Effects of Differentiated School Vouchers: Evidence From a Policy Change and Date of Birth Cutoffs

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Abstract

In this paper I study the effects of an increase in school choice by examining a 2008 reform that made the value of Chile's (previously flat, universal) school voucher a step function of student income. This policy increased the proportion of private schools that low income, eligible children could access free of charge from 0.5 to 0.7. I identify the impact of the policy by combining its introduction with variation from a date of birth enrollment cutoff for 1st grade. I show that the differentiated voucher lowered the probability that students used public schools by 1.5% and that these students shifted out of low achievement public schools to enroll in low achievement private schools, nonetheless, private schools where these students enrolled had better test scores and socioeconomic composition at baseline, and less experienced teachers and smaller class sizes than public schools where they would have enrolled in the absence of the program. Despite the improvement in some school observable characteristics, test scores did not increase for students more likely to move to private schools. Further analysis suggests a rise in test scores for students in public schools. These results suggest that the policy had an overall modest positive effect on test scores, but that this positive effect was caused by responses from public schools instead of by the re-sorting of students into private schools.

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1 Introduction

The past decades have seen the creation of dozens of school voucher programs. The motivation has been that if there were an increase in school choice and competition, it would improve educational outcomes (Friedman, 1962). Most of these programs remain small in size (Epple et al., 2015), and only in a few cases is their reach national. Consequently, there is still limited evidence on the effects of large school choice programs on achievement. These effects may differ from small-scale programs due, for example, to the possible re-sorting of students across schools (e.g., Hsieh and Urquiola, 2006), or to school responses to the increased competitive pressure (e.g., Neilson, 2013). In addition, the literature on large-scale programs has generally focused on the aggregate effects of such programs or used structural estimation. Thus, effects on different types of students are barely known. Finally, Epple et al. (2015) highlights that much work remains to be done on the design of school vouchers. For instance, should their value be flat or a function of students' income?

In this paper I consider a reform that allowed the value of the voucher to vary with family income in the context of Chile's nationwide voucher system, and I assess the effects of this reform on different types of students. Specifically, this policy allowed public and private schools to potentially receive significantly higher subsidies when they enrolled eligible, lower-income children. In exchange, the schools had to set achievement targets, and to stop charging tuition add-ons for eligible children. The number of private schools free of charge for eligible students increased by about 20 percentage points in the initial years of the policy.

To analyze the effects of this policy, I use the pool of students enrolling in 1st grade. I match these data to socioeconomic and test score information obtained from a national standardized exam that takes place every year for 4th grade students.

I combine two sources of variation to identify the impact of this reform. First, I exploit the timing of the policy, which was introduced in 2008. Second, I rely on the fact that, like other countries, Chile has an enrollment cutoff — children born after June 30th must, in principle, wait a year to enroll in school. Taken together, these facts imply that students born only a few days apart faced potentially different amounts of school choice when they enrolled in 1st grade.

A comparison of their outcomes in a regression discontinuity (RD) design thus provides an assessment of the effects of increased school choice. Additionally, by using the RD created by the enrollment cutoff for years prior to the introduction of the differentiated voucher, I can identify possible trends and confounders that could be biasing the RD estimates of the effects of the differentiated voucher. Then, taking differences of the RD estimates, I obtain unbiased estimates of the impact of the voucher reform. In contrast to most of the literature on large-scale voucher programs, this identification strategy allows me to analyze the effects of the increased school choice separately for different types of students.

The introduction of the differentiated voucher in 2008 seemingly implies that the increase in school choice will be a one-time event. However, in practice, information on the program seems to have disseminated slowly, thus, in most specifications I apply a similar analysis to subsequent cohorts. This is consistent with evidence that families did not understand their eligibility immediately, and that schools similarly were slow to understand the rules of the program. Additionally, this reflects that families had to research which private schools were participating in the program in order to benefit from the increased school choice.

I use the two sources of variation (i.e., timing of the policy and date of birth) to carry out three exercises. First, I quantify and characterize compliers — students that enrolled in private schools instead of public schools in response to the introduction of the differentiated voucher. Second, I look at changes in enrollment choices for all students, and I compare public schools where compliers would have enrolled in the absence of the program to the private schools where they actually enrolled, at baseline. Finally, I analyze the effects of the increased school choice on current school characteristics and test scores.

To quantify and characterize compliers, I instrument enrollment in private schools with the interaction of the timing of the policy and whether a student was born after the enrollment cutoff. From this first stage, I find that, although about 50 percent of the population was eligible for the new voucher, only about 1.5 percent of all students changed their enrollment decisions in response to the increased school choice.

