school available at 2nd and 4th grade. If we look at the full sample, we see a significant increase in the math test scores of the schools chosen. If we look at panel C, which shows the results for the subsample of students that were not already enrolled at the moment of the intervention, we find larger but only marginally significant effects, probably because of a smaller sample. These findings indicate that our intervention pushed parents to choose schools with higher test scores. It is interesting to note that the test scores are correlated with value-added measures and other proxies for quality such as teacher quality and parents satisfaction.<sup>24</sup>

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<sup>23</sup>We determined this in two ways, a) if the administrative data indicates that the child lives in a different municipality than at the beginning of the study, or b) if the child's distance to the school is greater than 99th percentile distance (further than 4 km).

<sup>24</sup>See figures O-10 and O-9 for evidence that the value added measure used is significantly correlated with spending per student and with teacher quality. Figure O-11 shows the very close relationship between value added controlling for a large vector of observables and when adding prior test scores. The Online Appendix for more descriptive evidence regarding the correlation between value added measures, test score outcomes, school inputs and parent satisfaction.

**Table 2: Effects on Student Outcomes Five Years After Treatment**

	Lang 4th	Math 4th
<i>Panel A: Full Sample</i>		
Treatment	0.0617 (0.0612)	0.1298** (0.0556)
N obs.	1,443	1,442
<i>Panel B: Already enrolled</i>		
Treatment	-0.1247 (0.1211)	-0.0635 (0.1036)
N obs.	506	495
<i>Panel C: Not enrolled</i>		
Treatment	0.2163** (0.0898)	0.2210 <sup>†</sup> (0.0723)
N obs.	772	779

Note: Randomization controls are used, which include market characteristics of schools (number and test scores mean, standard deviation and percentiles 25, 50 and 75.). † indicates significance at 0.01 confidence level, while \*\* and \* indicate 0.05 and 0.1 levels respectively.

Table 2 presents the effects on individual tests scores in 4th grade, five years after the treatment took place. For students that were not enrolled before the treatment, we see positive and significant impacts in virtually all specifications.<sup>25</sup> This is an important result because it provides evidence that the policy changes not only behavior, but also outcomes.<sup>26</sup> It also shows that parents do have some margin to improve their choices and get access to better schools if they have more information about both the importance of carefully choosing a school and the relative quality of the schools. The results lend credibility to value added estimates as well, since the RCT results coincide with the value-added predictions of which schools would improve students' test scores.

The intervention provides information of several types and has multiple aspects in the design that might shift behavior. We study whether the report card part of the intervention had any additional behavioral effects on choices beyond simple information provision that should be taken account when mapping the intervention to a model of choice. To do this, we investigate whether

<sup>25</sup>Families that reported having already enrolled at the time of the baseline survey were different from the group that had not previously enrolled. Relative to the unenrolled group, these families selected schools with higher test scores, they traveled about 0.14 km farther to their enrolled school and were more 25% more likely to choose schools with positive prices. This suggests that the unenrolled children at baseline may have faced more information frictions, which the intervention at least partially corrected.

<sup>26</sup>Table O-4 in the Appendix presents results for additional specifications.



information about options raised awareness of the options on the report card, leading to increased likelihood of choice. We also study whether the color coding of red and green schools had any additional effects. Table 3 presents results showing evidence of several interesting additional insights that help interpret the effects of the intervention. In the first column we see that treated families were less likely to matriculate in a school nearby their PreK and thus on the report card. The second column shows that there is no evidence that green schools were more likely to be chosen over red schools overall. Both of these results provide evidence against many potential mechanisms where the report card raised awareness of specific schools or the color coding played an inordinate role in nudging parents towards certain schools. The results are consistent with the idea that the more salient feature of the treatment was to increase search and awareness of the importance of school quality and not to focus on specific design features of the report card. In anything, this suggests the video and salience of the choice seemed to be the more likely channels through which the intervention affected choices.

**Table 3:** Summary - Potential Behavioral Effects

	In Cartilla		Green		Top 5	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: Full Sample</i>						
Treatment	-0.118*** (0.029)	-0.112*** (0.030)	0.039 (0.046)	0.028 (0.044)	0.075* (0.041)	0.064* (0.039)
N obs.	1775	1775	1136	1136	1136	1136
<i>Panel B: Enrolled sample</i>						
Treatment	-0.007 (0.054)	0.004 (0.053)	0.069 (0.076)	0.038 (0.072)	0.048 (0.069)	0.025 (0.069)
N obs.	596	596	389	389	389	389
<i>Panel C: Not enrolled sample</i>						
Treatment	-0.172*** (0.032)	-0.159*** (0.033)	0.019 (0.059)	0.036 (0.060)	0.076* (0.041)	0.090** (0.041)
N obs.	975	975	639	639	639	639
Randomization controls	×		×		×	
Expanded controls		×		×		×

Note: Randomization controls include market characteristics of schools (number and test scores mean, standard deviation and percentiles 25, 50 and 75.). Expanded controls include Mother's education, household information (size, durable goods, owned house), baseline school choice information.

The results presented in this section suggest that the intervention does indeed shift families' school choice towards better quality schools, in spite of the fact that they can be farther away and are more likely to charge out of pocket costs. The results on student test scores indicate the policy shifts students to schools that will help them learn more. The intervention is low cost and easy to scale-up, suggesting a policy expanding this intervention could make the education system more

efficient and equitable by moving less privileged students to more productive schools.

## 5 Empirical Model for Policy Analysis

In this section, we present our empirical model in more detail, guided by the framework in section 3.3. Our starting point for the empirical analysis is a model of demand for schools based on each family making a discrete choice about what school to send their child to. We apply recent empirical work in industrial organization on demand estimates to education markets and draw on the framework developed in Neilson (2013). We model families as heterogeneous agents based on their geographic location within a market. We also let families have heterogeneous preferences based on their observable and unobservable characteristics. We model schools as spatially differentiated firms that can choose price and quality. We abstract from explicitly modeling the firms' production function and input choices and instead choose a more parsimonious model where schools choose quality and price given capacity constraints. We explicitly allow families to have imperfect information about school attributes and avoid interpreting the weight they put on different school characteristics as a deep parameter associated with preferences.

This specification allows for rich heterogeneity among firm and consumer preferences and provides a realistic characterization of the choice set that each family faces. Viewing the experimental sample through this lens, we can describe in detail the set of schools and characteristics that each family faced when choosing a school. This allows us to rationalize the experimental results taking into account all the relevant dimensions of heterogeneity in both the choice set and across subjects in the experiment. We see this approach as a key contribution to uncovering the role of information in school choices since we explicitly model choice as a function of information.

### 5.1 Empirical Model of School Choice with Incomplete Information

We model the utility for family  $i$  from sending their children to school  $j$  in time  $t$  as a linear function of the school's observable and unobservable characteristics. To simplify notation, we drop the time subscript  $t$  from the demand model. The observable characteristics include quality,  $q_j$ , a measure of how much the school increases student's test scores. Another important observable characteristic is the out-of-pocket price  $op_{ij}$ , which is specific to family  $i$  due to different vouchers provided to different families at different schools. We approximate the distance between each school and each family with the linear distance  $d_{ij}$ . Other observable characteristics at the school level,  $x_j^r$ , are the school administration type (public, voucher or private), religious orientation, co-education and type of corporation (for-profit or not-for-profit). Families share a common preference for unobservable school characteristics, which we could think of as other dimensions of quality that do not translate into higher test scores,  $\zeta_j$ . Finally, each family  $i$  has a random iid

preference shock for school  $j$ ,  $\epsilon_{ij}$ . Preferences over quality, price and location are heterogeneous across family observable discrete type  $k$  that is given by the mothers education and income. With these definitions, we can describe family  $i$ 's utility from sending their children to school  $j$  to be

$$U_{ij} = \beta_k q_j - \alpha_k o p_{ij} + \lambda_k d_{ij} + \sum_r \eta_k^r x_j^r + \zeta_j + \epsilon_{ij}. \quad (9)$$

We assume families have incomplete information about school quality, price and distance. This implies that families must choose a school based on their beliefs, which are given by potentially heterogeneous information sets  $\mathcal{I}_i$ . To operationalize this assumption, we assume that families know the true distribution of quality,  $q_j \sim N(0, \sigma_q^2)$ , but only observe a noisy signal for school. This signal corresponds to the true quality plus an error distributed  $v(q)_{ij}^k \sim N(0, \sigma(q, \epsilon)_k^2)$ . The expected quality would be:  $q_{ij}^e = \rho_k^q (q_{ij} + v(q)_{ij}^k)$ , where  $\rho_k^q = \frac{\sigma_q^2}{\sigma_q^2 + \sigma(q, \epsilon)_k^2}$ . Beliefs about prices and distance have a similar form with varying  $\rho^o p_k$  and  $\rho_k^d$  given these attributes may be more or less easy to observable. For simplicity, we assume these signals are independent and unbiased, but these assumptions are not crucial. With these additional assumptions we have that expected utility from the families perspective is given by:

$$U_{ij}^{\mathcal{E}} = \phi_k^q q_j - \phi_k^{op} o p_{ij} + \phi_k^d d_{ij} + \sum_r \eta_k^r x_j^r + \zeta_j + \tilde{\epsilon}_{ij} \quad (10)$$

The reduced form parameters  $\phi$  represent the weight families place on the true quality, price and distance that are weighted by the precision of the signal. For example  $\phi_k^{op} = \alpha_k \rho_k^{op}$  and  $\phi_k^q = \beta_k \rho_k^q$ . The residual terms derived from signals and idiosyncratic tastes are accumulated in the  $\tilde{\epsilon}_{ij} = \rho_k^q \cdot v(q)_{ij}^k + \rho_k^{op} \cdot v(p)_{ij}^k + \rho_k^d \cdot v(d)_{ij}^k + \epsilon_{ij}$ .

The families choose school  $j$  to maximize their expected utility  $U_{ij}^{\mathcal{E}}$  based on their information and their choice set  $J_m$  which we assume includes all schools in market  $m$ . Assuming  $\tilde{\epsilon}_{ij}$  follows an extreme value distribution, the following expression describes the share of families of type  $k$  who live at node  $n$  that will select school  $j$  as a function of observables and parameters,  $(\mathbf{q}, \mathbf{op}, \theta)$  where  $\theta = \{\eta, \zeta, \phi, \sigma\}$  parameter vector  $\theta$ :

$$s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) = \sum_{i=1}^{N_{v_i}} w_{v_i} \left( \frac{\exp(\phi_k^q q_j - \phi_k^{op} o p_{ij} + \phi_k^d d_{ij} + \sum_r \eta_k^r x_j^r + \zeta_j)}{\sum_{\ell \in J_m} \exp(\phi_k^q q_\ell - \phi_k^{op} o p_{i\ell} + \phi_k^d d_{i\ell} + \sum_r \eta_k^r x_\ell^r + \zeta_\ell)} \right) \quad (11)$$

It is important to note that the role of incomplete information in this setting is to modify the weight families place on school characteristics when choosing what option maximizes their expected utility. The more noise associated with the signals about a school characteristic, the lower the weight placed on that characteristic,  $\frac{\partial \phi}{\partial \sigma_\epsilon^2} < 0$ . This allows the model to accommodate differences in choice produced by systematic differences in the precision of the signals across socioeco-

nomic groups. This, in turn, opens a role for the information treatment to play a part in shifting choices.

In practice, we define discrete family types based on: (i) their poverty status: poor or non poor, (ii) the mother’s education level, which is divided into three groups: incomplete high school, complete high school or more than high school. The market definition joins all urban areas that are five kilometers apart or less at their closest point, and this union of areas will define one market. The assumption is that these areas are close enough for these students to feasibly travel within them. Each market is comprised of a total of  $N$  students living on the discrete set of  $N^m$  nodes. In order to get the market level shares, we need to aggregate over the distribution of students of each type across the nodes in the city and across the distribution of students across nodes. The distribution of students of type  $k$  across nodes is given by the vector  $w_k^m$  with  $\sum_n w_{nk}^m = 1 \forall k$ . The proportion of the students in the market who are of type  $k$  is given by  $\pi_k^m$  where  $\sum_{k=1}^K \pi_k^m = 1$  so that average school quality for students  $k$  is given by Equation 13 and market shares for each school are given by Equation 12.

$$s_j(\mathbf{q}, \mathbf{op}, \theta) = \sum_k \left\{ \sum_n s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) \cdot w_{nk} \right\} \cdot \pi_k \quad (12)$$

$$\mu_q^{\text{type}}(\mathbf{q}, \mathbf{op}, \theta) = \sum_{j \in J^m} \sum_{n \in N^m} q_j \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) \cdot w_{nk} \quad (13)$$

### 5.1.1 Imbedding the RCT Effects into the Model

We incorporate the information treatment in the model of household behavior by shifting the weight families put on price, distance and quality. Given assumptions made above, this can occur either because treatment reduced the noise associated with the signal ( $\rho \rightarrow 1$ ) or because the structural preference parameter changed due to the treatment. In our empirical setting, this distinction is not material but it is important to note we will recover only a reduced form parameter quantifying how families change their choices but not their welfare and this does limit the type of questions we can answer with this model. We allow treatment to affect  $\phi^q$ ,  $\phi^{op}$ , and  $\phi^d$  differentially and potentially in heterogeneous ways for each type  $k$ . To operationalize this idea, we expand the types described above to incorporate the families in the RCT and generate new *treated* types. Thus we add six parameters to the model that modify the weight given to each school characteristic ( $\phi_k^q, \phi_k^{op}, \phi_k^d$ ) for  $k = 1, 2, 3, 4$ <sup>27</sup>. With this modified empirical framework, we can describe

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<sup>27</sup>Note there are only four types that are affected by the policy because there are very few mothers with more than a high school education ( $k = 5, 6$ ) in the sample of public PreK included in this study.

household choices for all families, with and without treatment.

$$\tilde{\phi}_i^{op} = \sum_k (\phi_k^{op} + \psi_k^{op} \cdot \text{Treat}_i) \cdot \text{Type}_{ik} \quad (14)$$

$$\tilde{\phi}_i^d = \sum_k (\phi_k^d + \psi_k^d \cdot \text{Treat}_i) \cdot \text{Type}_{ik} \quad (15)$$

$$\tilde{\phi}_i^q = \sum_k (\phi_k^q + \psi_k^q \cdot \text{Treat}_i) \cdot \text{Type}_{ik} + \beta^U v_i^q \quad (16)$$

Now we describe the aggregate effects of the policy by mapping different levels of treatment penetration to market shares. Define  $\tau_{nk}$  be the proportion of families of type  $k$  living in node  $n$  that are treated, and  $\tau$  a vector that collects  $\tau_{nk}$  for all  $(n, k)$ . Augmenting the parameter vector  $\vartheta = \{\theta, \psi\}$  we can now describe the share of students  $(n, k)$  that attend a school  $j$  as a function of other schools characteristics, estimated parameters and the proportion of students in the market that are treated:

$$s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta) = \sum_{i=1}^{N_{v_i}} w_{v_i} \left( \frac{\exp(\delta_j + \tilde{\phi}_k^q q_j - \tilde{\phi}_k^{op} op_{ij} + \tilde{\phi}_k^d d_{ij})}{\sum_{\ell \in J_m} \exp(\delta_k + \tilde{\phi}_k^q q_\ell - \tilde{\phi}_k^{op} op_{i\ell} + \tilde{\phi}_k^d d_{i\ell})} \right). \quad (17)$$

We can then write the demand for school  $j$ , coming from node  $n$ , family type  $k$ , treatment intensity  $\tau_{nk}$ , as,

$$s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta, \tau) = \tau_{nk} \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta) + (1 - \tau_{nk}) \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta). \quad (18)$$

To get an expression for the market share of a school  $j$  for type  $k$  students, we aggregate over geographical nodes in the market taking into account the vector of treatment intensity at each node  $\tau$ :

$$s_j^k(\mathbf{q}, \mathbf{op}, \vartheta, \tau) = \sum_n^{N_m} \left[ \tau_{nk} \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta) + (1 - \tau_{nk}) \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) \right] \cdot w_{nk}. \quad (19)$$

Finally, aggregate demand for a school  $j$ , with the treatment distribution  $\tau$ , is given by

$$s_j(\mathbf{q}, \mathbf{op}, \vartheta, \tau) = \sum_k^K \left\{ \sum_n^{N_m} \left[ \tau_{nk} \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta) + (1 - \tau_{nk}) \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) \right] \cdot w_{nk} \right\} \cdot \pi_k. \quad (20)$$

The average school quality attended by type  $k$  with the treatment distribution  $\tau$ , is given by

$$\mu_q^{\text{type}}(\mathbf{q}, \mathbf{op}, \vartheta, \tau) = \sum_{j \in J^m} \sum_{n \in N^m} q_j \cdot \left[ \tau_{nk} \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta) + (1 - \tau_{nk}) \cdot s_j^{nk}(\mathbf{q}, \mathbf{op}, \theta) \right] \cdot w_{nk}. \quad (21)$$

## 5.2 Supply side

We now present an empirical framework to model supply. We begin by assuming that privately owned, privately administered, for-profit schools will maximize profit. The profit function for a school  $j$  in a market with  $N$  students is given by aggregating revenue minus costs for each type of student. The school chooses a sticker price  $p_j$  and a school quality  $q_j$ , which is proxied by the school's ability to increase the student's test scores. Government voucher policy is described by the voucher schedule  $v_j^k(p_j)$  which can vary by school depending on the school's characteristics and chosen price. Marginal revenue is thus described by  $R_k(v_j^k, p_j)$  for each student as a function of the voucher schedule, the sticker price and the student type. Costs are given by fixed cost  $F_j$  and marginal costs which are a function of school quality and the student type  $MC(q_j, k)$ . We can then write the following expression for school profits:

$$\pi_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau) = \sum_k^K s_j^k(\mathbf{q}, \mathbf{op}, \vartheta, \tau) \cdot [R(v_{jk}, p_j) - MC(q_j, k)] - F_j. \quad (22)$$

We make some simplifying assumptions before applying our model to the empirical setting. First, we focus on a static model where each school's capacity is given by  $\bar{c}_j$  and schools can adjust their sticker prices  $p_j$  as well as inputs and effort to increase school quality  $q_j$ . We further assume that the marginal cost of providing a particular level of quality is linear conditional on a vector of school specific cost characteristics that are summarized in the vector  $w_j^l$ . In addition, we allow for a vector of unobservable cost shifters that add to the marginal cost of quality,  $\omega_j$ .

Given these assumptions, the marginal cost of school  $j$  can be expressed as

$$MC(q_j) = \sum_l \gamma_l w_j^l + (\gamma_q + \omega_j) \cdot q_j. \quad (23)$$

Another important simplifying assumption is to express revenue as  $R(v_j, p_j, k) = p_j + v_b$  where  $v_b$  is the baseline voucher not considering any additional targeting by type  $k$  that might occur in the implementation of a policy  $v_j(p, k)$ . In practice the relationship between price and revenue is slightly more complicated because in some cases  $v_k > p_j + v_b$  so  $R(v_j, p_j, k) = \max(p_j + v_b, v_k)$ . This more realistic version of the revenue function is described in detail in the appendix. We use the more realistic version in estimation but continue this section ignoring this deviation for the sake of exposition and intuition. With these two assumptions on revenue and marginal costs, we can write the first order condition for the static problem as

$$\frac{\partial \pi_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau)}{\partial q_j} = N \frac{\partial s_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau)}{\partial q_j} (v_b + p_j - MC(q_j)) - N s_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau) \cdot \frac{\partial MC(q_j)}{\partial q_j} = 0 \quad (24)$$

And the expression for the optimal level of quality as

$$q_j^* = \underbrace{\left[ \frac{v_b + p_j - \sum_l \gamma_l \omega_j^l}{\gamma_q + \omega_j} \right]}_{\text{Competitive Quality}} \underbrace{- s_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau)}_{\text{Quality Mark Down}} \left[ \frac{\partial s_j(\mathbf{q}, \mathbf{p}, \vartheta, \tau)}{\partial q_j} \right]^{-1}. \quad (25)$$

### 5.3 Estimation

We have to estimate three sets of parameters: the linear parameters in the utility function ( $\theta_1 = \eta$ ), the non-linear parameters in the utility function ( $\theta_2 = (\phi, \varphi)$ ) and the marginal cost function parameters ( $\theta_3 = \gamma$ ), which also include the vector of school fixed effects for the marginal cost of quality ( $\bar{\omega}_j$ ). Our estimation has three steps.<sup>28</sup>

#### 5.3.1 First Step: Demand Parameters Estimation

In the first step, we estimate the parameters ( $\theta_1, \theta_2$ ) following Berry (1994), Berry et al. (1995), Petrin (2002), Berry et al. (2004) and Neilson (2013). We combine aggregate moments to get the unobservable quality for each school, micro moments to approximate the heterogeneity in preferences across different types of families, and IV (demand) moments to deal with endogeneity.

First, we use *aggregate moments for the shares*. These moments make us choose the parameters such that for each year and school the model matches the predicted school market shares to observed shares, what will help us identifying the unobservable school quality ( $\xi$ ) parameter. We can summarize them as: Where  $s_{jt}(\theta_2)$  is the expression in Equation 12. These aggregate share calculations will not consider the treated types -we are assuming there are no general equilibrium effects. Then, the vector  $\pi^m$  will be such that  $\sum_{k=1}^6 \pi_k^m = 1$  and  $\pi_j = 0, j = 7, 8, 9, 10$ .

Second, we use *micro moments* as in Petrin (2002) and Berry et al. (2004). These moments help us choose parameters so that the expected characteristics of the chosen schools (in terms of quality, price and distance) match the true chosen characteristics.

These moments are particularly useful for identifying the heterogeneity of preferences for observed school characteristics by observed family types. From the micro-data we have  $N_m$  observations in market  $m$  of students identified as type  $k$  at time  $t$  and their choices. Then, we can use the empirical averages of quality, price and distance chosen by these families to approximate the expectations in the expressions above. We can obtain the expectation for each characteristic given

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<sup>28</sup>See Appendix O-4 for additional estimation details and a discussion on how we calculate standard errors.

the model's parameters from the distributions of student of each type in each node across schools in the market.

Finally we include *IV-demand moments*. Noting that  $\xi_j$  is correlated with both  $q_j$  and  $p_j$ , we deal with the endogeneity problem using an IV strategy that follows Berry et al. (1995). We define instruments taking advantage of the variation of costs across markets and changes to the voucher policy over time. These moments express an orthogonality condition between the demand side unobservable  $\xi_j$  and the chosen instruments.

We need instruments that are related to price and quality but not related to the unobserved quality of the school. The instruments include cross-market cost shifters such as the baseline voucher, which varies across time. Finally, we use the variation in prices induced by the SEP policy. This policy effectively eliminated prices at a significant number of schools for almost half of all students. The change in prices induced by this policy affect equilibrium prices and quality for all students through schools' first order conditions. This equilibrium effect occurs differentially across neighborhoods that have more or less concentration of eligible students, so the timing of the policy is interacted with the concentration of eligible students around the school.

### 5.3.2 Second Step: Estimation of Parameters for Treated Types

We estimate the parameters in  $(\varphi)$  in a second step using a set of moments that we call the *RCT Moments*, conditional on the demand estimates obtained in the first step.

With this set of moments we exploit the random assignment of the treatments. The idea is that the additional parameters for the treated types should replicate the treatment effects that we find in the reduced form, in terms of the quality, price and distance of the schools chosen by treated and non treated families, conditional on their family type. In particular, the moments will match the difference of the characteristics chosen by the control and treated families. These moments are useful at identifying the effect of the treatments in preferences for specific attributes.

We have two moments for each characteristic (one for each family type given by mother's education, incomplete high school and complete high school):

$$G_{q,k}^4(\theta_2, \theta_2^T) = \hat{\beta}_k - \hat{\beta}_k^{sim} = (X' M_D X)^{-1} X' M_D Q_k - (X' M_D X)^{-1} X' M_D Q_k^{sim} \quad (26)$$

$$G_{p,k}^4(\theta_2, \theta_2^T) = \hat{\alpha}_k - \hat{\alpha}_k^{sim} = (X' M_D X)^{-1} X' M_D P_k - (X' M_D X)^{-1} X' M_D P_k^{sim} \quad (27)$$

$$G_{D,k}^4(\theta_2, \theta_2^T) = \hat{\lambda}_k - \hat{\lambda}_k^{sim} = (X' M_D X)^{-1} X' M_D D_k - (X' M_D X)^{-1} X' M_D D_k^{sim} \quad (28)$$



where  $X$  is a vector with the treatment indicator,  $Q, Q^{sim}$  are the vector of true and simulated qualities for each experiment observation (analogous for price and distance). The matrix  $M_D$  transforms the data to include pre-school municipality fixed effects (the stratification in the original randomization).

### 5.3.3 Third Step: Supply Parameters Estimation

Finally, we estimate supply side parameters ( $\theta_3$ ) using *IV-Supply Moments* that exploit the orthogonality between unobserved costs and the instruments, together with the panel nature of the data.

We obtain an expression for the unobserved costs from the school first order conditions. As in the previous section, we will focus on the FOC for quality, as the pricing decision is more complicated because of the voucher. Voucher schools face some restrictions on how much they can charge, and many choose not to charge a fee on top of the voucher. The kink solutions generated by these restrictions and by the fact that some schools would even be willing to charge a negative price (given the voucher), which we cannot observe, complicates how we think about pricing decisions. Rearranging Equation 25 we get an expression for the unobservable shock that affects the marginal cost of rising quality:

$$\Delta\omega_{jt} = \frac{v + p_{jt} - \sum_l \gamma^l w_{jt}^l}{\left[ q_{jt}^* + s_{jt}(\mathbf{q}, \mathbf{p}, \boldsymbol{\xi}) \left[ \frac{\partial s_{jt}(\mathbf{q}, \mathbf{p}, \boldsymbol{\xi})}{\partial q_{jt}} \right]^{-1} \right]} - \gamma^q - \bar{\omega}_j. \quad (29)$$

For a description of how we estimate the school-specific fixed component of the cost,  $\bar{\omega}_j$ , see the Appendix O-4.

## 5.4 Parameter Estimates

### 5.4.1 Demand

Table 4 presents results for the estimated parameters for school choice  $\phi$  and the policy parameters  $\varphi$ . The three first rows show preferences for quality by family characteristics<sup>29</sup>. We refer the reader to Neilson (2013) for a discussion of the demand parameters overall and focus on the new estimates associated with the policy parameters  $\psi$ .

The estimates for the policy parameters show that they seem to reduce the differences across types in the weight given to school characteristics. In particular we can see that the  $\psi$  for non high

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<sup>29</sup>Using the estimated model parameters, we can show how well the model fits the empirical features we are interested in replicating. The distribution of school quality in aggregate fits perfectly given that the model must replicate the aggregate share of each school perfectly. The Online Appendix shows the fit of the model by the mothers' educational group, showing a relatively adequate fit given moments include only means across markets.

**Table 4: Demand Model Estimates**


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$\varphi_k^q$ - Weight on Quality	
Mother No HS	1.37 <sup>†</sup>
Mother HS	1.57 <sup>†</sup>
Mother College	1.89 <sup>†</sup>
Poor Household	-0.58 <sup>†</sup>
Treated Mother No HS	0.55 <sup>†</sup>
Treated Mother hspace	0.34 <sup>†</sup>
$\varphi_k^p$ - Weight on Price	
Mother No HS	-9.89 <sup>†</sup>
Mother HS	-2.84 <sup>†</sup>
Mother College	-0.01 <sup>†</sup>
Poor Household	-3.31 <sup>†</sup>
Treated Mother No HS	9.26 <sup>†</sup>
Treated Mother HS	2.80 <sup>†</sup>
$\varphi_k^d$ - Weight on Distance	
Mother No HS	-0.99 <sup>†</sup>
Mother HS	-0.70 <sup>†</sup>
Mother College	-0.38 <sup>†</sup>
Poor Household	-0.21 <sup>†</sup>
Treated Mother No HS	0.38 <sup>†</sup>
Treated Mother HS	0.12 <sup>†</sup>
$\sigma$ - Quality	0.13 <sup>†</sup>

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Note: † indicates significance at 0.01 confidence level.

school educated mothers pushes down the weight out of pocket prices  $op$  and distance play in determining choices, and raising the importance of school quality  $q$ . The differences in weights between non high school mothers and more than high school mothers is reduced substantially. Note that more educated mothers are not being treated in this policy, both in the RCT as in the planned scale up.

#### 5.4.2 Supply

The estimated marginal cost fixed effect at the school level is presented in Table 5. It can be seen in Figure 5 that firm specific marginal costs of quality are larger for public schools. There are also systematic differences in costs faced by schools in different markets as we show in the appendix. Religious schools have lower costs and for profit schools face higher marginal costs. During estimation we have assumed profit maximization in the objective function which is likely to be at odds with the objective function of public schools and some nonprofit schools like religious

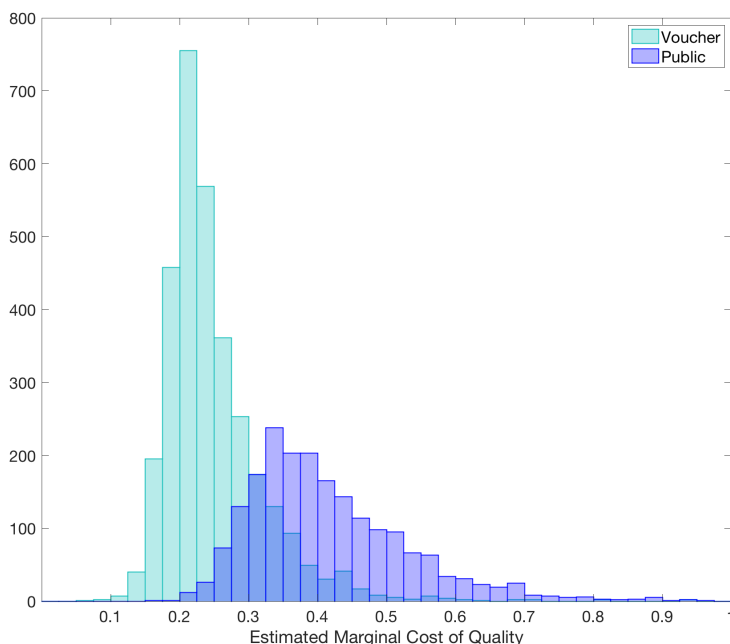
schools. However it is interesting to note that public schools, should they use all their funds to product quality without regard to their market power, would look more efficient through the lens of the first order condition of a profit maximizing firm. The fact that they seem more inefficient in this estimation suggests this is a upper bound on their efficiency and raises the possibility that these schools are much less efficient. This is corroborated in external data on school spending. The data on all school expenditures is not used in estimation and is presented in ?? showing a significant difference across private and public schools. The left panel shows expenditure per student and school quality while the right panel shows expenditure per teacher and school quality. Both tend to show that higher levels of spending produce higher levels of value added among private schools but that relationship is much more muted among the public schools.

**Table 5:** Supply Model Estimates

$\gamma_l$ - Marginal Cost	
Voucher	0.12 <sup>†</sup>
Public	0.65 <sup>†</sup>
For Profit	0.25 <sup>†</sup>
Religious	-0.10 <sup>†</sup>
Constant (Mean Market FE)	0.44
$\gamma_q$ - Quality Marginal Cost FE	
Constant (Mean Firm FE)	0.31

Note: † indicates significance at 0.01 confidence level. Mean Market FE and Mean Firm Effects are show to give a sense of the magnitude.

**Figure 5: Firm Level MgC(q)**



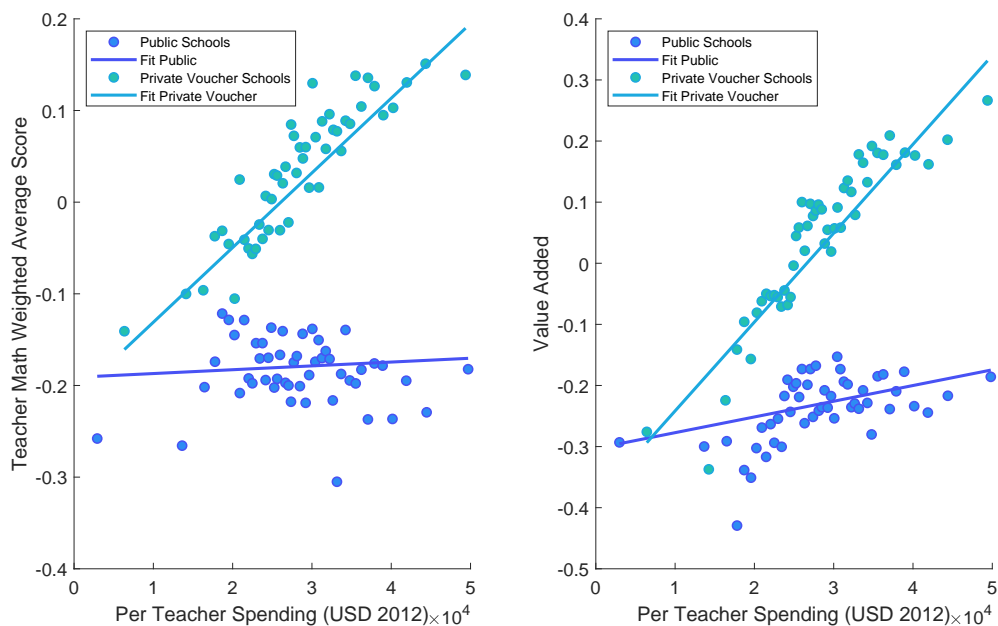
Note: This figure shows the distribution of  $\bar{\omega}_j$  for public and private voucher schools. The distribution of the schools marginal cost of quality is shifted to the right for public schools suggesting that more resources are needed to produce the same level of value added. See Table 5 for other cost parameters.

Specifying the school cost structure with a school specific marginal cost of quality is important because we will consider counterfactual policy where we want to predict the schools reaction to changing demand.

To explore whether the estimated marginal costs are reasonable we compare them with out of sample data of two types. The first comparison is to look at the correlation between spending on teachers and school quality. The main proxies for the productivity of teachers and teaching staff are test scores of teachers (a performance proxy) and the value added of the school. Figure O-26 shows the correlations between per teacher spending and these two measures. Per-teacher spending accounts for spending on labor resources divided by the number of teachers in the school. Teachers' math weighted average score represents the average of teachers' scores in the school weighted by their teaching hours. The math test is the test for entering college or tertiary education, at the end of high school. On the other hand, value added is a measure of the quality of the school (more details on the Value Added Section). The main takeaway from Figure O-26 is that private voucher schools have a positive relationship between their labor expenditures and their quality. Public schools seem to see no relationship between spending on teachers and quality.

These findings are consistent with the structural estimation that finds public sector providers to be less efficient.

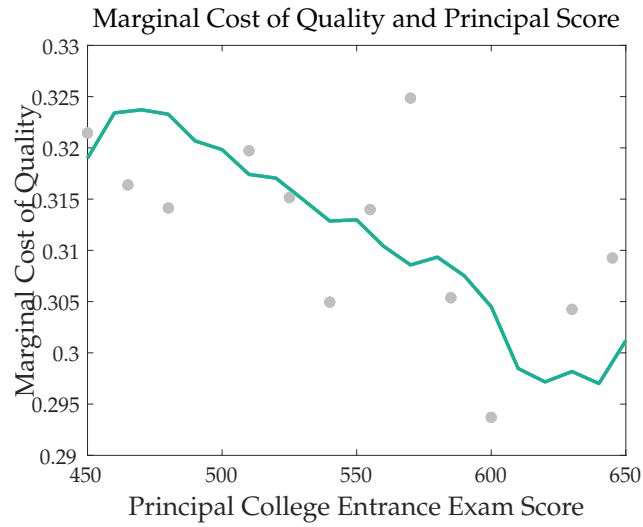
**Figure 6:** Share of Labor Spending over SEP Expenditure in 2012



Note: This figure shows the correlation between labor spending and the average weighted teachers' score of the school in the left subfigure; and the correlation between labor spending and the school value-added in the right subfigure. Both subfigures are differentiated by types of school, showing a positive relationship between labor spending and the productivity proxies for private voucher schools, while public schools show low or none relationship.

As a second out of sample test, we explore the relationship between firm specific marginal costs of quality and see if that is correlated with a measure of school administrator human capital. Specifically we merged digitalized public records of the college entrance exam for each school's principal as take that as a measure of their human capital and correlate that with the estimated school specific productivity. Figure 7 shows a binned scatter plot for the correlation between the estimated marginal costs of increasing quality by school and a measure of the school's principal ability given by their college entrance exam test average score. We find a negative correlation between these two variables, which is reasonable as we may expect more skilled administrators are more likely to be more efficient and be able to increase the quality of their school at a lower cost.

**Figure 7:** Correlation between MgC(q) and Principal's College Entrance Exam



Note: This figure shows the relationship between principals college entrance exams and the estimated school specific marginal cost of producing quality  $\bar{w}_j$ . The line plotted is the conditional mean for principals with scores within a window of  $0.1\sigma$  of the distribution of principals math scores. This relationship suggests that principals human capital is associated with more efficient schools.

## 5.5 Simulation of Aggregate Policy Effects

We can use the estimated empirical model to evaluate the potential effects of the information policy under different counterfactuals. The empirical model described in the previous sections provides a rich environment where we can simulate policies at different locations and in different intensities. For brevity we start with polar cases where  $\tau = 0$  or  $\tau = 1$  for all families with mothers without high school education and with mothers with high school education. In practice, a realistic version of the policy is implemented through the public preK network, so the detailed micro data on preK enrollment can be used to implement a more realistic version in which the proportion of families treated  $\tau < 1$  varies to replicate the coverage and attendance of private preKs. We also run simulations with different supply side flexibility. The different counterfactuals allow us to evaluate short and long run effects of a policy implemented at scale taking into account both demand and supply side adjustments.

We begin with a counterfactual that assumes no supply side reaction and no capacity constraint. This simulation approximates the potential effects through students sorting to the existing schools and does not take into account any adjustments or institutional restrictions. While not realistic, this simulation is informative regarding the size and direction of the effects given the location and quality of schools currently available. If we expect the supply side to not improve their quality, this can be considered an upper bound on the effects of the policy.

We then add more layers of complexity and simulate sorting with capacity constraints to approximate the effects of a more realistic at scale policy implementation and provide a quantitative measure of Equation 7. Specifically, in our second counterfactual, we take into account the fact that capacity constraints could bind once treatment shifts demand on aggregate. Using the estimated preferences, we generate a rank ordered list of the schools in the market for each student. We use the simulated applications to assign students to schools that have capacity constraints through a deferred acceptance algorithm with lottery numbers to break ties, which is the system that is currently being used in Chile. This is useful for simulations of counterfactuals as it limits the ability for schools to change their admissions policy given potential changes in demand.

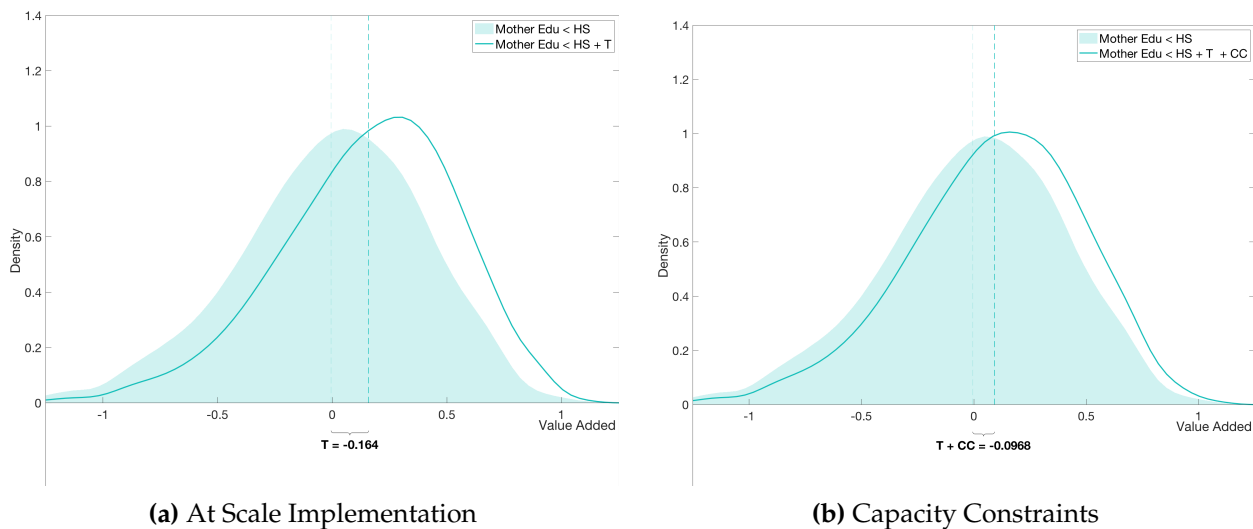
Then, we run a simulation that allows schools to choose quality and prices freely as a way to approximate a supply side reaction to the scale up version of the policy. This is a lower bound of what we can expect in a longer run equilibrium given by Equation 8.

In each simulation we report several statistics to summarize the new equilibrium and how its choices and alternatives have changed. The first is from Equation 6 and can be quantified by  $\mu_q^{\text{No HS}}(\mathbf{q}, \mathbf{op}, \vartheta, \tau = 1) - \mu_q^{\text{No HS}}(\mathbf{q}, \mathbf{op}, \vartheta, \tau = 0)$ . The second is to approximate the expression provided in Equation 21 where we recover the distribution of school value added across different SES groups under each counterfactual and use the difference in the average school quality as our main metric to compare outcomes under different scenarios.

### 5.5.1 At Scale Implementation, Demand Side Responses

In the very short run we can imagine schools will not be able to respond to an unpredicted demand shock. To implement this simulation, we will hold the set of schools and their quality and price fixed and apply the treatment to all students in the market so that  $\tau = 1$  for all nodes in each market. We start with this assumption and simulate probabilities of going to each school for all the students in each market. We compute the implied distribution of value added for the low SES group with and without treatment as is shown in Figure 8. We see a substantial difference in the average quality of school attended by students of low SES when compared to the baseline. However, the implied distribution of demand over capacity shown by the third curve of Figure 8a suggests that the better schools in poor neighborhoods would have to grow their matriculation substantially to make space for additional students. This suggests capacity constraints may be an important factor in the short run.

**Figure 8:** Distribution of Quality - At Scale Policy - Capacity Constraints



Note: This figure shows the distribution of school value added conditional on the students' mothers' education. Panel A shows a simulation where low SES families are all treated ( $\tau = 1 \forall n$ ) and schools cannot adjust prices or quality and there are no capacity constraints. This is the closest comparison to the small scale RCT given that the intervention and the change in behavior of families has no spillover effects on other families or schools. Panel B shows the change in the distribution of school value added conditional on the students' mothers' education in a simulation where low SES families are all treated ( $\tau = 1 \forall n$ ) and schools cannot adjust prices or quality but schools do face actual capacity constraints. This approximates what could happen in the very short run when schools have yet to adjust and demand has moved away from the prior equilibrium.

In the next simulation, we include the role of capacity constraints explicitly because while they are expected to bind, we are unsure how important this constraint may be quantitatively. Figure 8b shows the impact on the distribution of school quality with fully saturated treatment,



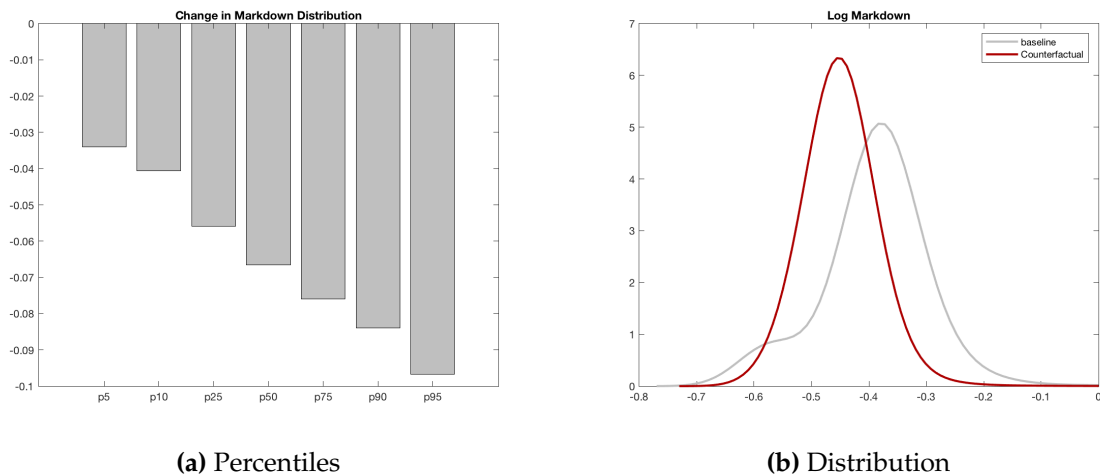
$\mu_q^{\text{No HS}}(\mathbf{q}, \mathbf{op}, \vartheta, \tau = 1)$ , and without the policy  $\mu_q^{\text{No HS}}(\mathbf{q}, \mathbf{op}, \vartheta, \tau = 0)$ . We use simulation of preferences as well as assignment lottery numbers to produce allocations and summarize the result in Figure 8b. We can see that when capacity constraints are taken into account the effects of the policy are reduced dramatically. The plot shows the distribution of quality attended for families with mothers with less than a high school education. The mean effects are indicated in the figures but the notable result is that average treatment effects found in the randomized control trial are almost halved when the policy is scaled up and capacity constraints are active.

### 5.5.2 At Scale Implementation, Demand and Supply Side Responses

The simulations in the previous section show lower effects due to congestion when the policy is scaled up. This suggests that there could be meaningful effects on school incentives. To explore the extend to which school incentives changed on impact, we calculate quality markdowns from the FOC defined in Equation 25 and how they change when the policy is implemented. We plot the distribution of the markdowns with and without the policy on impact in Figure 9 where we can observe that incentives change but the policy seems to have a significant degree of heterogeneity, suggesting that some schools would face larger changes in incentives than others.

This evidence is consistent with recent research emphasizing supply side reactions in education markets (Neilson (2013); Dinerstein and Smith (2015); Andrabi et al. (2017)) and suggests exploring whether supply side reactions in the aggregate can be expected to change the effects of the policy simulations. In this context, schools have many more margins through which to adjust

**Figure 9: Markdown Change on Impact**



Note: This figure shows the change in the distribution of school quality markdowns on impact when the policy is implemented at scale. No other schools adjustment is taken into account. This quantifies the change in incentives on impact of the policy. The graphs show significant heterogeneity across schools.

when considering a longer horizon. We focus on how the changing environment would lead to readjustment of the characteristics of the current schools and ignore other margins including entry, exit or investments in capacity. To explore the extent to which schools might readjust their characteristics once the policy is in place we conduct a simulation with a fully saturated policy again with  $\tau = 1$  and allow school to adjust quality. Prices have now been frozen due to recent policy changes. We calculate the new equilibrium vector of quality when demand shifts in response to the policy implemented at scale. Capacity is held constant so this simulation could be interpreted as a medium run outcome where prices are fixed due to regulation, capacities are fixed due to slow adjustment in school size but schools can hire more and better inputs such as teachers and exert more effort.