In the second stage, I obtain the average characteristics for compliers. The most relevant result is that around 90 percent of students that switched sectors in response to the new voucher had mothers that completed high school education. Therefore, compliers were not the poorest students within the group of eligible students. In addition, I use the fact that most compliers had mothers with high school education to classify students, since the proportion of eligible students in the population was not stable over the period. Thus, I divide students in groups depending on their mothers' education, given that the resulting groups are fairly constant over the period.

Next, I use the differences in RD estimates to examine the effects on enrollment decisions. My results show that the probability of enrolling in a public school fell slightly for students with mothers that had basic education or less, and for students with mothers that completed high school. This probability remained constant for students with mothers that completed university education. Furthermore, my results show that the probability of enrolling in elite private schools remained constant over the period. These results suggest that wealthier students did not try to avoid differentiated voucher users through enrolling in elite private schools.

Instrumenting enrollment in public and private schools in a two-stage least squares system, I find that, on average, compliers did not enroll in low achievement public schools and enrolled in low achievement private schools instead. Nevertheless, the schools they moved to had better socioeconomic characteristics and average test scores, smaller classes and less experienced teachers at baseline.

Regarding current school characteristics, the results of the difference in RD estimates show that, on average, no group of students classified according to the mother's education experiences changes in the socioeconomic composition of its peers after the introduction of the differentiated voucher. Additionally, students with mothers that completed high school, on average, have smaller class sizes and less experienced teachers, which is consistent with the changes in enrollment choice of compliers. With respect to students with mothers that had basic education or less — who were more likely to stay in public schools — my analysis uncovers one potential channel through which public schools could be responding to the introduction of the differentiated voucher. These students have, on average, less experienced teachers once the differentiated voucher is introduced. This suggests that public schools may have replaced more experienced teachers with less experienced instructors.

Despite the fact that compliers enrolled in schools with generally better characteristics, the difference in RD estimates shows that there are no effects on average test scores for students with mothers that completed high school. This result is consistent with a part of the literature in school choice that finds small or inexistent effects for students transferring to better schools (e.g., Abdulkadiroglu et al., 2011; Dobbie and Fryer, 2014).

In contrast, the average test scores of students with low education mothers — those were more likely to stay in public schools — increased. This is consistent with another strand of the school choice literature which suggests that school choice leads to responses by public schools (e.g., Hoxby, 2003; Chakrabarti, 2008). This impact in test scores could be related to the decrease in average experience of teachers for this group of students. But other mechanisms could be at work as well.

This paper relates to several strands of previous work. First, identification of the effects of large-scale voucher programs is generally difficult. These programs distribute vouchers nation-wide to all students who want to use them, and may have effects on non-voucher users through changes in student composition or other school characteristics. Therefore, it is hard to define control groups. Generally, the literature has either focused on the aggregate effects of such programs (e.g., Hsieh and Urquiola, 2006; Bohlmark and Lindahl, 2008) or used structural estimation (e.g., Neilson, 2013; Bravo, Mukhopadhyay and Todd, 2010). In a controlled experimental setting, Muralidharan and Sundararaman (2015) considered the effects of the introduction of targeted school vouchers in India on voucher users, students remaining in public schools and students already enrolled in private schools. My identification strategy allows me to quantify and characterize students responding to the introduction of a national differentiated voucher in Chile, compare schools where responding students would have enrolled and actually enrolled in response to the policy, and analyze the impact of the policy on students affected in different ways.

Since this large-scale program was overlaid on top of the national voucher system, its effects may have been more limited and thus relevant to work on small-scale programs. Thus, I also contribute to a broad literature on school choice that has found mixed results on outcomes of students that transfer to private or charter schools (e.g., Abdulkadiroglu et al., 2011; Hastings et al., 2012; Rouse,

1998) or to higher quality schools (e.g., Deming et al., 2014). My estimates suggest that students that enrolled in private schools instead of public schools, due to the differentiated voucher, did not significantly increase achievement, despite the improvement in some school characteristics.

Additionally, students left behind in public schools also have been shown to benefit from voucher programs, especially in public schools likely to be affected by the increased competition (Figlio and Hart, 2014; Hoxby, 2003). In this paper I show that, even though the program did not generate a large re-sorting of students, students more likely to stay in public schools experienced increases in average test scores. Even though many mechanisms could be responsible for this result, I find some evidence of response by public schools through changes in their teaching teams.