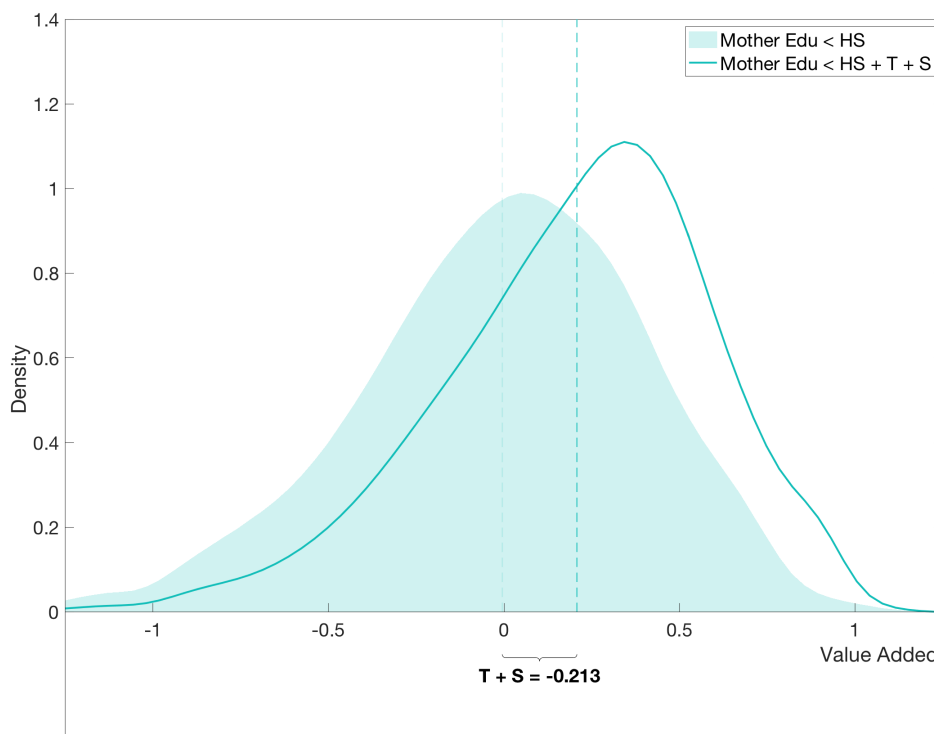
To implement the simulation, we look for a local equilibrium allowing schools to iteratively adjust their FOC in small steps. One intuition for this type of procedure is based on Doraszelski et al. (2018), where it is assumed that schools have uncertainty about their rivals' costs but know the demand parameters. After a policy change, schools will not immediately play the Nash equilibrium but will rather choose quality computing their first order conditions based on the demand they expect and their beliefs about their rivals' quality which can be heavily weighted on past observation in a context of a lot of uncertainty. Iterating over this adjustment process we find an equilibrium.<sup>30</sup>

Figure 10 shows the distribution of quality once the policy is expanded at scale and schools can adjust levels of quality. The effects are quite significant and the average treatment effects are similar if not bigger to the effects found in the randomized control trial. These simulations suggest the equilibrium effects will tend to be raised by increasing supply of school quality once families in poor neighborhoods are exposed to the policy and put more weight on school quality when choosing schools.

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<sup>30</sup>The results in Doraszelski et al. (2018) support the idea that in stable environments, play of this sort will generally converge to a Nash equilibrium. In this application, iteration on small adjustments quickly find new equilibria in each counterfactual simulation.

**Figure 10:** Distribution of Quality - At Scale Policy - Medium Run Effects



**(a)** No High School Mother Type

Note: This figure shows the change in the distribution of school value added conditional on the students' mothers' education in a simulation where low SES families are all treated ( $\tau = 1 \forall n$ ) and schools cannot adjust prices but can adjust quality and face actual capacity constraints. This approximates what could happen in the medium run when quality can adjust but prices are frozen as is the current policy in Chile.

## 5.6 Robustness and Discussion

It is expected that over time, investment in capacity or entry may play a bigger role. However, in prior work in the context of Chile, entry/exit margins were not found to be large drivers of change given current market structure and policy that seemingly has excess capacity (Neilson, 2013). Similar to the analysis in Wollmann (2018), this counterfactual focuses on the adjustment of product characteristic and is what we consider a lower bound on supply side effects over time. Capacity constraints and limiting entry both presumably dampen competition that is driving the change in incentives to invest in quality. This could also represent a medium run approximation to what could be expected to happen given the policy implementation.

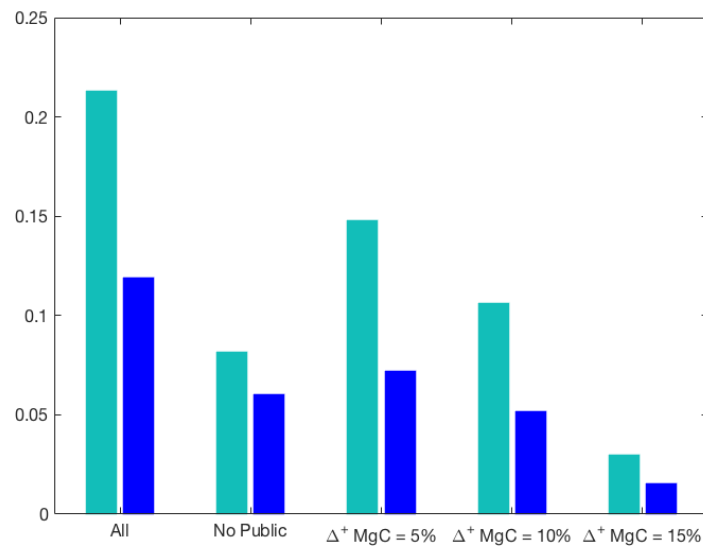
### 5.6.1 Alternative Assumptions About Participation

Additional simulations repeat the exercise with more realistic assumptions of supply responses. These results are presented in Figure 11. The first one is presented in the second column. For this exercise, we assume that public schools do not react at all, as they maximize quality given budget and ignore market conditions otherwise. We see that under this assumption low SES students are particularly affected.

### 5.6.2 Potential Spillovers to Inputs Markets

Policy changes that induce an increase in the provision of quality can put pressure on inputs markets. For example, schools may have to hire better teachers to increase their quality, increasing the demand and thus wages in teachers' labor markets. Schools' decisions could be different as they face higher marginal costs. In this simulation, we explore what might happen if increased demand for school quality inputs increased marginal costs across the board by 5%, 10% and 20%. In all cases we find positive effects although increasing costs and limiting supply side reactions reduce the average policy effect relative to the benchmark in Figure 11.

**Figure 11:** Difference with the Baseline mean Quality



Note: This figure shows the change in the average policy effect when different assumptions are made about the slope of the marginal cost of quality curve. As marginal costs can increase with more demand for quality in the aggregate, we test how big would these increases need to be to eliminate the observed supply side effects. We find that an increase of 15% would eliminate most of the effects.

### 5.6.3 Summary of Policy Simulation Exercises

The results from the counterfactual analysis are summarized in Table 6. We find that capacity constraints play an important role in limiting the policy effects. We also find evidence that schools will have incentives to improve quality, especially in poor neighborhoods. In practice these aggregate effects imply students not affected directly by the policy (parents did not attend meetings for example) would find the set of schools available to them having higher quality.

**Table 6:** Summary of Policy Effect Simulations

	Experiment	Model						
	ATE	T	T+CC	T+CC+S (All)	T+CC+S (noPub)	$\Delta^+5\%$	$\Delta^+10\%$	$\Delta^+15\%$
All	-	0.076	0.041	0.104	0.0449	0.0770	0.0569	0.0193
No HS Mother	0.118	0.164	0.097	0.213	0.0817	0.1477	0.1061	0.0299
HS Mother	0.048	0.091	0.056	0.119	0.0600	0.0721	0.0518	0.0150
College Mother	-	0.000	-0.015	0.015	0.0126	0.0110	0.0080	0.0060

Note: This table summarizes the results of the policy simulations under different assumptions about constraints and the adjustments schools are allowed.

An important aspect to note is that in these counterfactuals simulations we are leaning on several current institutional aspects that could play a crucial role in the quantitative exercises. One is that applications to schools are processed in a centralized application system and the other is that prices have been fixed. These allow us to ignore potential changes to admissions policies when demand suddenly shifts due to the policy. Estimation is implemented in a stable environment where we assume excess demand is less of an issue as school have had time to adjust price and quality but this assumption seems less reasonable if a large policy change happened suddenly. The second policy fixing prices is also likely to play a role because this shuts down the ability for a high quality school with excess demand to raise prices, potentially dissuading poorer families that value quality more but are still more price sensitive than richer families. While this reduces incentives for high quality firms to increase quality it still leaves low quality schools to have incentives to increase their quality.

## 5.7 Leveraging the Estimated Model to Design a Large Scale RCT

The information provided in the simulations approximates the equilibrium outcomes of the implementation of the information policy at scale. Policy makers can use the evidence from the randomized control trial, together with this menu of quantitative results that consider equilibrium constraints of different types to help inform decision making. However, in some cases, the risk of making a mistake in the implementation of a policy can be too great and a policy maker

might well be willing to invest in obtaining additional information about the effects of an at scale implementation of the policy. In this case, the RCT and the empirical model described in this paper can also help inform the design of an at scale.

The estimated empirical framework can be used to study the effects of different configurations of treatment and control neighborhoods. By controlling the  $\tau$  that is relevant for families in each node we can calculate the change in demand at the block level,  $s_j^{nk}(\mathbf{q}, \mathbf{op}, \vartheta, \tau)$ , once treatment is implemented by using Equation 18. Treating different sized clusters of blocks in an area will lead schools nearby to be exposed to different degrees of the policy treatment described by the vector  $\tau$  and the demand they face  $s_j^k(\mathbf{q}, \mathbf{op}, \vartheta, \tau)$  can be characterized by Equation 19. When enough blocks in the surrounding area are treated, a school will be full exposed to the change in demand but not necessarily the equilibrium effect of the policy if not all competing schools in the area are also fully exposed. Using the estimated parameters that describe the substitution patterns of families and the degree of competition across schools, we can simulate the effects that we would obtain under different cluster designs.

We propose a generic design that consist in clusters defined by three areas. First, the core of the cluster, which size will be defined by an inner radius and is shown in solid colors in Figure 12. This will be our unit of observation for the simulated effects of the policy on school congestion and school quality. Then, we have an the intermediate zone, which contains the area defined by a bubble which radius is the sum of the inner and the outer radius, including the core. This will be our unit for policy implementation. In treated clusters, all the nodes that fall inside these intermediate zones will be assigned to the treatment for simulations. Finally, we define a buffer zone, which is defined by an outside buffer of the intermediate zone. This area between treated and control neighborhoods is needed to have a clean experiment. The smaller the buffer, the more likely it is that there can be spillovers between treatment and control clusters.

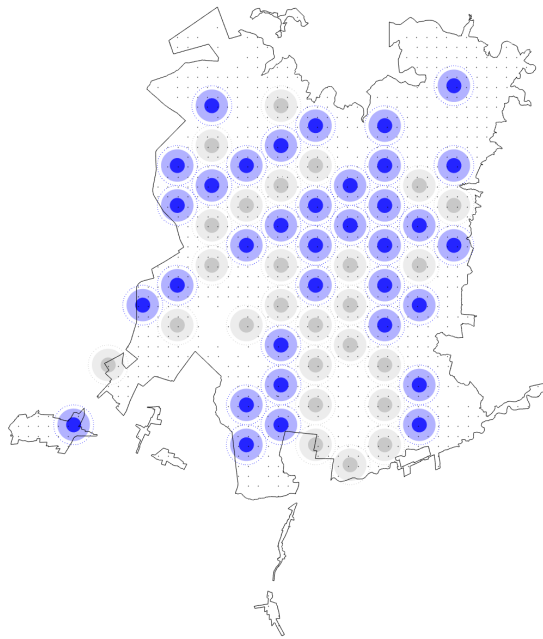
Figure 12 shows four different configurations of treatment and control clusters of blocks in Santiago. For simplicity, all clusters have the same buffer radius. Clusters A and B have the same total radius, but differ in the relative sizes of the inner and outer buffer. Same for clusters C and D, which both have a larger total radius than the first two. In all figures, the blue Then, we can use the estimated model and assign the treatment to the nodes cosimulate the demand and supply effects of the policy implemented only in treated groups. Spillover effects can be quantified and used to evaluate the properties of each experimental design.

Table 7 shows the results of running a regression on the simulated at scale RCT using Equation 30.

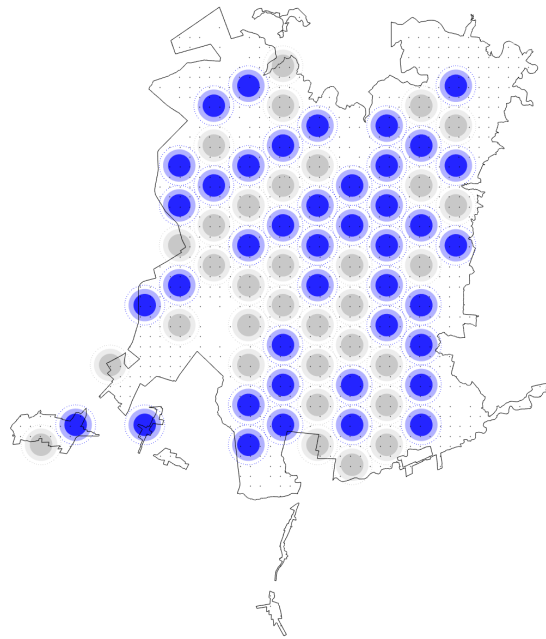
$$Y_{jt} = \alpha_m + \beta T_c + \gamma Y_{jt-1} + \epsilon_{jt} \quad (30)$$

Where  $m$  is the market and standard errors are clustered at the level of neighborhood  $c$ .

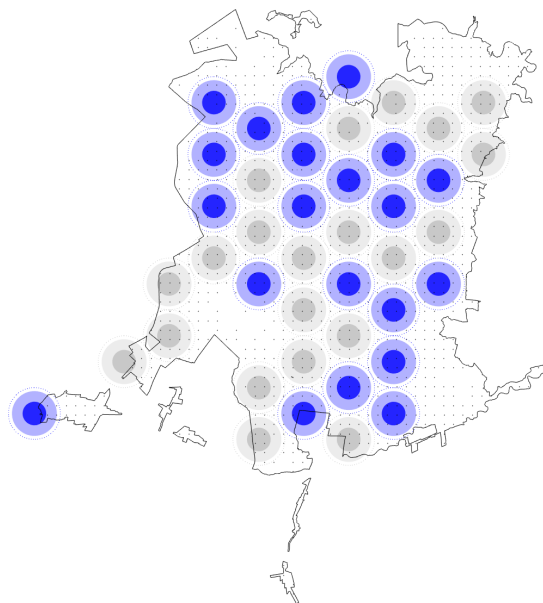
**Figure 12: Effect of School Choices**



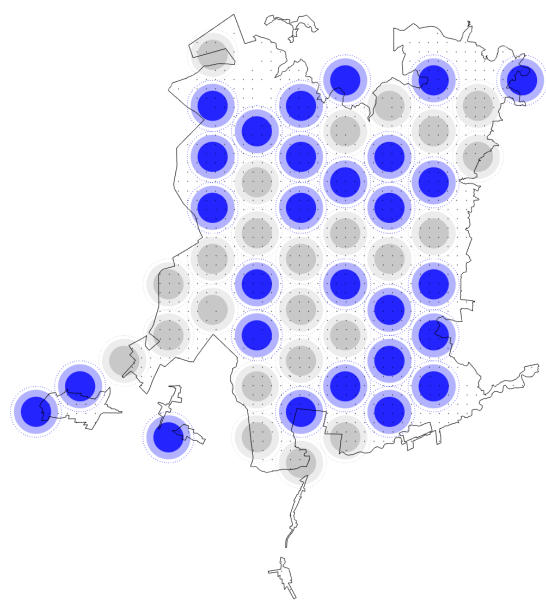
**(a)**  $I=0.6$  km,  $O=0.7$  km,  $B=0.3$  km



**(b)**  $I=0.9$  km,  $O=0.4$  km,  $B=0.3$  km



**(c)**  $I=1.0$  km,  $O=0.9$  km,  $B=0.3$  km



**(d)**  $I=1.3$  km,  $O=0.6$  km,  $B=0.3$  km

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Note: This figure shows two different configurations of treatment and control clusters of blocks. The appropriate choice of inner bubble and buffer zone respond to the degree of spillovers and the substitution patterns found among families school choice when treated and not treated.

**Table 7:** Expected Impact of At Scale Policy RCT

	Design (Numbers of)			Radius (km)				Simulated Effects	
	Obs	Clusters	Nodes	Total	Inner	Outer	Buffer	Diff T-C	Control Mean
<b>A</b>	326	122	930	1.6	0.6	0.7	0.3	0.0537 (0.0231)	0.0018 (0.0007)
<b>B</b>	818	148	1088	1.6	0.9	0.4	0.3	0.0346** (0.0176)	0.0029 (0.0012)
<b>C</b>	932	84	1692	2.2	1.0	0.9	0.3	0.0543* (0.0285)	0.0024 (0.0011)
<b>D</b>	1258	104	1712	2.2	1.3	0.6	0.3	0.0379 (0.0117)	0.0017 (0.0009)

This procedure is meant to be used together with other budgetary and political considerations when designing a randomized control trial at scale. The estimated model can incorporate the treatment effects on individual behavior and in addition can be used to aggregate the behavior to describe what spillover effects can be expected from a partial at scale implementation of the policy. The hope is this can be useful when designing large and expensive RCTs that do not have prior knowledge of how big spill over effects will be when supply side reactions are incorporated.

## 6 Discussion

Economist generally agree that an informed consumer demand is an important aspect of a well functioning market. A lack of information can lead individuals to make inefficient choices, and this could potentially have aggregate effects, decreasing efficiency. In the case of the market for education services, a growing body of evidence from different contexts suggests that providing information to individual families may indeed shift their school choice, and in some cases information provision can have aggregate effects. The prospect of a government policy based on this idea is very attractive since it has the potential to improve equity and efficiency at a very low cost. This is especially true in developing countries where private provision of services like education is common, but government supervision and regulation tend to be lax. In spite of this, when it comes to designing and implementing government policy, it is not clear how to extrapolate the existing evidence from different contexts. Design details, capacity constraints and supply side reactions can all make a particular intervention ineffective when it is implemented at scale.

In this paper, we employ a series of empirical tools and data to study the small- and large-



scale effects of a particular policy that promotes information provision. We draw upon insights from prior research to develop an intervention that is low cost, scalable, and compatible with local political, institutional, and logistical restrictions. Using a small-scale randomized control trial, we evaluate whether this type of intervention can affect choice and later outcomes. The results provide evidence that an intervention of this type does indeed shift parents choices and raises student achievement several years later. To extrapolate to aggregate policy implications and evaluate equilibrium considerations, we embed the randomized control trial within a structural model of school choice and competition, estimating the parameters that describe how supply and demand would react to the policy intervention. We estimate the parameters of the supply and demand model, taking advantage of rich administrative and survey data, variation from recent policy changes, and the variation generated from the randomized control trial.

Using the empirical estimates from our structural model of school choice and competition, we evaluate the policy effects of an at-scale evaluation when students sort, capacity constraints bind but schools do not react. We then evaluate the effects of supply side reactions in equilibrium under different assumptions regarding how public and private schools react, and how costs may vary with the scale of the policy. We find positive effects of the policy that range from 50%-120% of the average treatment effect in the randomized trial, suggesting positive effects overall but potentially small short run effects due to capacity constraints. Depending on the assumptions used, the effects on average school quality attended by low socioeconomic families varies between  $0.06\sigma - 0.22\sigma$ .

These results add to prior work such as Andrabi et al. (2017) and suggest that this information intervention can be a cost-effective way to improve efficiency and equity in education markets with a large private sector, as is the case in many developing countries. Researchers can use our empirical strategy to study aggregate effects of new ways to provide information. For example, virtual assistants or chatbots leverage artificial intelligence to provide rich and dynamic personalization of information and are rapidly being deployed in many markets, such as retail and health care (Agrawal et al., 2018). Future research should study whether these new tools can have an impact on individual decisions and market efficiency in education contexts. Our empirical strategy combining evidence from a small scale randomized control trial together with an equilibrium model of supply and demand can provide a platform to study the market level effects of these and other new innovations in information provision.

Measuring school quality and retrieving causal estimates of value added are difficult, and testing students regularly is expensive and impractical in many contexts. The evidence presented in this paper suggests that governments in developing countries could have a high return on investing in systems to collect and disseminate basic information about schooling options. It is important to note that the intervention we studied did not focus exclusively on information about test scores, but also tried to persuade families that the return on investing in effort to search and choose a school carefully is high. This second aspect is complementary to the available informational

structure and potentially less dependent on the quality of information available. Future research can help clarify the role of information provision in stimulating more search given that some very important aspects of education provision will remain fundamentally unobservable without some family effort.

Beyond the specific policy implications of this information intervention, we argue that the combination of randomized control trials and structural models of supply and demand can be useful for policy evaluation for several reasons. First, a randomized control trial implemented at scale is often politically or technically infeasible. Small-scale randomized control trials can be more cost effective for discovering what design details work best. The effects of the best version of the intervention can then be embedded into an empirical model that incorporates the main features governing supply and demand and researchers can use this model to evaluate impact before implementing a final and costly large-scale evaluation. In this sense, we would argue that in many cases, a small-scale randomized control trial combined with a structural model can be used to evaluate equilibrium considerations is a cost effective way of gaining further insight into the potential policy effects and aspects of design in practice. This could make small-scale experiments more appealing to governments, and be a relevant intermediate step to help guide funding institutions like USAID or DFID when allocating funding for expensive large at-scale evaluations.

Finally, it is important to mention that the methods implemented in this paper benefit from several unique policy changes, institutions and access to administrative data that may not be available in other settings. In particular, prior policy changes that shifted out of pocket prices and changed government transfers to schools are critical sources of instruments for key endogenous variables such as price and quality. The introduction of centralized assignment of students to schools make both estimation and simulation of counterfactuals much more realistic in this context as well. Access to administrative data on a large set of student characteristics as well as detailed data on school prices, capacities, revenue and expenditures also make ambitious empirical endeavours more manageable and in our view, starting from a small scale RCT, allow the empirical application to get quite far in providing aggregate policy advice. These data and institutional frameworks may not be available in some context but the trend in data rich environments suggests that empirical structural modeling strategies that leverage big data and credible small scale RCT evidence will have increasingly more scope to inform policy in the future.

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# Appendix

## A1 Appendix Tables and Figures

**Table A1: Treatment Balance at the School Level**

	Difference T-C		Control Group Mean	
	(1)		(2)	
Enrollment	-1.898	(3.248)	41.467	(2.530)
Mean attendance	-1.053	(2.430)	28.689	(1.903)
Mother HE	-0.643	(1.552)	9.495	(1.320)
Mother HS	-0.915	(2.195)	48.347	(1.652)
Mother NHS	0.760	(1.010)	7.309	(0.697)
Q1 Income	0.577	(2.996)	57.970	(2.348)
Q2 Income	0.288	(2.142)	31.365	(1.587)
Q3 Income	-1.136	(1.216)	8.752	(0.930)
Very Poor	0.637	(1.865)	14.947	(1.406)
Poor	0.083	(2.233)	40.619	(1.816)

Notes: Column 1 presents the coefficient and standard error for the difference between the treatment and control groups in a regression of each variable on treatment status. Column 2 presents the coefficient and standard error for the control group mean. \* p-value<10% \*\* p-value<5% \*\*\* p-value<1%.

**Table A2: Balance for Being Enrolled at Baseline**

	Difference Enrolled - Non-Enrolled		Non-Enrolled Group Mean	
	(1)		(2)	
<i>Panel A: SES characteristics</i>				
Household size	-0.035	(0.108)	4.927	(0.081)
Durable goods	0.382***	(0.116)	4.461	(0.080)
Owens Dwelling	0.047	(0.031)	0.343	(0.019)
Mother head of hh	0.001	(0.030)	0.832	(0.014)
Mother NHS	-0.010	(0.022)	0.192	(0.016)
Mother HS	-0.039	(0.025)	0.391	(0.019)
Mother HE	0.007	(0.019)	0.836	(0.016)
Poor	-0.013	(0.016)	0.895	(0.011)
Another child in primary	0.010	(0.029)	0.405	(0.018)
<i>Panel B: Birth characteristics</i>				
Gestation Weeks	-0.019	(0.094)	38.751	(0.056)
Birth Weight	-3.982	(25.338)	3,342.137	(15.176)
Mother's Age	0.329	(0.364)	25.332	(0.232)
Father's Age	-1.646	(1.217)	36.472	(0.933)
Marital Status	-0.021	(0.023)	1.735	(0.014)
Doctor	-0.011	(0.024)	0.333	(0.015)
Hospital	0.014*	(0.008)	0.959	(0.006)
Number of Children	0.102	(0.087)	1.871	(0.035)

Notes: Column 1 presents the coefficient for the difference between households enrolled and non-enrolled at baseline in a regression of each variable on an indicator for being enrolled at baseline. Column 2 presents the coefficient and standard errors for the non-enrolled group mean. Regressions include the observations for which there is data on baseline enrollment (N=1,612). \* p-value<10% \*\* p-value<5% \*\*\* p-value<1%.



## Online Appendix

### O-1 Provision of Preschool Services in Chile<sup>31</sup>

Access to preschool education has increased in the last years but it is still below levels of developed countries. Accordingly to for Economic Co-operation and Development (2016), enrollment of 0-2 year-olds in formal care is 18% (below the average of 33% in OECD countries). This increases to 54% for 3 year-olds in 2015 (which is almost twice enrollment in 2005 but below the average of 71% across the OECD). In terms of provision, there are public and private providers. Free public providers are organized in two networks: Junji and Fundación Integra, which administer approximately 3,000 and 1,000 centers respectively, and are explicitly tasked with providing access to Pre-K educational services for students all over the country. 42% of the 3-4 year olds enrolled in preschools in 2016 attended Junji centers and 18% attended Integra centers. The reminder children attended private providers, some of them receiving public funding and others charging relatively high tuition fees.

The application process to public and private centers is decentralized and public providers give priorities to poor families (Aguirre, 2011). Several targeted public programs also support families in sending children to preschools. In addition, Junji was also in charge of (light) monitoring of private providers until 2016 (mainly related to inputs). Currently, there is an independent agency in charge of the monitoring of preschool providers. Expenditure per student was \$ 6,408 in 2015 and 15% of that comes from private funding (OECD, 2016).

#### O-1.1 *Fundación Integra*

Fundación Integra (Integra, here on) is the second largest public supplier of preschools in Chile. It serves more than 72,000 children throughout the country in its 1,000 tuition-free centers. Integra focuses on low-income neighborhoods in order to “[constitute] a real support for families living in poverty, offering a safe space and an excellence educative program to their children from three months up to four years old”.

Working with Integra provides us with a unique setting to study school choice decisions by providing us with (i) an environment through which we can have access to families that are about to choose primary schools, being relatively confident that the results are not driven by self-selection into primary schools, and (ii) a cost-effective way to implement the intervention. Integra does not offer primary education, so students in the upper level of this program will necessarily have to choose a primary school to continue their education. In addition, working with them provides us with an exceptional opportunity to collect data and deliver interventions using the

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<sup>31</sup>This subsection is partially based on for Economic Co-operation and Development (2016).

existing infrastructure of the program. Otherwise, finding families that are about to choose would be very costly to implement.

## O-2 Sample Selection

With the aid of the Integra management team we decided to work in the three larger regions in the country, Valparaíso, Biobío and Santiago, and we identified which municipalities and preschools within each one were useful to our research questions. We chose preschools located in urban areas (according to Integra's criteria) and that met our criteria for having an adequate level of school competition. To do so, we defined that all preschools in municipality  $i$  would participate if there were at least 10 schools within a 2 kilometer radius (around 1.2 miles) and the ratio  $(\text{primary schools}_i / \text{preschools}_i) \geq 2$  for municipality  $i$ . In addition, we only considered schools in the three lower SES levels (according to the classification implemented by the Ministry of Education), which represent almost all the schools in the effective choice set among families of the first three income quintiles.

This left us with 143 preschools in the three regions mentioned above. Then we randomly assigned preschools to the treatment and control groups stratifying by region, grade and the number of schools within a 1.2 mile radius. We contacted each preschool to check whether they had any parents' meeting scheduled between August and December, 2010. If they had a scheduled meeting with parents, we asked if a person of our staff could go and apply the baseline survey during the meeting and apply the treatment (if the preschool was in that group).

Out of the 143 original preschools we selected, there were 10 for which we could not schedule a meeting. Among the main reasons were, a refusal by the principal, unavailability of dates and no parents attending the meeting. Table O-1 presents some differences in observable characteristics between schools included and not included in the experiment. The 10 preschools without meetings have a larger share of mothers with complete tertiary education, larger share of families in the second income quintile, and a lower proportion of indigent families. None of the parents in these schools were surveyed in the follow up, since no one was able to sign the informed consent. Thus for all practical reason our sample consist of the 133 preschools where we were able to attend the meeting.

In the 133 intervened preschools, a total of 1,832 parents signed the informed consent and answered the survey asking for contact information. The surveyed was applied before handing out any information and it included questions regarding the application process. We asked parents about whether they had decided to send their child to primary school in 2011, if they had already chosen a specific school, and whether they had already enrolled the child. Parents were also asked if they had any other children already enrolled in primary school, considering this could be an important determinant of school choice. Since our presence in the meeting was not announced,

**Table O-1: Differences between preschools with and without meetings**

	With Meeting	Without Meeting	Difference	t-test
Enrollment	40.21	46.50	-6.29	-1.02
Mean Attendance	27.99	32.40	-4.41	-0.77
Mother w. Complete Tertiary (%)	9.07	12.81	-3.74	-1.76*
Mother w. Complete Secondary (%)	47.74	45.36	2.38	0.70
Mother w. Incomplete Secondary (%)	34.72	34.89	-0.17	-0.05
Mother w. Complete Primary (%)	7.81	6.94	0.87	0.65
Q1 of Income (%)	58.35	53.89	4.47	1.22
Q2 of Income (%)	31.56	38.42	-6.86	-2.02**
Q3 of Income (%)	8.00	5.95	2.05	1.27
Indigent (%)	15.37	9.68	5.69	2.73***
Poor non-indigent (%)	40.67	42.10	-1.42	-0.41
Non-poor (%)	43.96	48.23	-4.27	-1.33
Number of Preschools	133	10	143	

Notes: Columns 1 and 2 present the average value for the respective variable for preschools treated (with meeting) and untreated (without meeting), Column 3 shows the difference between groups and column 4 the t-test of the null hypothesis of equality between averages, using standard errors clustered at the preschool level in parenthesis.

\* p-value<10% \*\* p-value<5% \*\*\* p-value<1%.

we would expect attendance to be similar across preschools, as we report in Table A2.

### O-3 Selection on enrollment at baseline

The timing in the delivery of information interventions is a key aspect for their effectiveness. Ideally, our treatment should have been delivered before parents decided which school they wanted to send their children to. Unfortunately, we find that an important number of parents in our sample had already enrolled their children in a school at baseline. In most of our reduced form analysis, we distinguish between parents who have already enrolled their children and the ones that have not made their enrollment decision, with the idea that the second sample will give us the causal effects of the intervention when the treatment is delivered on time.

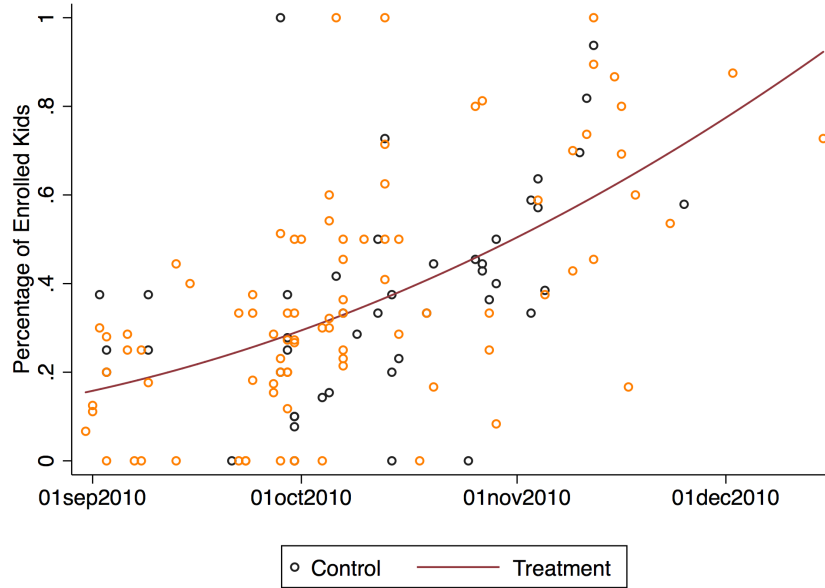
However, our results for the sub-sample of non-enrolled kids may not be generalizable if their parents are different to the ones of the kids that are already enrolled. In this section, we provide evidence that the likelihood of being enrolled in the baseline is mainly driven by the timing of the intervention and that both groups are not different in observable characteristics.

The meetings were conducted between August and December 2010, in a 16 weeks period. Figure O-1 shows the percentage of parents that reported to have chosen a school and already enrolled by the date of the meeting. Schools in which meetings were closer to the end of school year (December) had a higher share of enrolled parents. While in September a 20% of parents reported having already enrolled their kids, in November this number grew up to 65%.

Table A2 shows balance on observable for being enrolled at baseline. Both SES and birth characteristics are included. Enrolled parents seem to have more durable goods, but are not different

in terms of mothers education, poverty status, house hold size or birth outcomes, except for being born at a hospital, for which they are marginally more likely.

**Figure O-1: Timing and Probability of Matriculation**



### O-3.1 Treatment Design and Implementation

The intervention included two main components. The first was the provision of a Report Card designed for each preschool that included information about a subset of characteristics of the schools located in the same neighborhood<sup>32</sup>. The information provided in the Report Card included: (i) test scores, where to reduce the noise produce by a single observation, we averaged the results on Math and Reading (Spanish) over four years, between 2006 and 2009;(ii) a measure of the change in test scores between years, since a school in the median, but that has largely increased its test scores may be a better (o worst) match for some parents, than a school with the same median score, but that has largely worsened its results; (iii) the official tuition cost for parents, using data from the Ministry of Education<sup>33</sup>; (iv) the type of the school (whether it is public or private) and (v) its location (i.e. address). We also provided parents a map with all schools included in the

<sup>32</sup>As argued above, we excluded primary schools of higher SES, which generally charge higher fees and have more restrictive selection process, thus are not included in the effective choice set of parents in this context. We were also limited to include up to 30 schools due to space constraints. When a preschool had more than 30 schools within 2 Km. we randomly deleted some schools that were not in the extremes of the Report Card, in order to reduce the bias from presenting a selected part of information.

<sup>33</sup>Note, however, that this is not a perfect measure of what parents actually pay, since there may be other costs, including materials or fees for parents' association. Schools could also offer discounts and scholarships to some students. Since we do not have data on those payments, we included the official co-payment since it is an objective measure and it is comparable across schools.

Figure O-2: Report Card - Front

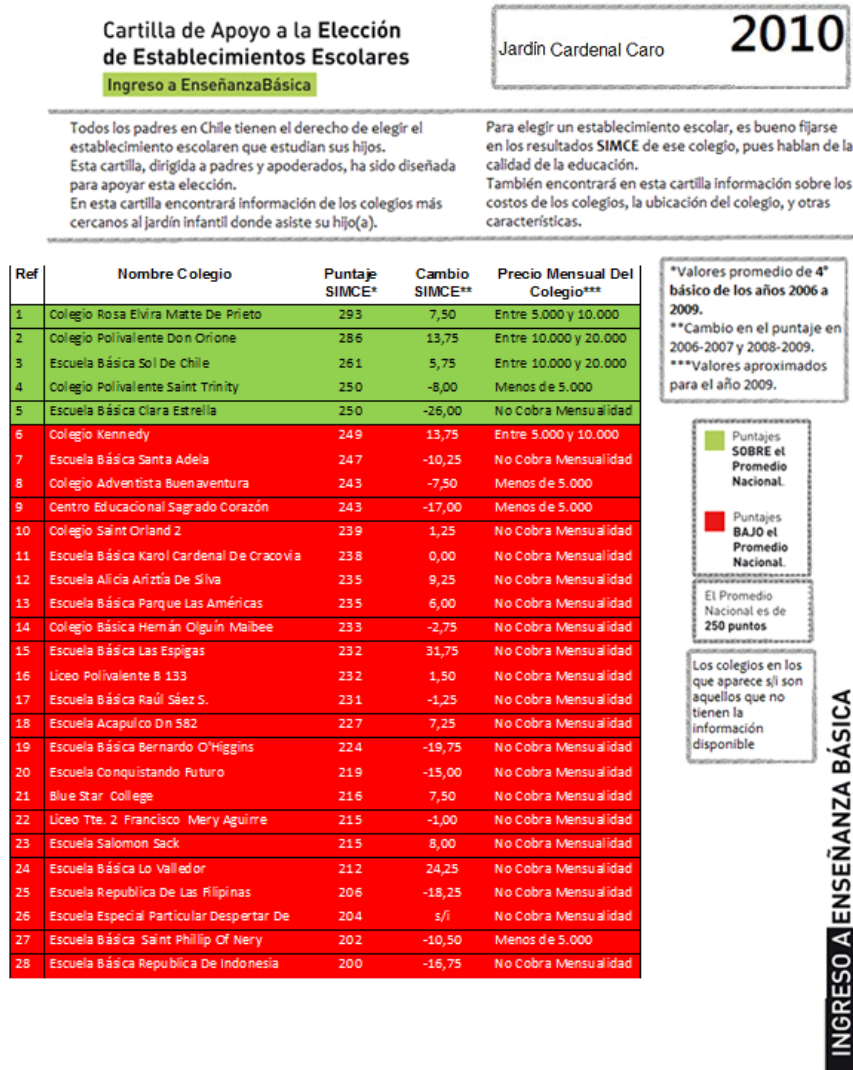


Figure O-3: Report Card - Back

Cartilla de Apoyo a la Elección  
de Establecimientos Escolares

Jardín Cardenal Caro

2010

Ingreso a Enseñanza Básica

Ref	NOMBRE COLEGIO	DIRECCION	Cursos	Dependencia*	Alumnos SIMCE**
1	Colegio Rosa Elvira Matte De Prieto	Buenaventura 3824	Párvulos a 4º Medio	PSUB	101
2	Colegio Polivalente Don Orión	Av. Pedro Aguirre Cerda 7335	1º Básico a 4º Medio	PSUB	90
3	Escuela Básica Sol De Chile	León De La Barra N. 9211	Párvulos 8º Básico	PSUB	63
4	Colegio Polivalente Saint Trinity	9 De Enero N. 02699	Párvulos a 4º Medio	PSUB	57
5	Escuela Básica Clara Estrella	Váparaiso 6990	Párvulos 8º Básico	MUN	55
6	Colegio Kennedy	Maipú N. 9485	Párvulos 8º Básico	PSUB	50
7	Escuela Básica Santa Adela	Los Profesores N. 7400	Párvulos 8º Básico	MUN	47
8	Colegio Adventista Buenaventura	Buenaventura N. 03928	Párvulos a 4º Medio	PSUB	40
9	Centro Educativo Sagrado Corazón	Huasco N° 7147	Párvulos 4º Medio	PSUB	31
10	Colegio Saint Orión 2	Passaje Saturno 03955	Párvulos 8º Básico	PSUB	55
11	Escuela Básica Karol Cardenal De Graçovia	8 Norte N. 09922	Párvulos 8º Básico	PSUB	114
12	Escuela Alicia Arista De Silva	México N. 02444 Rob. Santa Olga	Párvulos 8º Básico	MUN	34
13	Escuela Básica Parque Las Américas	Lo Ovalle N. 3915	Párvulos 8º Básico	MUN	38
14	Colegio Básica Hermin Olguín Malbec	Avenida Central N. 8108	Párvulos 8º Básico	MUN	103
15	Escuela Básica Las Espigas	19 Sur N. 03820	Párvulos 6º Básico	PSUB	15
16	Liceo Polivalente B 133	Insú De Suárez N. 6970	Párvulos 4º Medio	MUN	14
17	Escuela Básica Raúl Sáez S.	Veracruz N. 5245	Párvulos 8º Básico	MUN	39
18	Escuela Acapulco Dn 582	Acapulco N. 7661	Párvulos 8º Básico	MUN	69
19	Escuela Básica Bernardo O'Higgins	Pío XI N. 7148	Párvulos 8º Básico	MUN	32
20	Escuela Conquistando Futuro	La Habana N. 7461	Párvulos 8º Básico	MUN	20
21	Blue Star College	Monte Rey N. 7519	Párvulos 8º Básico	MUN	44
22	Liceo Tte. 2 Francisco Méry Aguirre	Avenida Centenario N. 02854	Párvulos 4º Medio	MUN	19
23	Escuela Salomón Sack	Avenida Las Torres N. 7850	Párvulos 8º Básico	MUN	26
24	Escuela Básica Lo Valledor	Arturo Alessandri N. 6378	Párvulos 8º Básico	MUN	20
25	Escuela República De las Filipinas	Júpiter N. 7746	Párvulos 8º Básico	MUN	33
26	Escuela Especial Particular Despertar De	Calle Jalisco N. 02407	1º a 4º Básico	PSUB	13
27	Escuela Básica Saint Phillip Of Nery	Astaburuga N. 9350	Párvulos 8º Básico	PSUB	19
28	Escuela Básica República De Indonesia	Ortiz De Zarate N. 03873	Párvulos 8º Básico	MUN	35

■ Puntajes **SOBRE** el Promedio Nacional

■ Puntajes **BAJO** el Promedio Nacional

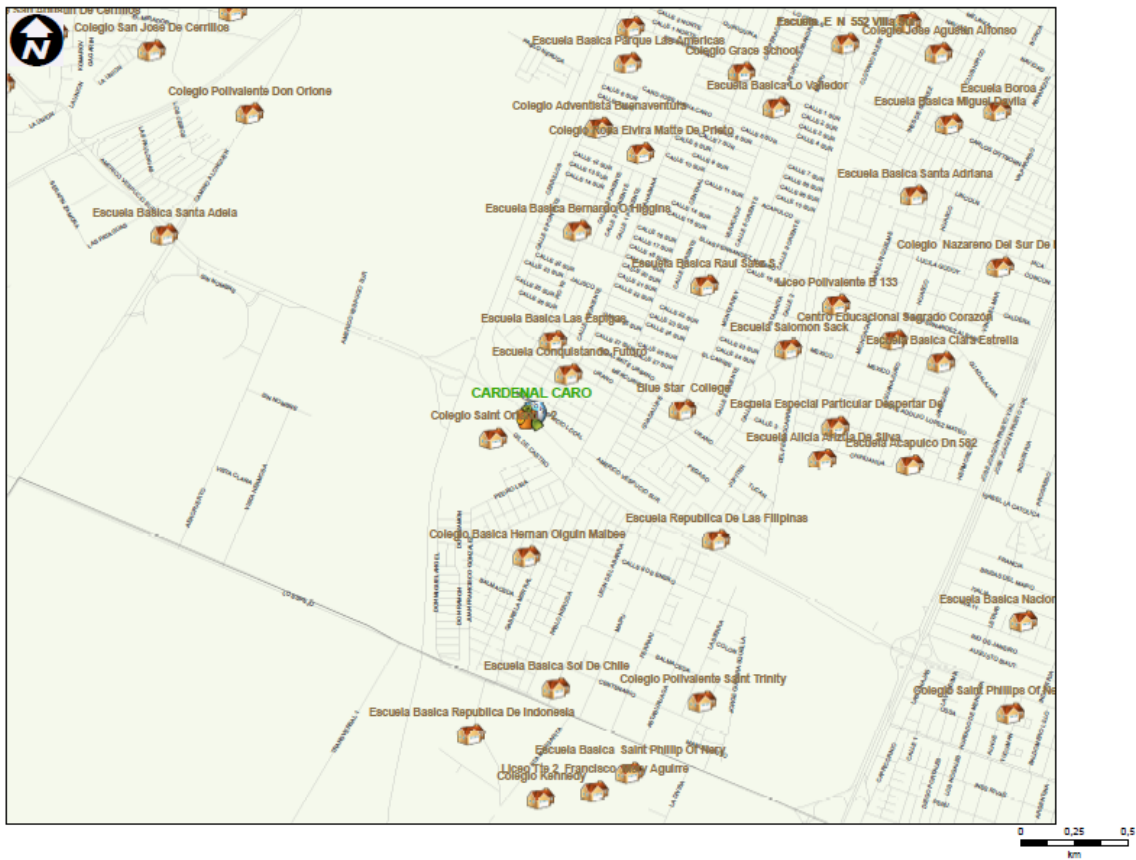
El Promedio Nacional es de **250 puntos**

\*MUN: Colegio Municipal  
PSUB: Colegio Particular Subvencionado

\*\*Número de niños promedio que dieron el SIMCE 2006 y 2009

Figure O-4: School Map

### Jardín Cardenal Caro



In order to send a signal about relatively “good” and “bad” schools, establishments that are above the nationwide mean test score (roughly 250 points) were signaled in green and schools that lied below the nationwide mean test scores were signaled in red. Figures O-2, O-3 and O-4 present an example of the Report Card and a map. This aspect mirrors policy maker preferences for the type of intervention that was planned and the hope is this design feature will address the potential asymmetry of information parents may have regarding the quality of schools. The underlying hypothesis is that parents do care about the quality of the education their children receive, though are not aware of which schools are those that provide such high-quality education.

A second component of the policy is a video where we prepared with testimonies of: (i) a mother that had decided to change her son that attended second grade to a better school, with higher test scores, in order to give him a better education, (ii) a current college student ending his degree, who went to a relatively good high school in a poor neighborhood, and (iii) a young girl who also came from a poor background but, in part due to her relatively good high school, was able to study a vocational career and now holds a job in a bank.

What these three testimonies share in common is that their characters belong to a low socioeconomic status. The objective was to show people that they can access good schools and higher educational levels and that this is not restricted to high-income families. The choice of these role models is in line with Nguyen (2008) results on the provision of information by people from similar background as the intervened group.

The video also provided some information about rates of return of tertiary education in Chile<sup>34</sup>, and argued that there is a relation between the primary school results and the chances of enrollment in college or vocational tertiary school, although it didn't argue any causal effect, only the observed correlation (in a similar way than Jensen (2010)).

This aspect aimed to complement the potential lack of information regarding good schools with information on the benefits of providing the child with high-quality education. The hypothesis is that even if parents were aware of which are the high-quality schools in their neighborhood, they might not be conscious of the potential benefits of a good education, thus their schooling decisions reflect other determinants rather than quality, such as distance, or parents simply enrolling their children in the same school they once attended.

### *O-3.2 Additional Statistics On RCT Design, Implementation and Results*

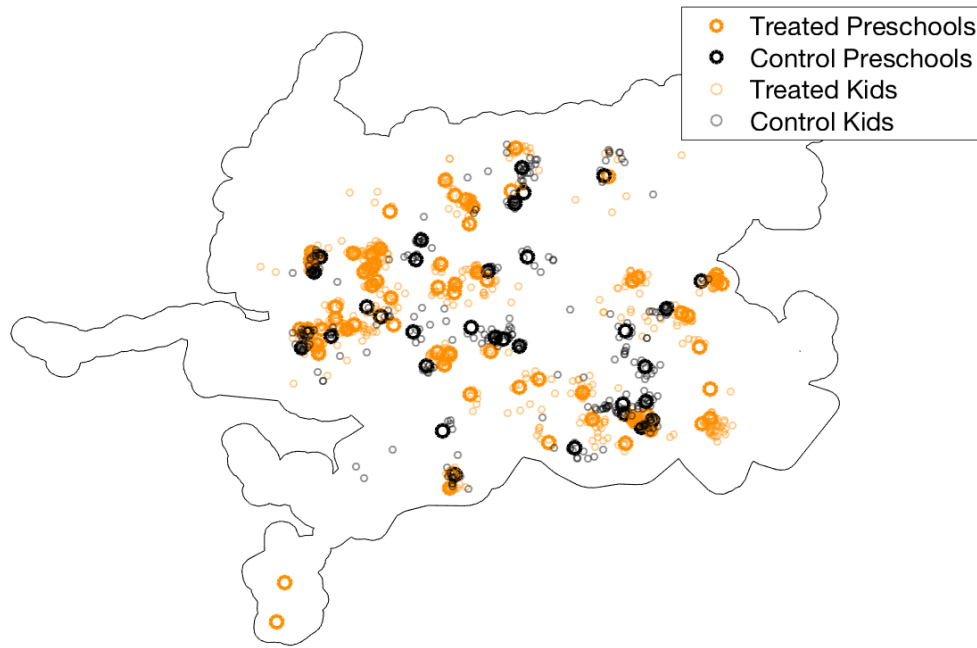
Figure O-5 shows the distributions of treatment and control schools and students in the map of the city of Santiago. It is important to mention that the Pre-K schools were selected so that the report card provided would not overlap with any other Pre-K schools in the study.