The remainder of the paper is organized as follows: the following section describes the differentiated voucher program and the Chilean school system. Section 3 explains the possible effects that the introduction of the differentiated voucher could have generated, then, section 4 discusses the data used in this paper and presents descriptive statistics. Section 5 describes my empirical strategy and the differences in RD design, followed by section 6 that discusses the characteristics of students who switched enrollment decisions in response to the policy. Section 7 presents my results and, finally, section 8 concludes this paper.

2 Background

In 1981, school vouchers were introduced in Chile. These vouchers were universal and nationwide: every student had access to a voucher of equal monetary value.

The introduction of vouchers defined three main school types, on the basis of financing and control, that have remained unchanged since 1981:

1. *Public (or municipal) schools.* These schools are controlled by the municipalities and funded centrally through a per-student payment for every child attending their schools. Public schools can only legally turn away students if they are oversubscribed.

2. *Elite private schools.* These private institutions do not receive public funding and are financed through tuition fees. They account for around 7% of total enrollment and serve mainly high-income households.

3. *Voucher (private) schools.* These schools are privately controlled and up to 1993 were funded exclusively through the same per-student payment as public schools. Since 1993 these schools can charge supplementary tuition.[1] If they choose to do so, the per-student payment is progressively reduced as tuition increases, but this reduction does not offset the tuition revenues except for very high tuition levels. In contrast to public schools, voucher schools were allowed

[1] Law 19.247 of September 15, 1993.

to select students up to 2009.[2]

Supplementary financing for specific types of school was introduced after 1981, such as the *P-900* program that transferred resources to schools with low absolute performance, but the basic features of the school voucher program remained constant until 2008.

In the late 1990s, some observers began to suggest a differentiated per-student voucher that might correct educational inequities. However, the voucher payments remained flat until 2008, when a new differentiated voucher was created through the Preferential School Subsidy Law.[3]

The Preferential School Subsidy Law created a two-step voucher that depends on the socioeconomic characteristics of students. All students still receive the original flat voucher, but now participating schools receive an additional amount for each eligible student enrolled.

Through the new differentiated voucher the government wanted to recognize that educating low socioeconomic status students is more costly than educating wealthier students. Furthermore, it hoped that low income students (eligible students) would be more appealing to selective participating voucher schools due to the additional payment, and that, as a consequence, voucher schools would have greater incentives to locate in low-income neighborhoods.

In order to receive the differentiated voucher, schools must formally join the program by signing a four-year agreement with the Ministry of Education.[4] If they do so, schools receive an additional payment worth around 50% of the flat voucher amount for each eligible student enrolled. Participating schools can also receive an additional subsidy if the school has a high percentage of eligible students.[5] This extra subsidy is much smaller in size than the differentiated voucher, and increases with the proportion of eligible students in the school, with discontinuities at 15, 30, 45 and 60 percent of the total student population in the school.

In exchange, participating schools commit to provide a plan that explains how the differentiated voucher resources will be spent to improve the school. They are held accountable for these expenses and must set achievement targets in terms of standardized test results with a special focus on increasing test scores for eligible students.[6] Additionally, this agreement forbids selecting or expelling students between kindergarten and 6th grade and finally, it also forbids charging any compulsory fees to eligible students.

This last condition implied that due to the participation of voucher schools in the differentiated voucher program, the proportion of free voucher schools for eligible students jumped from around 0.52 in 2007 to 0.65 in 2008, as shown in Figure 1, and then rose up smoothly to 0.71 in 2010. Thus, there was an immediate increase in school choice for eligible students followed by additional

[2] Article 12 in Law 20.370 of September 12, 2009. Carrasco et al. (2014) suggest that voucher schools continue to select students.

[3] *Ley de Subvención Escolar Preferencial, number 20.248.*

[4] *The agreement is called Convenio de Igualdad de Oportunidades.*

[5] *The additional subsidy is called Subvención por Concentración.*

[6] Minimum increases in test scores were set by the Ministry of Education.

subsequent increases.

Enrollment responses were gradual, additionally, because there were difficulties in informing parents about the policy and about eligibility. Initially eligibility information was distributed through letters to families, sometimes sent through the school where the students were enrolled. This information was not always understood by families (Soto Aranda, 2011).

Starting in 2010, the responsibility to inform parents about the differentiated voucher program was transferred to the schools, with the Ministry of Education distributing eligibility information by logging into a website. The computer access requirement may reduce access to eligibility information for the poorest eligible students.

On top of the difficulties to obtain information on the differentiated voucher program and eligibility, parents additionally need to research about voucher school participation in the program if they want to benefit from the increased school choice.