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<sup>34</sup>Specifically the video showed that on average, a person with college degree earns around three times what the average person only with high school does.



**Figure O-5:** Report Cards - treatment and control schools and students in the map



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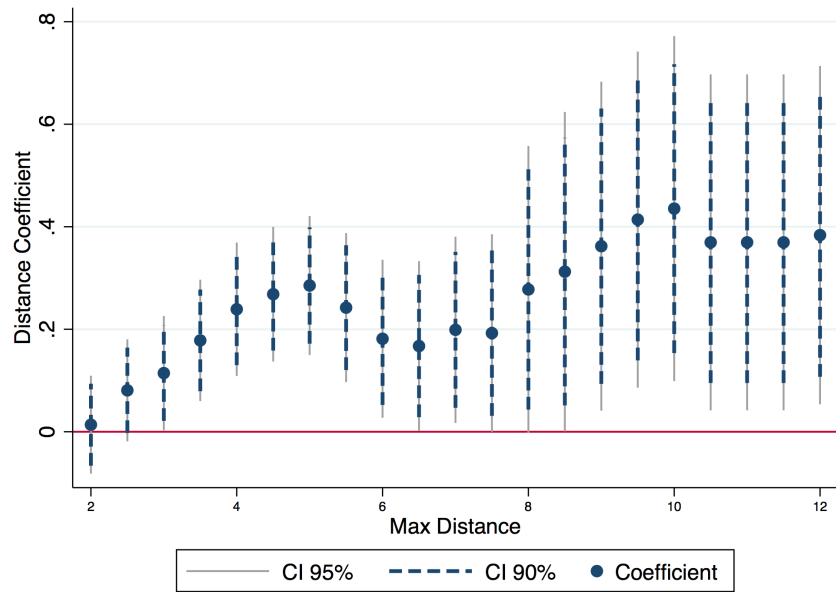
Note: This figure shows a map of Santiago. Treatment and control preschools are indicated on the map with larger, bold circles. Student homes are indicated with smaller circles. The color differentiates treatment and control.

**Table O-2: Treatment Balance at the Family Level**

	Full Sample (N=1,832)		Enrolled (N=606)		Non-Enrolled (N=1,006)	
	Difference T-C (1)	Control Mean (2)	Difference T-C (3)	Control Mean (4)	Difference T-C (5)	Control Mean (6)
<i>Panel A: SES characteristics</i>						
Household size	0.114 (0.126)	4.837 (0.101)	0.060 (0.172)	4.852 (0.144)	0.146 (0.158)	4.829 (0.118)
Durable goods	0.069 (0.179)	4.558 (0.160)	0.221 (0.259)	4.694 (0.231)	-0.023 (0.182)	4.477 (0.159)
Owns Dwelling	0.022 (0.039)	0.345 (0.032)	0.116** (0.058)	0.311 (0.046)	-0.035 (0.042)	0.366 (0.036)
Mother head of hh	0.010 (0.027)	0.826 (0.021)	-0.035 (0.047)	0.857 (0.029)	0.037 (0.031)	0.807 (0.025)
Mother NHS	-0.022 (0.031)	0.203 (0.026)	-0.017 (0.046)	0.194 (0.038)	-0.025 (0.034)	0.209 (0.029)
Mother HS	-0.051 (0.039)	0.411 (0.032)	-0.038 (0.057)	0.378 (0.046)	-0.059 (0.040)	0.431 (0.033)
Mother HE	0.029 (0.028)	0.820 (0.022)	0.041 (0.039)	0.816 (0.032)	0.022 (0.032)	0.822 (0.025)
<i>Panel B: Baseline school choice</i>						
Already enrolled	0.002 (0.048)	0.375 (0.038)	-	-	-	-
Another child	-0.012 (0.032)	0.416 (0.024)	-0.008 (0.051)	0.420*** (0.039)	-0.015 (0.037)	0.414 (0.029)
<i>Panel C: School choice 2011</i>						
Will apply on 2011	-0.015 (0.042)	0.759 (0.033)	-0.00778 (0.0512)	0.420*** (0.0389)	-0.0146 (0.0367)	0.414 (0.0294)

Notes: Columns 1, 3 and 5 present the coefficient and standard error for the difference between the treatment and control groups in a regression of each variable on treatment status. Columns 2, 4 and 6 present the coefficient and standard errors for the control group mean. Combining the baseline and follow up surveys, there are 1,612 observations for which we have information on whether they were enrolled or not at the time of the intervention. p-value<10% \*\* p-value<5% \*\*\* p-value<10%.

Figure O-6: Treatment Effects on Distance by Bandwidth



**Table O-3: Effect of Treatment on Value Added Chosen**

	VA 1 (1P)		VA 2 (2P)		VA 3 (1E)		VA 4 (2E)	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel A: Full Sample</i>								
Treatment	0.027 (0.029)	0.023 (0.027)	0.025 (0.028)	0.022 (0.026)	0.027 (0.029)	0.023 (0.027)	0.027 (0.027)	0.024 (0.026)
N obs.	1744	1744	1744	1744	1752	1752	1752	1752
<i>Panel B: Enrolled sample</i>								
Treatment	-0.034 (0.051)	-0.050 (0.051)	-0.035 (0.050)	-0.052 (0.050)	-0.033 (0.051)	-0.049 (0.051)	-0.032 (0.050)	-0.048 (0.050)
N obs.	590	590	590	590	590	590	590	590
<i>Panel C: Not enrolled sample</i>								
Treatment	0.067* (0.036)	0.064* (0.036)	0.068* (0.036)	0.066* (0.035)	0.071** (0.035)	0.068* (0.035)	0.072** (0.035)	0.069** (0.035)
N obs.	956	956	956	956	962	962	962	962
Randomization controls	×	×	×	×	×	×	×	×
Expanded controls	×	×	×	×	×	×	×	×

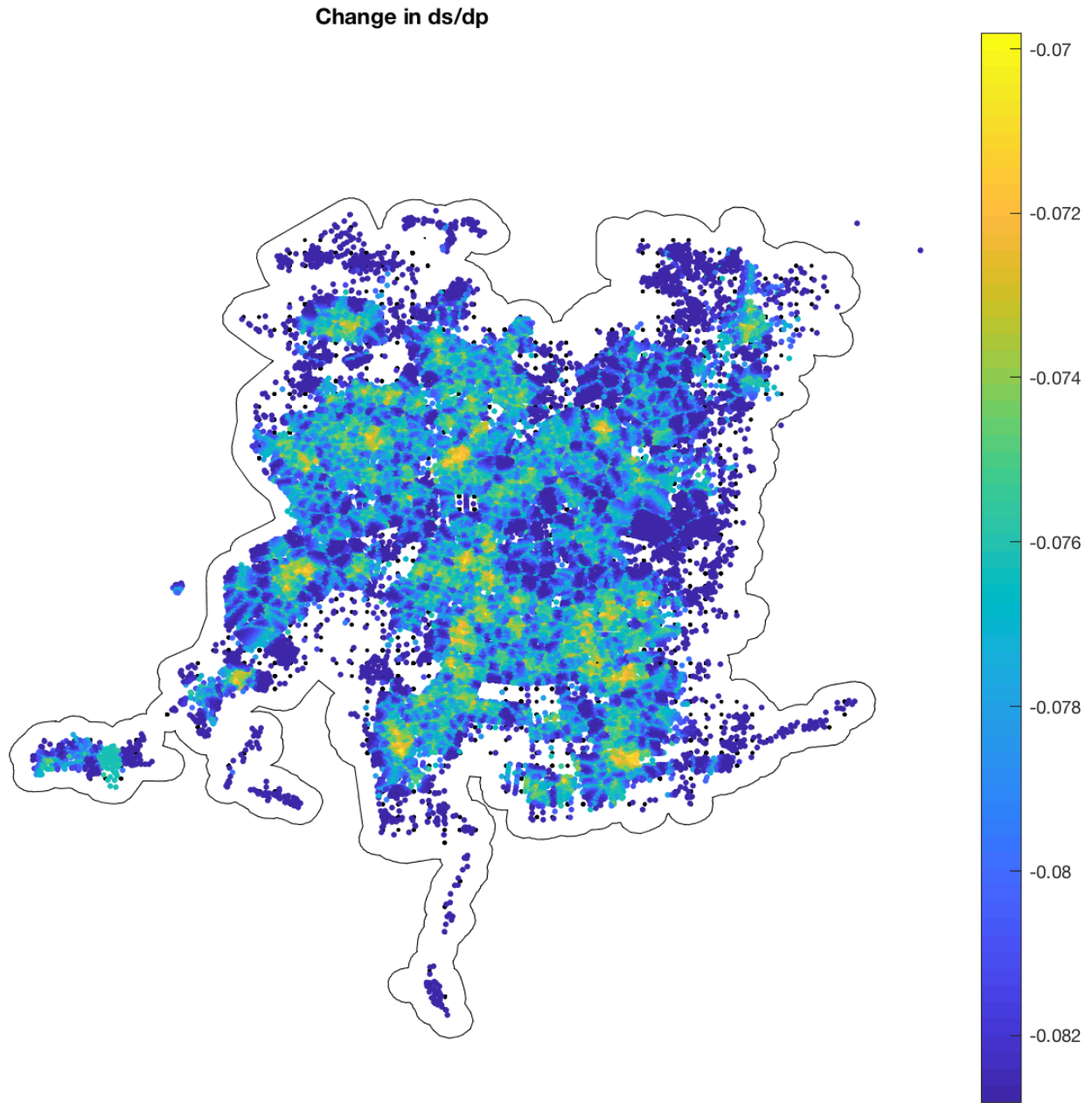
Note: Randomization controls include market characteristics of schools (number and test scores mean, standard deviation and percentiles 25, 50 and 75.). Expanded controls include Mother's education, household information (size, durable goods, owned house), baseline school choice information.

**Table O-4: Effect of Treatment on Student Test Scores**

	Lang - 2nd		Average - 4th		Lang - 4th		Math - 4th	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Panel A: Full Sample</i>								
Treatment	-0.008 (0.052)	-0.028 (0.059)	0.103* (0.058)	0.085 (0.058)	0.046 (0.066)	0.021 (0.068)	0.149** (0.062)	0.137** (0.060)
N obs.	1392	1218	1267	1112	1242	1093	1240	1090
<i>Panel B: Enrolled sample</i>								
Treatment	-0.076 (0.110)	-0.110 (0.109)	-0.080 (0.103)	-0.115 (0.107)	-0.102 (0.120)	-0.140 (0.126)	-0.012 (0.111)	-0.036 (0.115)
N obs.	492	484	450	443	448	441	438	432
<i>Panel C: Not enrolled sample</i>								
Treatment	0.068 (0.072)	0.050 (0.073)	0.232*** (0.083)	0.214*** (0.078)	0.173* (0.099)	0.136 (0.092)	0.254*** (0.079)	0.257*** (0.076)
N obs.	761	734	695	669	677	652	682	658
Randomization controls	×		×		×		×	
Expanded controls		×		×		×		×

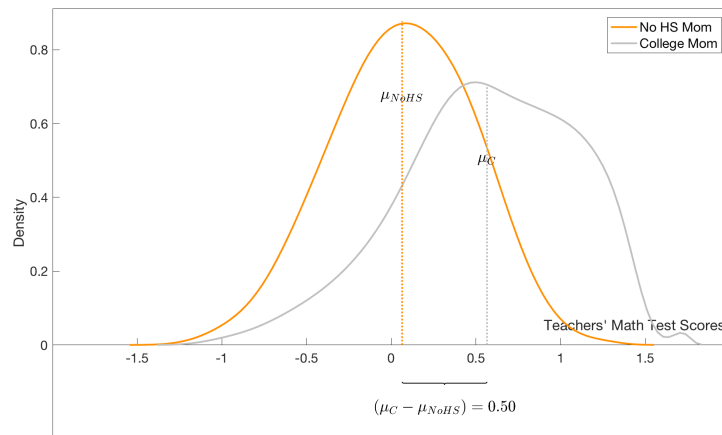
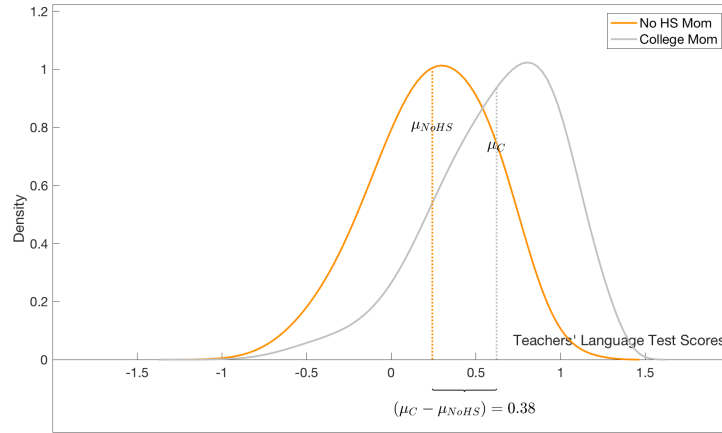
Note: Randomization controls include market characteristics of schools (number and test scores mean, standard deviation and percentiles 25, 50 and 75.). Expanded controls include Mother's education, household information (size, durable goods, owned house), baseline school choice information.

Figure O-7: Markdown distribution in the Map - Santiago



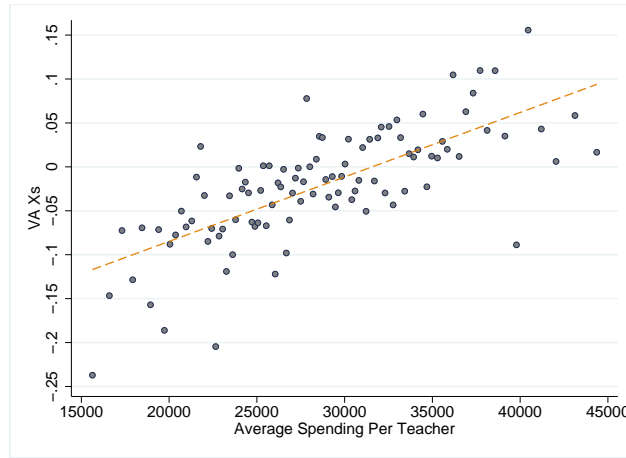
O-3.3 Distribution of School Inputs by Student SES

Figure O-8: Distribution of Teachers College Entrance Exam Scores

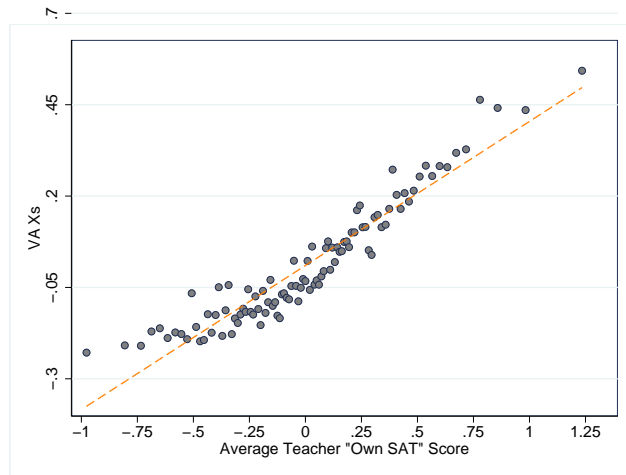


O-3.4 Correlations between test scores and other measures of school quality

**Figure O-9:** School Expenditures on Teacher Salaries and VA

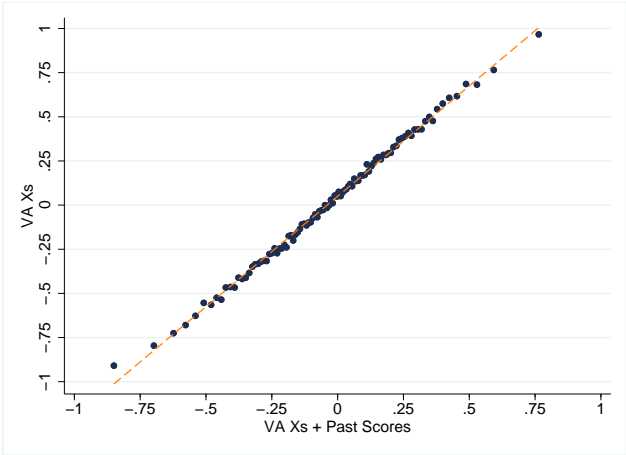


**Figure O-10:** Teachers College Entrance Exam Scores and VA





**Figure O-11: Comparing Measures of Value Added**



## O-4 Estimation Specifics

In the first step, we implement the estimation of the parameters  $(\theta_1, \theta_2)$  by using the MPEC approach. This method exploits the sparsity structure of the Jacobian of the market share equations, as the unobserved qualities affect the demand of other products in the market but not the demand for products in other markets. The method includes the unobserved qualities as additional parameters to be estimated. The optimization problem that we solve is:

$$(\theta_1^*, \theta_2^*, \xi) = \operatorname{argmin}_{\theta_1, \theta_2} \begin{bmatrix} g_2 \\ g_3 \end{bmatrix}' \begin{bmatrix} W_{MM} & 0 \\ 0 & W_{IV-D} \end{bmatrix} \begin{bmatrix} g_2 \\ g_3 \end{bmatrix} \quad (31)$$

Subject to the following constraints:

$$\begin{aligned} (M(\delta, \theta_2) - \bar{M}) - g_2 &= 0 && \text{Micro moments from school choice decision} && \text{(i)} \\ \left[ \omega(\theta_2) \right]' \cdot IV - g_3 &= 0 && \text{IV moments} && \text{(ii)} \\ \delta - s^{-1}(\bar{S}, \theta_2) &= 0 && \text{Inner loop} && \text{(iii)} \\ \xi(\theta_2) - \delta(\theta_2) - f(\theta_1) &= 0 && \text{Demand disturbance} && \text{(iv)} \\ \zeta^{norm} &= 0 && \text{Normalization restrictions} && \text{(vi)} \end{aligned}$$

Where  $f(\theta_1) = \sum_r \eta_k^r x_{jt}^r$ .

In the second step, we estimate  $\varphi$  under the following optimization problem:

$$\varphi^* = \operatorname{argmin}_{\varphi} g_4(\theta)' W_{RCT} g_4(\theta) \quad (32)$$

Subject to the following constraints:

$$\hat{\beta}^{RCT} - \hat{\beta}^{sim} - g_3 = 0 \quad \text{RCT moments} \quad \text{(i)}$$

In the third step, we estimate supply side parameters  $(\theta_3)$ . To do so, we need to get an expression for  $\Delta\omega_{jt}$

When we rearrange the first order condition for quality we can get an expression for the unobserved component that affects the marginal cost of rising quality :

$$\omega_{jt} = \frac{v + p_{jt} - \sum_l \gamma^l \omega_{jt}^l}{\underbrace{\left[ q_{jt}^* + s_{jt}(\mathbf{q}, \mathbf{p}, \xi) \left[ \frac{\partial s_{jt}(\mathbf{q}, \mathbf{p}, \xi)}{\partial q_{jt}} \right]^{-1} \right]}_{A_{jt}}} - \gamma^q \quad (33)$$

Where  $\omega_{jt} = \bar{\omega}_j + \Delta\omega_{jt}$ . We use two strategies to identify the supply parameters. First, we exploit the panel nature of our data to estimate the fixed unobservable that impacts the marginal cost of quality  $\bar{\omega}_j$ .

To do so, let's name the first term at the right side of Equation 33  $A_{jt}$ . For a given set of parameters  $\gamma_l$ , we can calculate the expression  $A_{jt}$  for every school-year combination and take the mean. we also redefine  $A_{jt}$  as  $A_{jt} = \bar{\omega}_j + \Delta\omega_{jt} + \gamma^q$ .

$$\bar{A}_j = \frac{\sum_{t=1}^T \bar{\omega}_j + \Delta\omega_{jt} + \gamma^q}{N_T} = \bar{\omega}_j + \gamma^q$$

We can rearrange the expression in Equation 33 and subtract  $\bar{A}_j$  at both sides:

$$\omega_{jt} + \gamma^q - \bar{\omega}_j + \gamma^q = A_{jt} - \bar{A}_j$$

$$\Delta\omega_{jt} = A_{jt} - \bar{A}_j$$

our optimization problem for the third step will be:

$$\theta_3^* = \operatorname{argmin}_{\theta_3} g_5(\theta)' W_{IV-S} g_5(\theta) \quad (34)$$

Subject to the following constraints:

$$w(\hat{\theta}_2) - h(\theta_3, s(\hat{\theta}_2), \nabla s(\theta_2)^{-1}) = 0 \quad \text{Cost disturbance} \quad (v)$$

## O-5 Calculating Standard Errors

The standard errors of the estimated parameters in each step of the estimation procedure are obtained from the variance-covariance matrix for the GMM estimator proposed by Hansen (1982). We will discuss how we calculate the standard error for a generic case (the parameters  $\theta$  and moments  $\mathbf{M}$ ), and then we discuss the case of each set of parameters more specifically. Each one of our GMM estimators is the result of an optimization problem in which the objective function has a quadratic form:

$$\min_{\theta} Q_{obj} = \mathbf{M}' W_m \mathbf{M}$$

For which the gradient is:

$$\frac{\partial Q_{obj}}{\partial \theta} = 2 \cdot \mathbf{J}'_M \mathbf{W}_m \mathbf{M}$$

Where  $\mathbf{J}_M$  is the Jacobian.

The variance-covariance matrix for a GMM estimator is calculated using the estimator proposed by Hansen (1982):

$$\text{cov}(\theta) = (\mathbf{J}'_M \mathbf{W}_m \mathbf{J}_M)^{-1} \mathbf{J}'_M \mathbf{W}_m \mathbf{V} \mathbf{W}'_m \mathbf{J}_M (\mathbf{J}'_M \mathbf{W}_m \mathbf{J}_M)^{-1}$$

Where  $V$  is the vector for the variance of the moments. For estimating the demand and supply parameters, this variance corresponds to simulation error in our calculations of the model's predictions. This element is estimated by simulating the sample moment at the estimate of  $\theta$  for many independent sets of  $N_v$  simulation draws and calculating the variance across the calculated moment vectors. In the case of the parameters that we estimate from the experiment moments, we need to take into account the fact that the variance in our moments is not only affected by simulation error but also by sampling error in the OLS estimator for the treatment effects. As discussed by Berry et al. (2004) the simulation and sampling errors are independent of each other. The RCT moments in Equation 26 take the difference between the estimated treatment effects and our model's predictions for it. Then, the variance of the moment conditions can be expressed as the sum of the variances due to sampling and simulation errors. The second one can be estimated as we already mentioned. The variance due to sampling error can be consistently estimated by calculating the variance of the moment conditions at the estimate of the parameter values holding the simulation draws constant.

## O-6 Revenues and Expenses Analysis

In this section, we describe the composition of revenues and expenses of schools in Chile. Public resources come mainly from the voucher system, the principal source of income for public schools, and not less relevant for private voucher schools. Vouchers are significant economic resources that the state, through the Ministry of Education, gives to public and private education, in order to support its financing. These resources have different functions and assignation reasons, and they can be delivered based on school enrollment or school's characteristics. The voucher system is one of the main items in the public education budget (representing between 50% and 60% of it). On the other hand, these revenues are spent on different resources and educational projects, which must be reported annually in the schools' public accounts.

First, we will review the different types of vouchers and assignations that become revenues for schools, analyzing their composition and distribution. Second, we will study how these resources are used and what for, analyzing how is the spending behavior of schools.

### O-6.1 Revenues

Schools' revenues can be obtained from different sources. On the one hand, there are incomes reported by school owners in their annual public accountability report. However, these entries are less detailed and, as will be explained in the expenses sub-section, categories vary over the years.

On the other hand, the other source of information about school revenues are the records published by the Ministry of Education about all vouchers delivered to each school. In these databases, each school has associated the amounts it receives for each voucher and assignation monthly, considering discounts according to the conditions of the school. This information allows us to have more detailed data about income sources and to do comparative statistics about the composition of total revenue.

After a description of the school, student, and teacher vouchers, we will analyze per capita school revenue for schools considered in schooling markets.

#### *Vouchers Description*

Since 1980, with the educational reform which conceives the different types of school (public, private voucher and private), and the DFL No. 2 that established the diverse transfers delivered to schools, there have been various vouchers created along the years. Table O-5 summarizes the entry of the vouchers that we will describe in the next subsection between 1990 and 2017.

**Table O-5: Vouchers Timeline**

Vouchers	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
General Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Educational Integration Program	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Zona assignment	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Boarding School Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rural Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Educational Reinforcement Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Voucher for Student Retention	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Preferential Voucher (SEF)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Extended Preferential Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SEP Concentration Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Difficult Conditions	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Special Conditions to teaching assistants	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Special Additional Voucher (SAE)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Education Assistants Voucher	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Excellence Performance Voucher (SNED)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pedagogical Excellence assignment (AEP)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Assignment Individual Performance (AVDI)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Assignment for Collective Performance (ADECO)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Professional Acknowledgment Bonus	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Note: This table summarizes the entry of the different voucher described in this document along the years.

## *Vouchers for Schools and Students*

The schools' transfers from public resources are made up of a base voucher, increases and discounts to that voucher, other minor subsidies, and assignments or bonuses. Most of the subsidies or vouchers are calculated using a factor expressed in a unit of account called USE (*School Voucher Unit* in Spanish, School Voucher Unit), which varies its value according to changes in CPI and other economic parameters. From here on, we will talk about total revenue referring to the total transfers received by schools from public resources. In these descriptions, we do not consider the top-off fees (co-payment) that private voucher schools can charge to families, but it will be analyzed later.

This section will describe the vouchers that are reported annually for all schools. There may be other transfers to schools not detailed in this report, but they are marginal contributions to total revenue.

In the first place, the **general/base voucher** or **educational voucher**<sup>35</sup> is the core of the public financing system for schools (public or private voucher). Created in 1980, it consists of a monthly payment to the owner of the establishment per student attended. This amount may differ depending on the level or grade of the student, the school day he attends (full or half day) and the educational modality that the school imparts.

There are three major levels in the Chilean educational system: preschool, primary, and secondary education. Preschool education can start is composed of the 1st and the 2nd transition levels (students between four and five years old). Primary education accounts for levels 1 to 8 (6 to 14 years old), while secondary education has another four levels. The general voucher is different for the following categories (depending on the school-day length): (1) preschool students; (2) 1st grade, and 2nd-grade primary students; (3) 3rd to 6th-grade primary students; (4) 7th and 8th-grade primary students; and (5) 1st to 4th-grade secondary students. However, they can have the same voucher established within them<sup>36</sup>.

The voucher can also differ between different education modalities. In secondary school, there are two types: technical education and professional education. There are also other modalities like Differential Special Education and Adult Education.

Finally, schools can have different school day lengths. Before 1997, schools could have a full-school-day (FSD) regime, or multiple (often 2) shifts for enrolling and teaching students, daytime and evening school day. In 1997, Law No. 19.532 established the FSD mandatory for most of the

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<sup>35</sup>Article 9 DFL No. 2/98 and its modifications.

<sup>36</sup>The general voucher for preschool education was only for no full-school-day (FSD) schools until October 2012, when Law No. 20,637 established an increase in the general voucher and the expansion of it for preschool students in FSD schools, among other modifications. After that, the general voucher for preschool students is the same as the one for 1st and 2nd-grade primary students in FSD schools.

subsidized schools (public and private) for third primary grade and above. The implementation was gradual because of infrastructure and resources-related constraints, and some schools were not included because of their education modalities.

Table O-6 shows the values of the general voucher in 2012, measured in dollars of the same year, for some of the different modalities, levels, and school day lengths.

**Table O-6:** General Voucher 2012, monthly values

	FSD	No FSD
Preschool (1st and 2nd transitional levels)	-	80
Primary (1st and 6th grade)	110	80
Primary (7th and 8th grade)	110	87
Secondary Professional (Scientist-Humanist)	131	97
Secondary Technical (Agricultural and Maritime)	177	144
Secondary Technical (Industrial)	139	112
Secondary Technical (Commercial)	131	101

Note: This table summarize the different monthly values of the general voucher for some levels and modalities of education in 2012. Values are expressed on 2012 dollars and they are the official published values before November 2012, when Law No. 20,637 comes into force. There are other modalities, as Differential Special Education and Adult Education, that have different values for the base voucher.

There are assignments or other vouchers that add-up to the general voucher. The first one is the **increment for the Educational Integration Program or PIE increment**<sup>37</sup>- in Spanish *Programa de Integración Escolar*, that increases the base voucher for students with transitory or permanent Special Educational Needs (NEE in Spanish). The voucher is increased only if the student joins educational levels that develop school integration projects approved by the Ministry of Education.

The second one is the **geographic zone assignment** or the **area assignment**, established in the 11th article of DFL No. 2. It consist of a percentage increase applied to the voucher, depending on where the establishment is located, and it is intended to compensate teachers and other school workers<sup>38</sup>. The percentage can go from 0% to 140%, and is higher in areas that the cost of living could be expensive because of mobilization or connection issues<sup>39</sup>. Table O-7 shows the percentage of schools in each range of the zone assignment for 2012, disaggregated by region. The ranges represent the percentage of the general voucher that is added to its full value. We can see that in the most central regions, such as the Metropolitan Region (13th), where the capital Santiago is located, the area assignment is zero; while if we observe more remote regions, such as the southern

<sup>37</sup>Article 9 DFL No. 2

<sup>38</sup>This voucher can be classified as a Teacher Voucher as well, but we consider it as a school voucher because it depends on school geographic conditions.

<sup>39</sup>The percentage of increase can be: 0, 10, 15, 20, 25, 30, 35, 40, 50, 55, 60, 70, 80, 90, 95, 105



part of the country (regions 11th and 12th) or the northern ones (15th and 1st), we can see much higher values for this assignation.

**Table O-7:** Percentage of schools in each range of the Zone Assignment in 2012

Region	0%	10-30%	35-70%	80-105%	115-140%
1	0	0	87	13	0
2	0	52	46	2	0
3	0	80	20	0	0
4	0	100	0	0	0
5	99	1	0	0	0
6	100	0	0	0	0
7	86	13	1	0	0
8	0	99	1	0	0
9	0	95	5	0	0
10	0	57	40	3	0
11	0	0	0	65	35
12	0	0	64	35	1
13	100	0	0	0	0
14	0	100	0	0	0
15	0	0	87	13	0

Note: This table summarizes the percentage of schools in each range of the zone assignment, by region in 2012. The percentage of increase can be: 0, 10, 15, 20, 25, 30, 35, 40, 50, 55, 60, 70, 80, 90, 95, 105. Remote regions have higher percentages for zone assignment because it compensates for the cost of living due to mobilization and connection issues. The 13th, 6th, and 5th regions are the ones with the lowest percentages because they are the central regions (the capital Santiago is located in the 13th region), while the southern (11th and 12th regions) and the northern regions (15th and 1st), are the ones with the highest percentages.

The third voucher that add-up to the base voucher is the **Boarding School Voucher**. This subsidy goes to schools that serve as boarding schools to finance expenses for housing and feeding students, and expenses for maintenance and operation of the establishment. It also allows scholarly attention to students with access problems, either by mobilization or distance.

As mentioned above, private voucher schools can charge top-off fees and enrollment charges to families for entering the school. There are certain conditions under which students do not pay charges, like being a priority student (more details in the description of SEP voucher). Schools who charge top-off fees are called schools with *financiamiento compartido* or shared-funding<sup>40</sup>, and it has consequences in the general voucher that they receive. Schools that have shared-funding have a discount over the general voucher, based on the price that they charge (as shown in Table

<sup>40</sup>The shared-funding or co-payment was first announced in Law No. 18,768 (46th Article), in 1988, as a new regime only for school owners of private voucher schools. Later in 1993, Law No. 19,247 (9th Article) made more attractive this form of funding, increasing the co-payment limit and reducing the discount to the general voucher that was linked to the top-off fees charged.

O-8). The discount is known as **Shared-Funding Discount**.

**Table O-8:** Groups of voucher discount for schools with shared-funding

Group	Average amount charged by shared-funding		% of discount
	in U.S.E.	in 2012 USD	in general voucher
I	Less or equal to 0.5	Less or equal to 19.6	0 %
II	Over 0.5 USE to 1	Over 19.6 USD to 39.2	10 %
III	Over 1 USE to 2	Over 39.2 USD to 78.5	20 %
IV	Over 2 USE to 4	Over 78.5 USD to 157.0	35 %

Note: This table shows the groups for school voucher discount by shared funding amount charged established in Law No. 19,247 (1993). Values are in U.S.E. (*Unidad de Subvención Educacional*, or Educational Voucher Unit) and in the equivalent amount on USD for 2012. With the Inclusion Law in 2015, the maximum amount charged for shared funding in that year was frozen in its nominal value, so that it decreases with the devaluation of the currency, while the decrease in resources is compensated with a nominal increase of the average school voucher and the application of new types of targeted vouchers for middle and low income families.

The Rurality Increment and the Contribution for Rural Floor are transfers that seek to compensate for the higher cost of educating children in rural areas. These vouchers are unified in the **Voucher for Rurality** and it varies according to the number of children attending the school. Also, it includes urban schools that are in *comunas* that do not exceed 5,000 inhabitants and with a population density of no more than two inhabitants per square kilometer. The zone assignment does not multiply the voucher for rurality.

There are some vouchers related to the support of students development by the school, like the **Voucher for Student Retention** and the **Educational Reinforcement Voucher**. Both vouchers aim to improve incentives from schools to enhance the educational achievements of students. The objective of the Voucher for Student Retention is to promote the incorporation, continuity, and end of the twelve years of schooling of students from 7th grade (primary) to 4th grade (secondary). This voucher applies for public and private voucher schools, and for students that belong to families participating in the *Chile Solidario* program<sup>41</sup>. On the other hand, the Educational Reinforcement Voucher is a transfer for schools that perform reinforcement courses to support low-performance students and help them improve, preferably considering students in higher social risk.

In 2008, Law No. 20,248 established the **Preferential School Voucher** or *Subvención Escolar Preferencial (SEP)*. This voucher was the most important voucher that add-on resources to the general voucher because it raises the transfers per kid in 50% for low-income students, changing the voucher structure from a flat voucher to a targeted voucher. It is intended to increase funding to low-income families to improve their school choice and the students' performance. The voucher goes to *priority students*, who are students that: (1) belong to the *Chile Solidario* program;

<sup>41</sup>*Chile Solidario* is a public system of social protection focused on families from extreme poverty levels, aimed to promote their inclusion to social networks and to improve their living conditions (established in Law No. 19,949, 2004).

(2) they are in the bottom 30% of the income distribution (measured by the score of the Social Protection Record<sup>42</sup>); (3) they are affiliated to the lower-income segment in the public health insurance system; or (4) they present vulnerable socioeconomic conditions (related to the education of the mother and the rurality and poverty of their *comuna* of residence). In the first year, the classification of students as priority students was from 4th grade and below. Every year, another level was included in the classification (and more resources were delivered to schools), to follow-up the same cohort of students, until 2016 where the policy covered all levels.

One side of the SEP policy is to raise educational vouchers to vulnerable students to increase schools' incentives to enroll them. The other side is that vulnerable students can choose more and better schools because they are exempt from paying any tuition or top-off fees. These conditions rule for schools that sign an agreement with the Ministry of Education to accept priority students without financial charges or selection of any type, in exchange for receiving more resources. A more detailed and deep explanation in ().

There are two more vouchers related to the SEP policy. The first one is the **SEP Concentration Voucher**, which accounts for additional resources for schools with a higher concentration of priority students. The value of the voucher increases as the percentage of priority students in the school grows, starting from 15% upwards, defining four concentration segments: between 15 and 30%, between 30 and 45%, between 45 and 60%, and 60% upwards. The second SEP-related voucher is the voucher for **Preferent Students**. It began in 2016 and it is an extension of the SEP voucher for students that are not priority students, but whose families are in the bottom 80% of the income distribution. This additional subsidy is half the value of the original SEP voucher.

Table O-9 shows the annual values of the regular voucher and SEP vouchers. Values are calculated using the official monthly value reported by the Ministry each year and multiplied for twelve months. These vouchers are paid based on the enrollment of the school according to the different types of students.

Finally, there are other vouchers directed to schools and students not detailed in this report, like the **school maintenance support voucher**, established in 1998 in the DFL No. 2 and the **contribution for free schooling**, established in 2015 with the Inclusion Law (Law No. 20,845).

#### *Vouchers for Teachers*

There are contributions and vouchers delivered directly to compensate teachers and education workers, either for work conditions or for their performance. Within the compensations for working conditions, we have in the first place the **Assignment of Performance under Difficult**

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<sup>42</sup>The Social Protection Record is an instrument built by the Ministry of Social Development to identify vulnerable families, for them to apply to financial or social benefits given by the State. It was replaced in 2016 for a social support system called Social Household Registry (*Registro Social de Hogares*)

**Table O-9: Vouchers Value per Student**

Year	Regular Voucher	SEP	Preferent SEP	SEP Concentration
2005	974	-	-	-
2006	997	-	-	-
2007	973	-	-	-
2008	974	-	-	-
2010	1,110	564	-	102
2011	1,238	629	-	113
2012	1,314	798	-	142
2013	1,384	813	-	145
2014	1,390	816	-	146
2015	1,411	829	-	148
2016	1,430	1,008	504	150
2017	1,498	1,017	508	151

Note: This table shows the annual values in 2012 dollars of the general voucher and SEP-related vouchers. The values correspond to the subsidies that would receive a 1st-grade student that attends a school with a high concentration of priority students (more than 60%). Values are calculated using the official monthly value reported by the Ministry of Education each year, and it is multiplied for twelve months. These vouchers are paid based on the average enrollment of the school for the past three months. For months that are not accounted in the scholar year, the voucher considers the three nearest “active” months before the month paid.

**Conditions.** This assignment is aimed at teachers who work in schools classified as “difficult performance” due to their geographical location, marginality, extreme poverty, or other similar characteristics. The benefit corresponds to a percentage of up to 30 % of the Minimum National Basic Remuneration (MNBR)<sup>43</sup>. As of 2016, the schools receive an additional Assignment of Performance for Difficult Conditions associated with the **Assistant Education Personnel**, in addition to that corresponding to the teachers. However, Law No. 20,903 was published in the same year, creating a new System of Professional Development for Teachers, which built a new structure of remunerations for teachers and other education workers, modifying the existing assignments. In particular, one of the vouchers that the law derogates is the Assignment for Difficult Conditions.

Within wage compensations for teachers due working conditions, the **Special Additional Voucher** (SAE in Spanish) is an important contribution in this item. This voucher accounts for three different assignments: the Proportional Bonus (*Bono Proporcional*), the Complementary Form (*Planilla Complementaria*) and the Extraordinary Bonus (*Bono Extraordinario*).

Law 19,410 (1995) established the SAE, which was an amount given to school owners based on the enrollment of the school (adding-up to the base voucher) for compensating teachers’ wages

<sup>43</sup>The Minimum National Basic Remuneration is the minimum monthly income for teachers, understood as the product of the minimum value of the chronological hour set by law for each level of the educational system, multiplied by the number of weekly chronological hours for which the education professional has been hired.

through these three different bonuses<sup>44</sup>. The 8th article established the permanent right of teachers of public and private voucher schools to receive an increment proportional to their designated working hours (the proportional bonus); while the 9th article states the permanent right of receiving an amount that complements the remuneration when it is below the MNBR (the complementary form). Finally, the 10th article determines that if there are resources left from these two transfers, it will be another bonus for teachers (the extraordinary bonus). These three bonuses remained until 2016 when they were derogated by Law No. 20,903, leaving only the complementary form. In 2012, the value of the monthly SAE voucher was 3.5 US dollars (US dollars of 2012) per student in average for primary education students.

In the same line of increases in remuneration, Law No. 19,464 (1996) established a contribution to wages of the education assistants staff, called **Education Assistants Voucher**. This voucher is proportional to the working hours of the assistants, and its value is determined every January for the rest of the respective year.

There are other cases in which wage compensations are delivered due to the position that the teachers fulfill in the school. In this category, we have the **Assignment for Collective Performance** or ADECO established in Law No. 19,933, which benefits education workers who fulfill teaching-directive and technical-pedagogical functions in public or private voucher schools<sup>45</sup>. For rural schools, there is another compensation called **Bonification to Teacher in Charge**, which is an income that goes directly to the teacher who is in charge of rural subsidized schools when there is not a director, and that additionally does teaching tasks.

As we mentioned before, vouchers for compensating teachers can be attributed because of working conditions or because of teachers performance. These latest vouchers are not recorded as regular income for schools because they can change annually, but they can be a relevant contribution to total revenues every year.

In its 16th article, Law No. 19,410 creates the National System of Performance Evaluation or SNED (for *Sistema Nacional de Evaluación de Desempeño* in Spanish), which is applied since 1996 to identify best-performance schools within public and private voucher schools from the same region. Schools are evaluated in six fields: effectiveness, overcoming, initiative, school conditions improvement, opportunities equality and integration of the school community<sup>46</sup>. The best-evaluated schools become creditors of the **Excellence Performance Voucher** (*Subvención por*

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<sup>44</sup>Law 19,410 only established this voucher regime for 1995 and 1996, so later in 1995, Law No. 19,429 determined an annual increase of the SAE, setting it as a permanent transfer. Law No. 19,598 (1999) and Law No. 20,247 (2008) made modifications in the same direction. The first one stated that the value of SAE must be expressed in U.S.E., meaning that it will increase proportionally with other vouchers; and the second one officially incorporated SAE to the permanent voucher system

<sup>45</sup>The school must have more than 250 students enrolled in March each year

<sup>46</sup>The first two fields are measured based on standardized test scores of the school. The rest of the fields have their own measures.

*Desempeño de Excelencia*) for two years, which is an economic benefit for teachers aimed at the improvement of the education quality. Schools have to use 90% of these resources directly in compensating teachers, while the rest can be spent in other fields defined by each school. In 2008, Law No. 20,244 expands the voucher for Excellence Performance to education assistants.

In 2004, Law No. 19,961 established a system of evaluation for teachers who fulfill classroom teaching functions in public schools<sup>47</sup>. The Center for Improvement, Experimentation and Pedagogical Research (CPEIP in Spanish), an institution belonging to the Ministry of Education, is in charge of the technical coordination for the correct implementation of evaluation processes. The evaluation is composed of four instruments: a portfolio, an auto-evaluation, an interview with another teacher, and reference reports.

The portfolio aims to evaluate different fields of the teaching practice, inside and outside the classroom. It is composed of reflection activities about the teaching vocation and a recorded class, to evaluate the class structure and the teacher behavior with students (participation promotion, feedback, support to students). The auto-evaluation, the interview with another teacher (which finishes in a pair-evaluation), and the reference reports written by the director or other high administrators, aim to evaluate the teaching practice and performance of the teacher on its own development and within the school community.

Teachers can be qualified as outstanding, competent, basic, and unsatisfactory. These results not only imply quality and professional development signaling for the teacher but can also mean wage increases for the well-qualified teachers. Outstanding and competent teachers can apply to the **Variable Assignment for Individual Performance (AVDI)**, a transfer of resources that seeks to strengthen the quality of education and recognize the merits of teachers. However, it was derogated by Law No. 20,903 in 2016.

Another voucher that was created to enhance quality education and to recognize teachers of excellence, but was also derogated by Law No. 20,903, was the **Assignment for Pedagogical Excellence** or AEP. This voucher was delivered to schools to compensate teachers that were accredited as teachers of excellence through the evaluation of a knowledge test and a portfolio, similar to the AVDI.

Finally, to recognize teachers' education level, there is a monthly remuneration benefit to teachers who are accredited having a professional degree and a major diploma. The amount of this contribution, called **Professional Acknowledgment Bonus**, is determined for a 30-hour working day (proportionally paid for teachers who work less than 30 hours) and is distributed 75% for the professional degree and 25% for the major diploma.

Some other vouchers addressed to teachers not detailed in this document are the **compen-**

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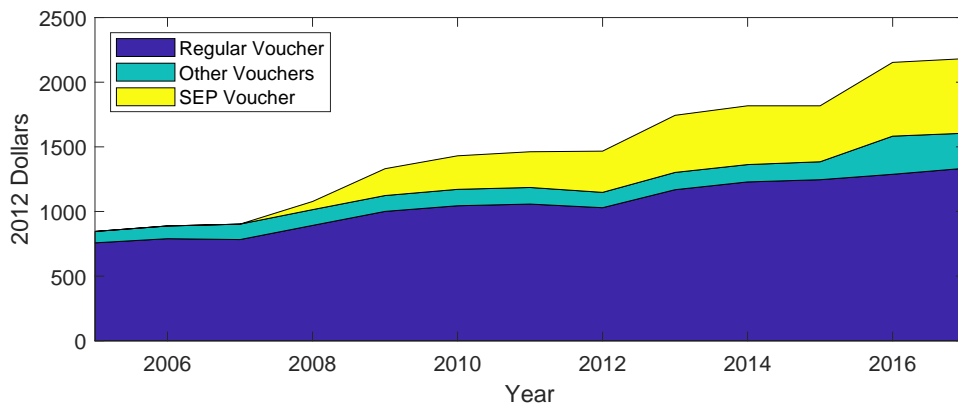
<sup>47</sup>The evaluation is compulsory for teachers in public schools. In 2017, private voucher schools requested access to participate in the evaluation system in 2018.

satory bonus, the assignation for professional development, and the assignation for teaching in schools with a high concentration of priority students. The last two assignations were established with Law No. 20,903, and they replace the AVDI and the AEP for the first one, and the Assignation of Performance under Difficult Conditions for the second one.

### Revenue Analysis

The composition of total school revenue shown in Figures O-12 and O-13 for schools in markets reveal that the highest contribution is the educational or general voucher<sup>48</sup>. The second highest contribution of resources for schools is the increasing share coming from the SEP voucher since 2008. This pattern is similar between public and private voucher schools. Note that private schools can receive more resources from top-off fees.

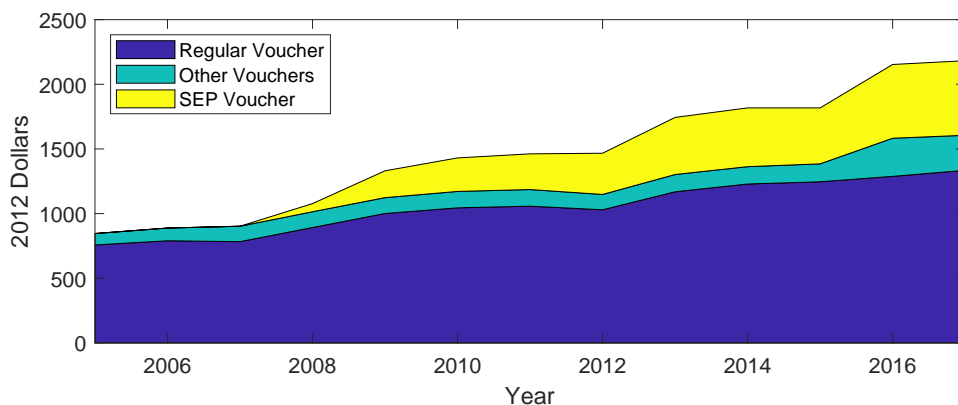
**Figure O-12: Schools Revenue Composition: Public Schools**



Note: This figure shows per capita annual revenue from the different vouchers for public schools. Other vouchers consider all the vouchers described in the previous section except for general voucher and SEP-related vouchers. This figure shows average values for urban schools, and it does not account for the area assignation, assuming schools located in centralized urban areas (as the capital city, Santiago). The figure shows that the highest contribution is made from the general voucher, while the second highest contribution is the SEP voucher.