As a result, the effects of the policy on enrollment choices were smooth over time, as parents slowly learned about the differentiated voucher program, eligibility and participating schools. Therefore, in my analysis I will consider that students that enrolled in 2008 and each subsequent year were exposed to a new increase in school choice for each year, as parents learned about the differentiated voucher program and were more able to respond to the increase in school choice.

2.1 Eligibility

Approximately the poorest 50% of the population is eligible for the differentiated voucher program. Eligibility is determined according to socioeconomic indicators. Specifically, a student is eligible if any of the following conditions are met: (i) the student belongs the lowest third of the distribution of scores of a government instrument that measures the family capability to generate income, (ii) the student participates in a social program that targets the 10% poorest population,[7] or (iii) the student is classified in the poorest group of the National Health Fund (FONASA). Finally, students could be temporarily deemed eligible according to socioeconomic indicators.

In 2010, 55% of eligible students were eligible through criteria (1), 30% were eligible through criteria (2), and the remaining 15% through other criteria.

Unfortunately, the instrument used to identify most eligible students, the *Ficha de Protección Social*, was introduced in 2007, and it was not administered to students who could be eligible for the differentiated voucher until 2009.[8]

Additionally, since this same instrument was used to determine eligibility for most social benefits in Chile, citizens had incentives to reduce their scores. Many of them learned how to game the

[7] *Chile Solidario*.

[8] Herrera, Larrañaga and Telias (2010).

instrument and became eligible,[9] which led to small or even nonexistent differences between eligible and ineligible students as determined by the instrument.

Consequently, eligibility information is not suited to analyze the effects of the differentiated voucher program. Therefore, to analyze the effects of this policy I characterize students responding to the program, as explained in section 6, and use the education level of the mother to classify students.

3 Potential Partial and General Equilibrium Effects

In a regular school voucher program, in which students can use school vouchers to pay for tuition in private schools, there are three types of students depending on voucher use: (1) voucher users, students that enroll in private schools instead of public schools using the voucher, (2) students left behind in public schools, and (3) students that were already enrolled in private schools.

Suppose that country A introduces a small-scale voucher program in which, for example, a small number of students is eligible for school vouchers that allow them to enroll in private schools. Assuming that private schools are different from public schools, students in group (1), voucher users, would attend schools with different characteristics with respect to the public school they would have enrolled in if the voucher did not exist. These students may or may not experience increases in test scores.

If the voucher program is very small-scale, the change in student composition in public schools would be minimal, and students remaining in public schools should not be affected by voucher users leaving public schools. Additionally, public schools are unlikely to feel threatened by the increased competition.

Similarly, if voucher users are evenly distributed among private schools, students in private schools receiving these voucher users should not be affected. The number of voucher users would be too small to have an effect on the socioeconomic composition of private schools and to have any negative effect on students already enrolled in private schools.

In summary, the effects of a small-scale voucher program would be dominated by the effects on voucher users, since non-voucher users would be barely affected.

The differentiated school voucher program in Chile is, in contrast, a large-scale program. Approximately 50% of the population were eligible for the differentiated voucher. Additionally, participating voucher schools were not allowed to select students anymore. Almost 70% of eligible students were enrolled in public schools in the pre-policy period and, thanks to the differentiated voucher, could enroll in participating voucher schools for free. However, this program was a reform to the already

[9] Poblete, J. (2012, April 30) *Detectan 50.512 casos de información falsa en ficha de protección social*, *La Tercera*. retrieved from: http://diario.latercera.com/.

existing national voucher system. Therefore, its effects on re-sorting the students could be large, but also could be small if all students who wanted to enroll in voucher schools were already enrolled in voucher schools using the existing (flat) voucher.

Suppose that eligible students have a strong preference for voucher schools over public schools, but, before the differentiated voucher was introduced, were prevented from enrolling in voucher schools due to student selection and school prices. If this is the case, in response to the differentiated voucher program, a large number of eligible students could enroll in participating voucher schools instead of public schools. As a consequence, if the number of students switching enrollment is sufficiently large, all 3 groups of students could be affected. Additionally, the possible benefits for voucher users of enrolling in a voucher school may be dampened.

In this case, voucher users would leave public schools to enroll in voucher schools that had, at baseline, better characteristics. However, since the poorest half of the population is eligible for the differentiated school voucher and participating voucher schools are not allowed to select students anymore, participating voucher schools could potentially be flooded with voucher users in a way that could affect the school characteristics. In an extreme case, and assuming no differences in value-added, it is possible that voucher schools accepting voucher users would end up with the same socioeconomic characteristics as public schools and with larger class sizes, causing a decline in achievement for students transferring from public schools.