<sup>48</sup>For rural schools, not considered in the analysis of schooling markets, both the general voucher and the rural voucher mean a great source of resources as we would expect. Also, they received a significant share of their total revenue from the area assignation, the bonus for teacher in charge, and the assignation for difficult conditions, vouchers targeted to rural and/or vulnerable schools.

**Figure O-13: Schools Revenue Composition: Private Voucher Schools**



Note: This figure shows per capita annual revenue from the different vouchers for private schools. Other vouchers consider all the vouchers described in the previous section except for general voucher and SEP-related vouchers. This figure shows average values for urban schools, and it does not account for the area assignment, assuming schools located in centralized urban areas (as the capital city, Santiago). The figure shows that the highest contribution is made from the general voucher, while the second highest contribution is the SEP voucher.

The analysis of aggregate revenue we effectuate in this report is based on per capita revenue of schools, measured as total annual income for the general voucher and other regular vouchers over the average enrollment by year. The total revenue includes the general voucher, the PIE increment, the area assignment, the boarding school voucher, the rurality voucher, the assignment of performance under difficult conditions, the special additional voucher, the education assistants voucher, and the bonification to teacher in charge<sup>49</sup>. For private voucher schools, the total revenue also includes contributions and discount related to shared-funding and the price that they can charge to families (top-off fees).

We also consider two different measures for total school revenue. The first one is the one described above, the annual sum of all the vouchers and other incomes received by the schools every month. The second one is the annual median of monthly revenue per school, multiplied by 12. This measure can solve minor problems due to deviations for outliers months or schools that report less than 12 months of income. However, as those cases represent less than 2% of the sample and the analysis remains very similar, we are showing figures for the first measure.

Figure O-14 shows per-capita (per-student) revenue between 2005 and 2017, differentiating by socioeconomic context of the school. This socioeconomic context or status is defined by quintiles of the percentage of 1st-grade students eligible for the SEP voucher less than or at 1 km away from the school. The first quintile corresponds to 20% of the schools with the lowest proportion

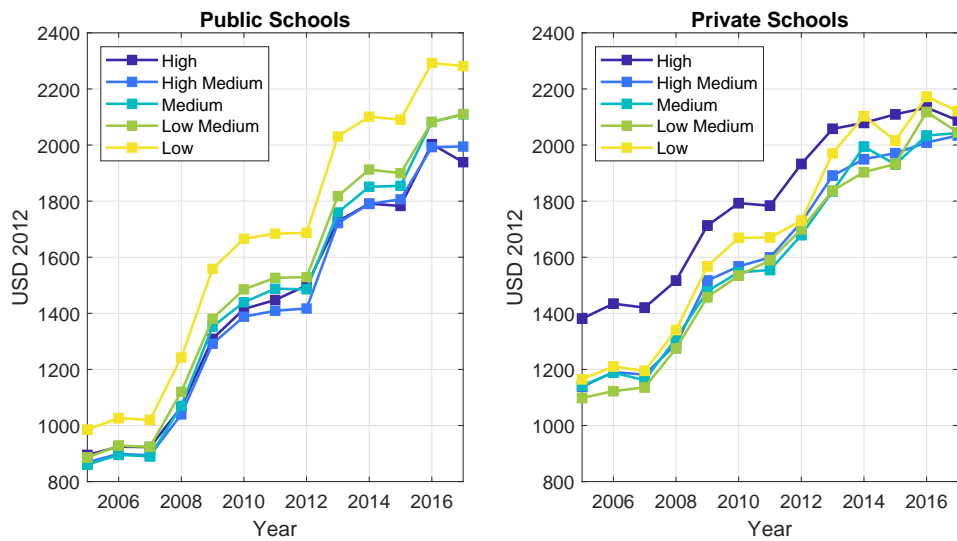
<sup>49</sup>The rurality voucher and the bonification to teacher in charge are less relevant in schools considered for the analysis, because rural schools are not contemplated in the studied schooling markets.



of eligible children less than 1km away, and it is classified as “High SES”. The fifth quintile then is classified as “Low SES”. Eligible students in 2007 are identified as eligible students in 2008 who attended second grade, assuming they would maintain their eligibility status the previous year. For 2005 to 2007, the share of eligible students defining the socioeconomic status of the school is fixed.

We can see that per-capita revenue has been growing across the years, being higher for Low SES public schools relative to other public schools. For private schools, it is higher for High SES schools at the beginning, but then the gap between High and Low SES becomes smaller until it fully reverts near 2015. In the figures we can see three major jumps on schools revenue: the implementation of the SEP policy in 2008; then its reforms throughout 2011 (noticed in 2012) that increased the value and the usage flexibility of the subsidy; and in 2015 with the Inclusion Law, which not only increased transfers to schools but also created a new category to receive resources from the SEP policy. These jumps are more markedly for public schools.

**Figure O-14: Per Capita Revenue by SES Group**

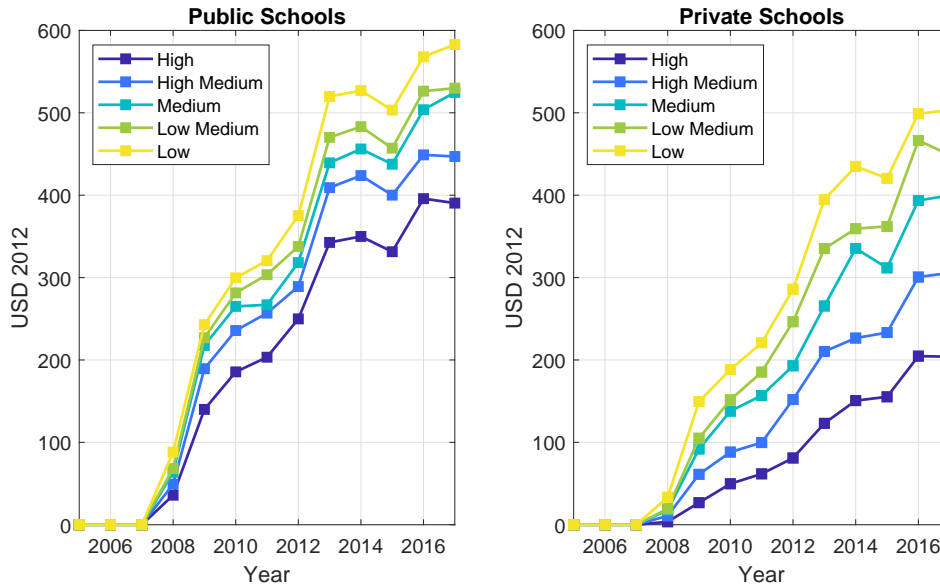


Note: This figure shows the per capita annual revenue for public and private schools, differentiated by socioeconomic group. It shows that schools’ incomes have been increasing over time and that Low SES public schools receive more resources (from public transfers as vouchers) relative to other SES groups within public schools. On the other hand, High SES private schools receive more resources (from public transfers as vouchers and for top-off fees charged to families) relative to other SES groups within private schools.

Figure O-15 shows per capita revenue that schools receive from SEP vouchers. Income from the SEP policy has continuously grown for both public and private schools, and it is always higher the lower is the socioeconomic status of the school. This trend arises because Low SES schools concentrate more vulnerable students, increasing not only the individual SEP voucher but the

concentration voucher as well.

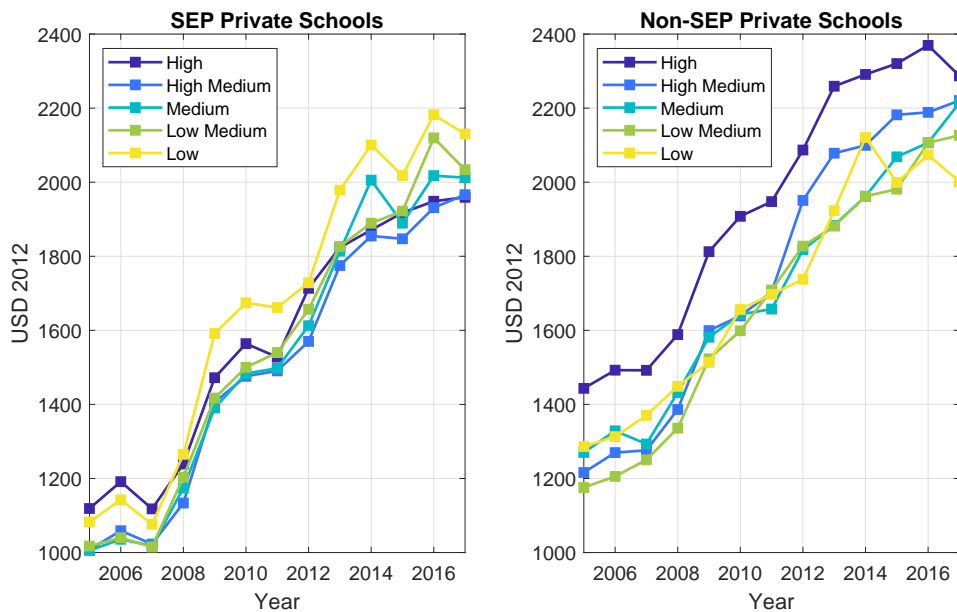
**Figure O-15: Per Capita SEP Income by SES Group**



Note: This figure shows the per capita annual revenue for public and private schools due to the SEP policy, differentiated by socioeconomic group. It shows that income from the SEP voucher has been increasing over time, and it is always higher the lower is the socioeconomic status of the school.

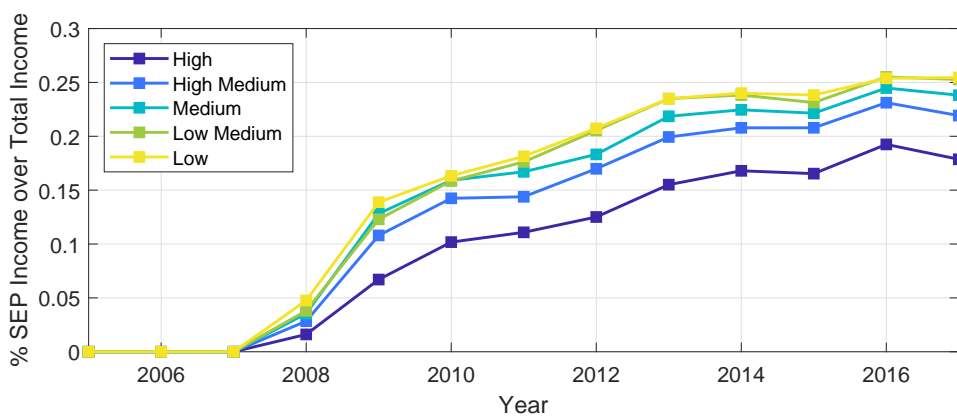
If we differentiate per capita revenue for private schools between those that have SEP vouchers and those that do not, as shown in Figure O-16, we can see that it is higher for Low SES private schools within SEP private schools. This fact is directly related to what is mentioned in the previous figure, given that the schools of Low SES concentrate more vulnerable students. For non-SEP private schools, the situation is the opposite, High SES schools always have more per capita revenue within SES groups across the years, because of higher prices. Figure O-17 shows the importance of SEP income over total revenue for SEP private schools, and it can be noted the growing trend of the share of SEP resources, specifically for Low SES schools. Figure O-18 shows the heterogeneity of the distribution of SEP importance through its percentiles 25, 50, and 75, within public and private schools in 2012.

**Figure O-16: Per Capita Revenue by SES Group and SEP status (Private Schools)**



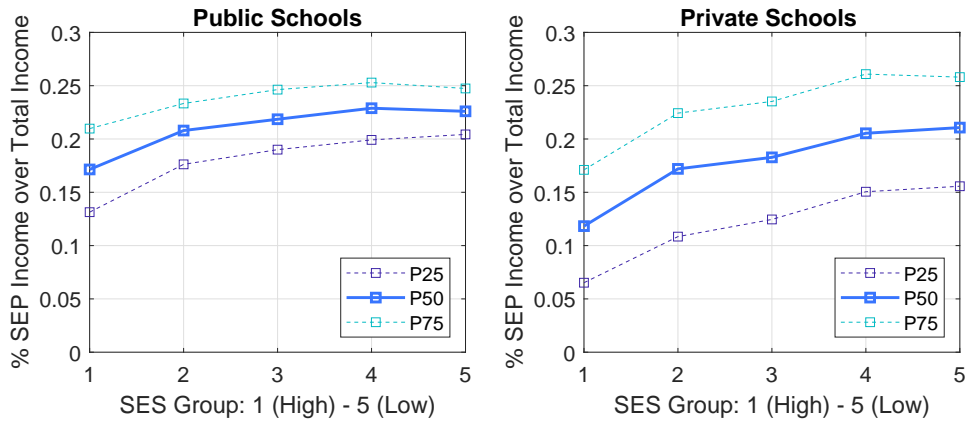
Note: This figure shows the per capita annual revenue for private schools, differentiated by the socioeconomic group and the SEP status. It shows the inverse relation between SES Group and per capita revenue when we analyze SEP/non-SEP private schools.

**Figure O-17: SEP Importance over Total Revenue: SEP Private Schools**



Note: This figure shows the percentage of SEP income over total revenue for SEP private schools. It shows a growing trend of the share of SEP resources over total resources, being higher for the lower SES groups.

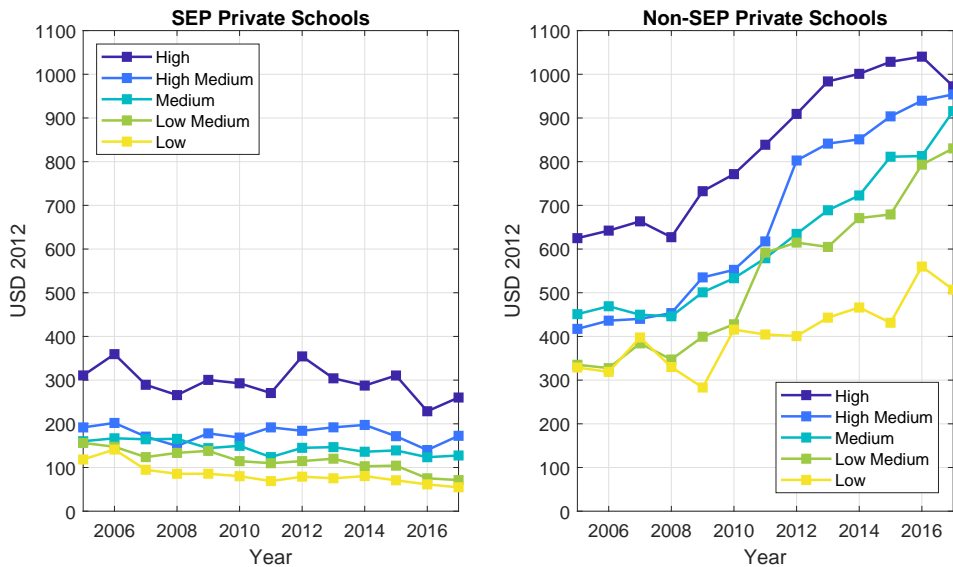
**Figure O-18: SEP Importance over Total Revenue in 2012**



Note: This figure shows the percentage of SEP income over total revenue for SEP private schools and public schools, by SES groups in 2012. It shows percentiles 25, 50, and 75 of SEP importance for SEP schools in each case.

To check the previous point, we can see in Figure O-19 the evolution of the prices charged by private schools, differentiated by SEP and non-SEP schools. SEP private schools have maintained their average price charged since the application of the SEP Law, with a small downward trend for Low and Medium-Low SES schools. This situation arises because they can not charge priority students, so the average price decreases to a higher number of priority students. On the other hand, non-SEP private schools have increased their prices since 2008.

**Figure O-19: Private Schools' Prices by SES Group and SEP status**



Note: This figure shows the evolution of prices for private schools, differentiated by SES Group and SEP status. It shows how prices for SEP private schools have remained flat with slight downward trends, while prices for non-SEP private schools have increased.

*Marginal revenue from students*

For further analysis and estimation, we use values reported in Table O-9 to obtain the marginal revenue that every school in the markets receive for the different types of 1st-grade students. First, we assume that every school has full-school-day. This assumption is close to reality since the fraction of students who attended a full-day school grew from 20% in 1997 to 90% in 2014 (Alfaro et al., 2015). Then, we computed the share of priority students in each school by year, to assign the SEP concentration voucher<sup>50</sup>. Finally, we compute three different values: the marginal transfers from a regular student, the marginal school revenue from a regular student, and the marginal school revenue from a priority student. The first one is different from the second one because the first one accounts for public transfers (i.e., vouchers), while the second one accounts for vouchers and price charged to the student if the school charges top-off fees. In many cases, when the school does not charge top-of-fees, the marginal transfer and the marginal revenue for regular students are the same.

The marginal transfers account for the general voucher, adding the area assignation and the discount for shared-funding if the school charges top-of-fees. Then, as stated above, the marginal

<sup>50</sup>The values of the Concentration Voucher are different for the four groups previously defined. Table 3 only reports the highest values for the 4th group, with 60% or more priority students.

revenue from regular students accounts for the marginal transfers and the price, if it is larger than zero. Finally, the marginal revenue from a priority student accounts for the transfers of a regular student, the SEP voucher, and the SEP concentration voucher, which depends on the share of priority students in each school every year.

### *O-6.2 Expenses*

The accountability of public resources is a relevant issue in educational policy because it is necessary for ensuring the proper use and efficiency of public resources. The SEP Law (Law No. 20,248) in 2008 establishes in the letter (a) of its 7th article that the school owners must report to the Ministry of Education regarding the use of all the resources received under the SEP policy. Given that, both revenues and expenses were only reported if they used SEP resources and if they went to the Educational Improvement Plan actions.

In 2009, article No. 46 of Decree with Force of Law (DFL) No. 2 of the Ministry of Education stated that all school owners who receive public resources have to account publicly for the use of resources and they will be subject to the audit and supervision of the Superintendency of Education. However, there were not common records reporting expenses as administrative data, apart from the SEP-expenses reports.

In August 2011, Law 20.529 created a new system for quality education guarantee, called the “National System for Quality Assuring of Pre-School, Primary and Secondary Education”. This system aims to ensure quality and equity on education through policies, evaluations, and support and supervision mechanisms over schools and other agents in the educational system. In the 54th article of this law, it is established that all school owners who receive public resources must annually account for the use of all the resources they receive, both public and private, and not only for SEP-related expenses. These accountability records must follow the procedures and setup established by the Superintendency of Education, through the National System for Quality Assuring.

In September 2013, Decree No. 469 approved the rules that established the characteristics, modalities, and conditions for the shared mechanism of public accountability of the use of resources. This mechanism has to be followed by all school owners of public or private voucher schools<sup>51</sup>.

The accountability processes for the years 2013 and 2014 had some discrepancies that were perceived in the administrative data. In the first place, in 2014, the Superintendency of Education notified the existence of about 1300 schools that had not sent their reports on the use of resources of the general subsidy in 2012. These cases were allowed to render accounts for 2012 in the 2013

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<sup>51</sup>Decree 469 will be modified later in 2016 by Decree 575, adding more details in the descriptions of central concepts and giving more time to schools to send the reports.

process (which took place in 2014). Then, that same year, the Superintendency established a new revenue and expense report format that had much more detailed entries. For example, in the case of expenses, it goes from having six categories, to having eighteen.

All these changes caused the administrative expenditure records for 2012 and 2013 to be inconsistent with the other years. The data of expenses that we receive from the Superintendency are balanced and consistent between 2008 and 2011 for exclusive SEP-related expenses, and between 2014 and 2017 for aggregate expenses. However, about 90% of the schools that register expenses in 2012 only have SEP expenses, 4% only report according to the new detailed expense format, and 6% report both. For 2013, 1% reported only SEP expenses, 30% reported only under the new detailed norm, and the remaining 69% reported both. Also, the total number of schools that reported expenses in 2012 was 8,189, while in 2013 they were 11,531, suggesting

Considering the context, we will do two separate analyses: (1) General expenses between 2014 and 2017, and (2) SEP-related expenses between 2008 and 2012, considering the 90% mentioned above. The principal analysis will describe the use of general resources, and we will link the schools' behavior with the use of SEP resources. Even though the 69% who report both types of expenses in 2013 could be considered in the 2014-2017 analysis, there could be some selection bias if the difference between the records is due to the engagement of the school owner (reporting or not within the established date), and from 2014 onward other spending categories are defined that do not coincide with the detailed format of 2012-2013. Since the 2014 process, the Superintendency of Education publishes manuals for accountability records each year.

### *Expenses Description*

#### *General Expenses*

In this subsection, we will describe the detailed categories where general expenses are classified. For the analysis, some related expenses will be grouped into more general categories.

The first class of expenses is Remuneration Expenses, and they account for wages and compensations for teachers, assistants, and other educational workers. Items considered in these records are the base wages, payment for extra hours, and some other compensations and vouchers as the ones described in the subsection of Teacher Vouchers, in the Vouchers Description Section (SNED, AVDI, AEP, among others).

Then, we have expenses assigned to the payment for bonuses established in the Readjustment Law of the Public Sector (which is set every December); pension contributions to workers; other transfers due to indemnities; and other remuneration adjustments.

All of these expenses that are related to teachers' and workers' payments will be grouped into **Labor Expenditures** for the upcoming analysis.

The **Technical Advisory and Training** expenses are directed to invest in advisory services, consultancies, and training for the school workers. The resources are used to qualify teachers and assistants, and to improve their pedagogical and technical abilities.

Learning Resources expenses are dedicated to acquiring resources for the correct development of the students' learning process. Some examples are laboratory implements, sports implements, musical and artistic instruments, audiovisual resources and educational softwares, books, and educational and cultural events. Pedagogical Support Equipment expenses, on the other hand, accounts for the acquisition of needed equipment to develop the students' learning process. Some examples are photography equipment, interactive boards, computers and notebooks, televisions, DVD players and projectors, printers, scanners, and speakers.

There is a category of expenses named Expenditures on Student Welfare, that record all resources used for the students' basic needs, like meals, clothing, transfers for public shuttle, and school supplies, among others.

For the analysis, we will add up Learning Resources, Pedagogical Support Equipment, and Student Welfare Expenditures into an only group for **Learning and Development Resources**.

The **Operational Expenses** are the expenditures aimed at ensuring the proper functioning of the establishment. In this context, they include expenses for rent of school transport, operation of transportation, office supplies, computer inputs for administrative areas, and expenses related to specific activities of the school (events and field trips).

Expenditures on services are split into two types: Basic Services and General Services. Basic Services satisfy the primary needs for running the school, like water, electricity, gas, internet, mail, telephone, and heating. General Services, on the other hand, correspond to services that require the hiring of workers (or enterprises), such as cleaning, gardening, and security. These two types of expenditures are analyzed as **Services Expenses**.

We have five categories in school expenses records related to investment in school infrastructure. First, we have the lease of real estates, such as the educational place or possible administration offices; and the lease of movable property, such as furniture and machinery. Then, we have the expenses in construction and maintenance of the infrastructure, which considers both the heavy construction and the lighter installations; and the expenditures in maintenance and repair of movable property. Finally, the expenses in the acquisition of movable and immovable property are also considered, for those schools that decide to buy them. These five categories are considered as **Infrastructure Expenses** for further analysis.

Finally, schools have to account for **Expenses for Contingencies**, and they run them with petty cash that has a fixed amount of money to operate with cash available to schools' dependencies or officials, in case it is needed. Also, schools have to record payments for **Fines and Interests** that the school owner must pay for non-compliance and infractions of the regulations. Note that it



does not include fines issued by the Superintendency of Education, because these are deducted from the voucher settlement.

We add into a ninth category all **other expenses** reported by schools that do not fit in the categories previously defined. These expenses are adjustments for rectification, centralized resources, late reports for Law N0. 20,550 (See SEP expenses subsection) and withdrawals.

### *SEP Expenses*

The SEP-related expenses are classified in similar categories that the general ones, but they have more restrictions and have to be exclusively related to the actions of the Educational Improvement Plan (EIP). In this subsection, we describe the nine different categories used in the accountability report for SEP expenditures.

First, we have **Operational Expenses** on goods and services. This entry accounts for all resources directed to daily use material, regular consumption goods, several services, leases, and minor expenses related exclusively to the EIP. The expenses of the regular operation of the establishment cannot be imputed to the SEP.

**Staff or Labor expenses** are the resources destined to the remunerations of the educational workers for their work in exclusive relation with the execution of the EIP. In 2011, Law No. 20,550 modified the SEP Law in multiple fields, but in particular, it extended the permitted expenses in staff, mostly to hire more teachers and education assistants and to extend the working hours of the available personnel. More details in the SEP Policy section ().

Another group of expenses is the one for **Technical Advisory and Training** directed to invest in advisory services, consultancies, and training in pedagogical or administrative matters for the school workers, within the framework of the EIP. Entities who provide these services have an essential influence on school development and its preparation for setting goals at the EIP, so they must be supervised by the Superintendency of Education. They can be natural or legal agents, and they have to register in the ATE Registry (External Technical Advisory in Spanish) to be accountable for schools.

The EIP establishes different actions in each learning environment that requires resources both for its implementation and for its development. In this context, we have two groups of defined expenses: expenses in **Pedagogical Support Equipment** and expenses in **Learning Resources**. Pedagogical Support Equipment expenses account for the acquisition of goods and equipment to carry out the actions on the EIP; while Learning Resources are those resources allocated to the consumable and non-consumable material to develop pedagogical activities of support and reinforcement of the students, within the framework of the EIP. Examples of these two groups of expenses are presented in the General Expenses subsection.

There are two other groups of expenses defined by special situations: **Contingencies Expenditures** and **Centralized Resources**. Expenses for contingencies can exceed the 5% of SEP resources and they have to be within the context of the SEP policy, by solving problems with SEP rules or expenses linked with the EIP. When school owners have more than one school in the SEP policy, they can allocate up to 10% of SEP resources to Central Administration. These resources must be spent on technical, pedagogical, and administrative financial support tasks that involve the preparation and implementation of each EIP.

Another change introduced by **Law No. 20,550** in 2011 was that, for schools that have entered into the SEP policy between 2008 and October of 2011 and have not reached the minimum percentage of SEP spending required, can benefit from exceptional requirements and conditions in the first renewal of the SEP agreement.

The minimum percentage of spending for SEP resources was 70%. As mentioned in the 7th bis article and the transitory 15th article of Law No. 20,248, the requirements for the first renewal of the agreement in this extraordinary situation are: (a) to have asked the Ministry of Education for an agreement renewal at least sixty days before its expiration; (b) to have accounted for all SEP resources in the previous years; and (c) to have spent at least 50% of these resources in EIP's actions. Additionally, it can be exceptionally considered for the third requirement expenses for up to 15% of total voucher incomes spent in actions out of the EIP. As we will see in the spending analysis, expenses for Law No. 20,550 were only reported for 2012 because it was an extraordinary situation.

Finally, the last expenses reported by schools in the SEP policy context are expenses due to **Law No. 20,452** published in July 2010. This law approved extraordinary conditions for the use of voucher resources for infrastructure repair and construction, and equipment replacement needed after the earthquake that took place on February 27, 2010.

### *Spending Analysis*

In this subsection, we analyze the spending behavior of schools considered in markets, examining the use of general resources between 2014 and 2017.

Table O-10 shows the spending behavior of schools within the nine categories described before. It is clear to see that Labor expenditures are the main subject of spending for both the private voucher and public schools. Figure O-20 shows the distribution of the share of labor expenses between public and private schools<sup>52</sup>. As we can see, private schools have a wider distribution in this expense subject, but public schools spend more on average. This situation can be justified because labor expenses account for bonuses for the public sector and other costs that public schools

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<sup>52</sup>The figure consider all years between 2014 to 2017. The figures for each year show similar results.

are more likely to spend in.

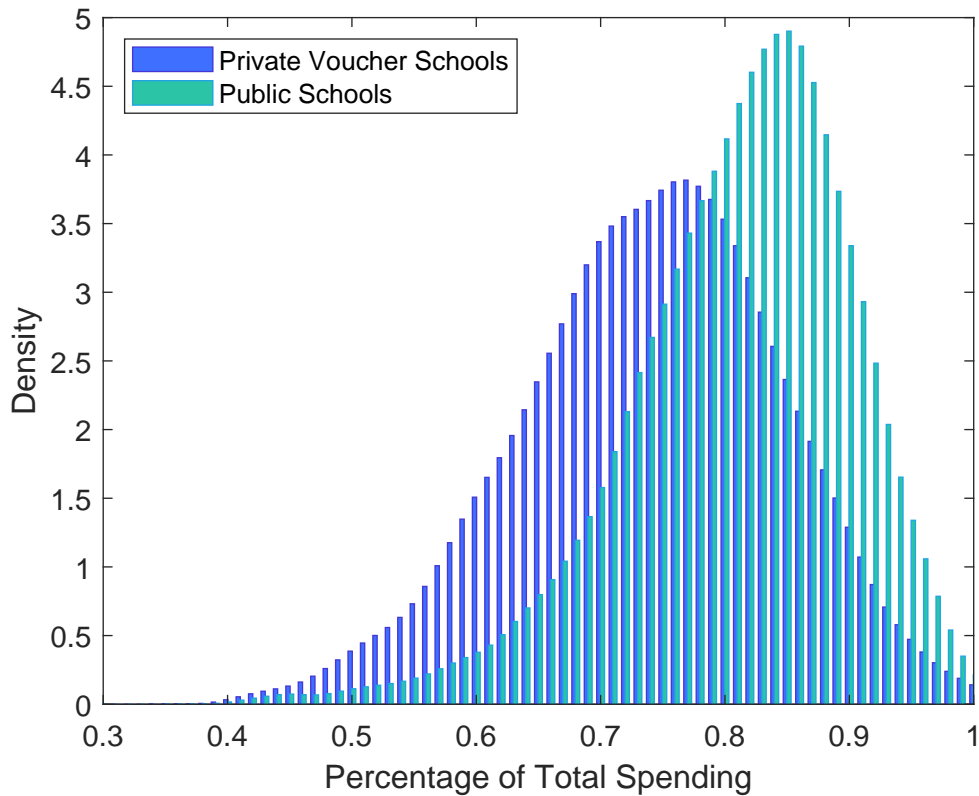
Figures O-21 and O-22 show the distribution of the share of operational expenses and learning resources expenses, respectively. For operational expenses, private voucher schools spend more than public schools, most probably because the latter depends on municipalities where operational costs can be centralized. For expenses on learning and development resources, schools' behavior is similar between private voucher and public schools, showing that both types of schools dedicate an equal share of their resources to provide students with school supplies and equipment for a proper learning environment.

**Table O-10:** Spending 2014 - 2017 Percentage of Total Spending

Expense Type	2014		2015		2016		2017	
	P	PV	P	PV	P	PV	P	PV
Labor	80	74	81	74	80	74	81	73
Technical Advisory and Training	2	1	1	1	1	1	1	1
Learning and Development Resources	4	4	4	4	5	4	5	5
Operational	4	6	4	7	4	7	3	6
Services	3	4	2	4	2	4	2	4
Infrastructure	1	9	0	8	1	8	1	8
Contingencies	0	0	0	0	0	0	0	0
Fines and Interests	0	0	0	0	0	0	0	0
Other Expenses	7	2	7	3	7	2	8	2

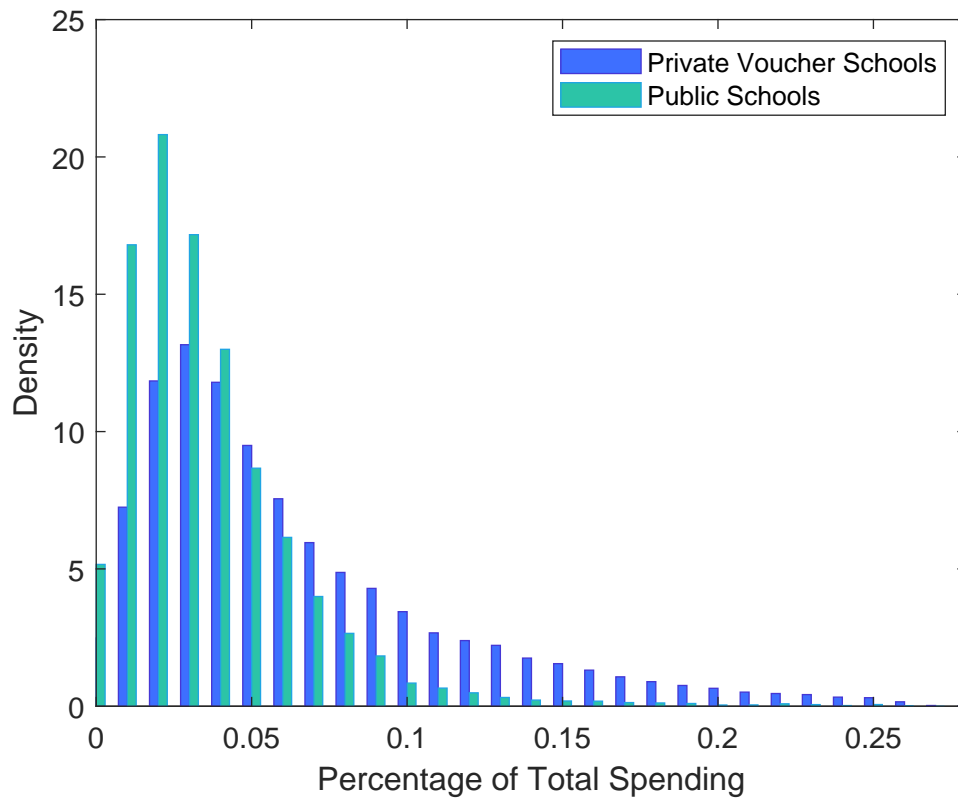
Note: This table presents schools' types of spending as a percentage of total spending between 2014 and 2017, self-reported data. This data includes SEP spending, but it isn't differentiated between General and SEP sources. 'P' columns are for public schools, and 'PV' columns for private voucher schools. Labor Expenses account for remuneration expenses, bonuses for the public sector, pension contributions, indemnities, and other remuneration adjustments. Learning and Development Resources account for learning resources expenses, student welfare expenditures, and pedagogical support equipment expenses. Services expenses account for Basic and General Services expenses. Other expenses consider adjustments for rectification, centralized resources, late reports for Law N0. 20,500 and withdrawals.

**Figure O-20: Share of Labor Spending over General Expenses**



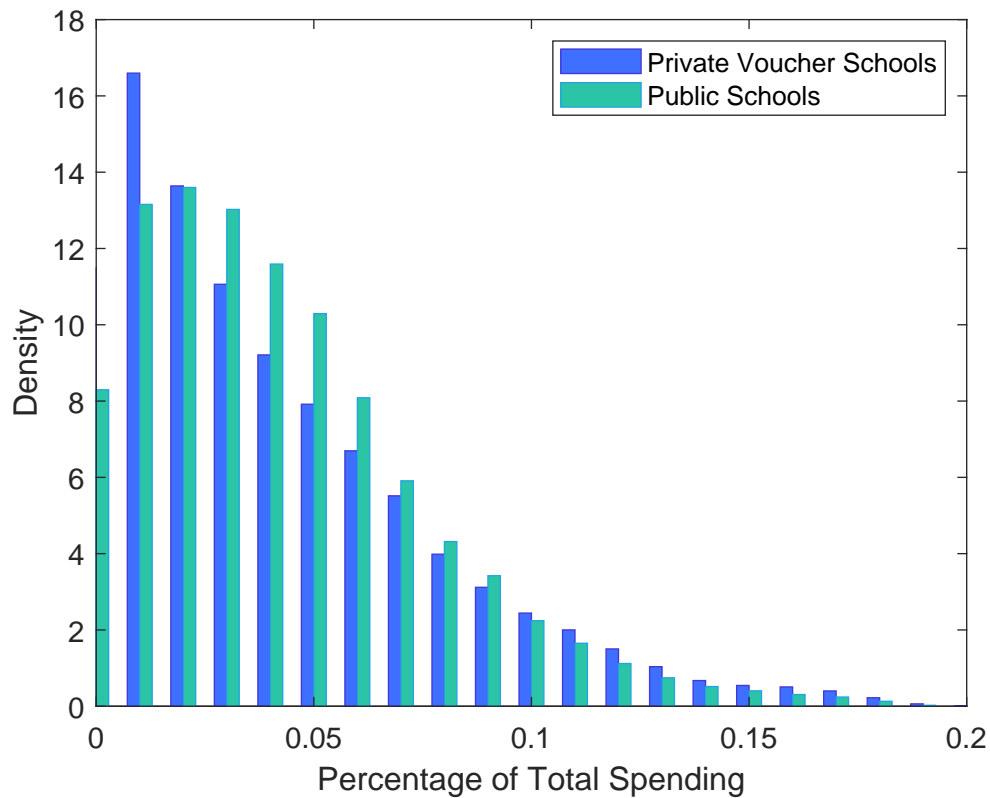
Note: This figure shows the distribution between public and private voucher schools of the percentage of labor spending over general spending. Labor spending accounts for remuneration expenses, bonuses for the public sector, pension contributions, indemnities, and other remuneration adjustments.

**Figure O-21: Share of Operation Spending over General Expenses**



Note: This figure shows the distribution between public and private voucher schools of the percentage of operational spending over general spending.

**Figure O-22:** Share of Learning and Development Resources Spending over General Expenses



Note: This figure shows the distribution between public and private voucher schools of the percentage of learning resources spending over general spending. Learning and Development spending accounts for learning resources expenses, student welfare expenditures, and pedagogical support equipment expenses.

### *Analysis of SEP Expenses*

In this subsection, we show the spending behavior of schools considered in markets respecting SEP expenses, for 2008 to 2012. Table O-11 shows the spending behavior of schools within the nine categories described in the description subsection.

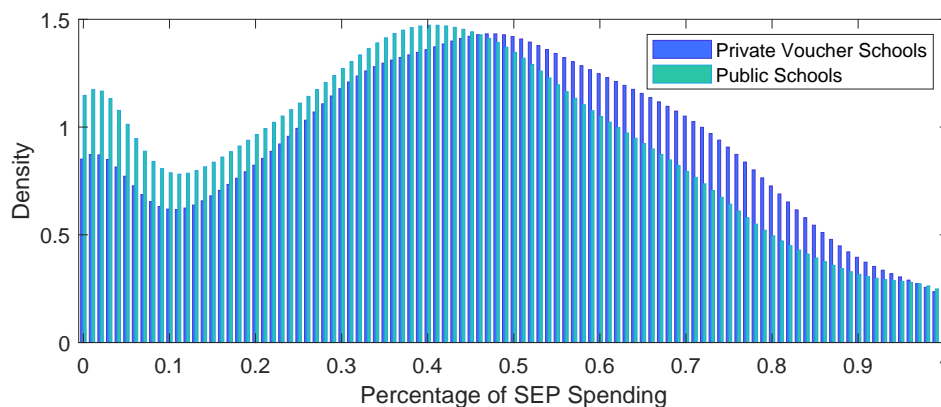
**Table O-11: SEP Spending 2008 - 2012 Percentage of Total SEP Expenditures**

Expense Type	2008		2009		2010		2011		2012	
	P	PV	P	PV	P	PV	P	PV	P	PV
Operational	31	24	15	18	15	18	15	17	12	16
Labor	36	35	35	39	41	46	45	49	43	50
Technical Advisory and Training	13	6	10	8	10	6	13	9	9	7
Pedagogical Support Equipment	11	19	17	17	10	12	7	9	6	8
Learning Resources	8	15	13	16	14	14	12	13	10	13
Contingencies	0	1	1	1	1	1	1	1	1	1
Centralized Resources	0	0	8	1	8	1	8	1	6	1
Law N. 20.550	0	0	0	0	0	0	0	0	13	4
Law N. 20.452	0	0	0	0	0	1	0	1	0	0

Note: This table presents schools' types of SEP spending as a percentage of total SEP expenditures between 2008 and 2012. 'P' columns are for public schools, and 'PV' columns for private voucher schools.

Once again, as we saw for general expenses, labor-related expenses are the main subject of spending for all types of school. Considering that rules for SEP expenditures were more rigid than for general resources, and only since 2012 with the reform of 2011 (Law No. 20,550) schools have fewer restrictions to hire and to extend teachers' working hours, it is expectable that the share of Labor expenditures on total SEP expenditure is lower than the same percentage in general spending.

**Figure O-23: Share of Labor Spending over SEP Expenditure**

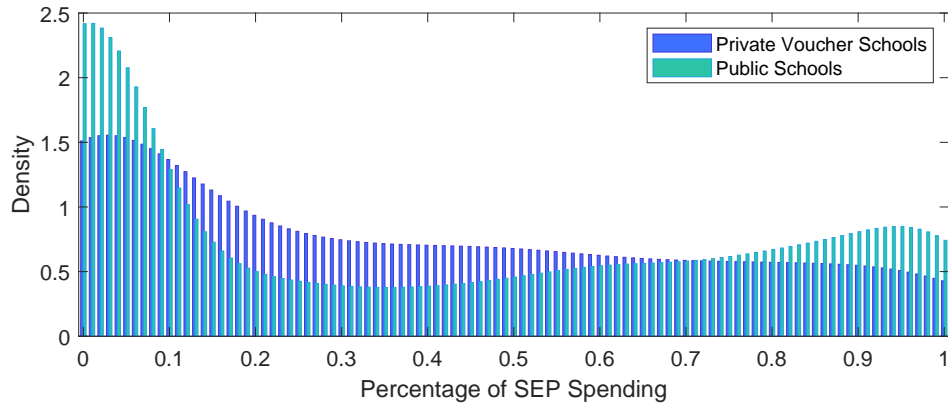


Note: This figure shows the distribution between public and private voucher SEP schools of the percentage of labor spending over SEP spending.

Figure O-23 shows the distribution of the share of labor expenses over SEP expenditure, including from 2008 to 2012. The distribution is more heterogeneous than the one for general resources, what it has to do with the legal change. We can split the data between years to see if the reform in 2011 change how schools spent their resources. Figures O-24 and O-25 show the same distribution as Figure O-23, but for 2008 and 2012, respectively. This evidence shows how the law

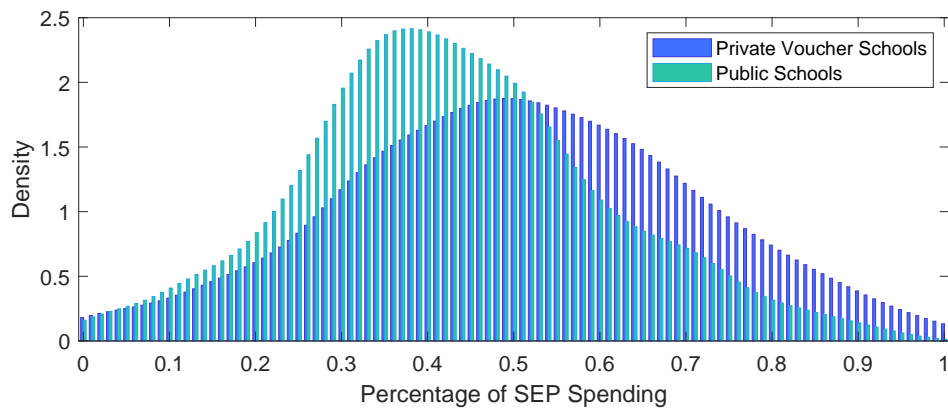
change compress and increase the rate of resources spent on labor because of the more flexibility to do it.

**Figure O-24:** Share of Labor Spending over SEP Expenditure in 2008



Note: This figure shows the distribution between public and private voucher SEP schools of the percentage of labor spending over SEP spending for 2008.

**Figure O-25:** Share of Labor Spending over SEP Expenditure in 2012



Note: This figure shows the distribution between public and private voucher SEP schools of the percentage of labor spending over SEP spending for 2012.

### *Productivity of expenditures*

Considering that the labor expenditures are the most significant component in the spending structure of schools, we can wonder if all these resources are being well-spent. There is a part of the literature on the economics of education that studies whether a higher amount of resources

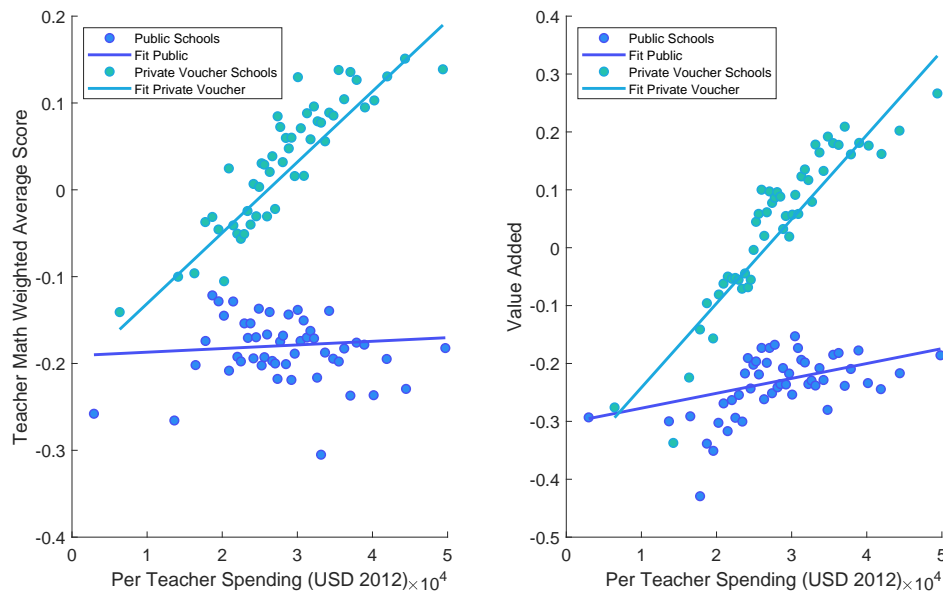


and their usage, implies greater productivity and product(Glewwe et al., 2011; Mizala and Torche, 2012). Although these researchers conclude that more resources do not necessarily lead to better educational outcomes, there could be different nuances of the efficiency of the expenditure if we differentiate for type school.

To check if schools' expenditures on labor are productive, we can see the correlation between the amount of spending and signs of productivity of the labor. In this context, the main proxies for the productivity of teachers and teaching staff are test scores of teachers (a performance proxy) and the value added of the school. Figure O-26 shows the correlations between per teacher spending and these two measures. Per-teacher spending accounts for spending on labor resources divided by the number of teachers in the school. Teachers' math weighted average score represents the average of teachers' scores in the school weighted by their teaching hours. The math test is the test for entering college or tertiary education, at the end of high school. On the other hand, value added is a measure of the quality of the school (more details on the Value Added Section).

The main conclusion about Figure O-26 is that private voucher schools have a positive relationship between their labor expenses and the quality of the resources they get. However, public schools can spend less or more resources, without changing their quality significantly, being less productive on their expenses.

**Figure O-26:** Share of Labor Spending over SEP Expenditure in 2012



Note: This figure shows the correlation between labor spending and the average weighted teachers' score of the school in the left subfigure; and the correlation between labor spending and the school value-added in the right subfigure. Both subfigures are differentiated by types of school, showing a positive relationship between labor spending and the productivity proxies for private voucher schools, while public schools show low or none relationship.