Alternatively, these students may distribute evenly across schools and may not significantly affect student composition, or simply benefit from more effective teachers in voucher schools and achieve test scores.

Students left behind in public schools may also be affected. If a sufficiently large number of students leaves public schools, they may have smaller class sizes, better teacher per student ratios, and better targeting of instruction (Duflo et al., 2011). Additionally, public schools may actively compete for enrollment, and carry out changes at the school level to improve achievement. Therefore, it is possible that students left behind in public schools are positively affected.

Another possibility is that the best students in public schools leave due to the differentiated voucher, and students in public schools have a worse peer composition. In the case in which teachers do not respond by readapting their teaching targets, and schools do not respond, the negative effect due to the worse peer composition could dominate, leading to a decline in achievement by students left behind in public schools.

Finally, students already enrolled in voucher schools may experience negative consequences caused by the change in student composition in participating voucher schools. If the change is sufficiently large, it could slow teaching pace and lower teaching targets, causing a reduction in learning and test scores for students that were already enrolled in voucher schools.

Also, these students may respond to the change in school characteristics by deciding to enroll somewhere else as, for example, in non-participating voucher schools or elite private schools.

In contrast, another possibility is that as the differentiated voucher program was overlaid on the existing voucher system in Chile, very few eligible students switched enrollment decisions. If this is the case, the impact would be the same as in a small-scale program, with the variation that public schools may respond. Given the characteristics of the program, potential competition for public schools increased. Thus, if the perceived increase in school competition is sufficiently large, public schools may try to improve achievement in order to keep students from transferring to voucher schools.

Consequently, as the differentiated voucher was an addition to the already existing national voucher system, the effects of this program on re-sorting and achievement could be large or small. If the effects on re-sorting are large, all students, including the non-voucher users and ineligible students, could be affected, and changes in achievement could go in either direction. If the effects on re-sorting are small, there could still be effects on achievement if the public schools respond to the increase in potential competition. Therefore, since the effects of the introduction of the differentiated voucher program are theoretically ambiguous, empirical evidence is needed. The remainder of this paper will try to clarify which of these scenarios best fits the effects of the introduction of the differentiated voucher in Chile.

4 Data

I rely on two sources of administrative data, the Chilean Ministry of Education and the Education Quality Assurance Agency.

From the Ministry of Education, I use the individual enrollment information for all students in primary education from 2005 to 2014, including date of birth, grade, year and school enrolled in and the municipality of residence. Additionally, I use school information from 2005 to 2014, including type of school, school municipality and total enrollment, school average prices for voucher schools from 2005 to 2013, teacher hiring and firing, and teacher characteristics from 2005 to 2013. Finally, I use information about the differentiated voucher program at the school level, including school participation from 2008 to 2014, and funds received and used from the differentiated voucher at the school level for 2008-2012.

From the Education Quality Assurance Agency I use individual standardized test results for 4^{th} grade of basic education, and survey information on socioeconomic characteristics, including parents' education and family gross monthly income from 2008 to 2013.

I will use the sample of students enrolling in 1^{st} grade each year from 2005 to 2010 to determine the effects of the differentiated voucher on school enrollment choices and achievement. Since there are costs related to school switching, I will focus on the initial school enrollment decision, students enrolling in 1st grade.[10]

4.1 Descriptive Statistics

Summary statistics can be found in Table 1 and Table 2. Table 1 shows summary statistics of the sample of students and schools used by year of enrollment in 1st grade, while table 2 shows average characteristics of schools by type and year.

As shown in Table 1, there was a steady decrease in enrollment in public schools during the period, with a corresponding increase in enrollment in voucher schools. With regard to test scores, average test scores for a standardized exam carried out in 4th grade increased smoothly during the period, and, on average, do not seem to improve significantly more for students that enrolled once the differentiated voucher program had been introduced.

Finally, the last panel of Table 1 shows that the number of schools was relatively stable over the period. However, there were changes in the composition of schools in the market, with a reduction in the proportion of public schools and a corresponding increase on the proportion of voucher schools. Almost all public schools participated in the differentiated voucher since the first year, but only approximately 50% of voucher schools participated in the first year of the differentiated voucher program. Voucher school participation in the program increased smoothly in the following years.

Table 2 shows changes in school characteristics by school type over time. Average class size is largest in voucher schools and lowest in elite private schools. While class sizes in these two school types remained fairly constant, class size fell in public schools once the differentiated voucher program was established. Thus, the number of teachers per student increased in public schools starting in 2008. In terms of average school size, all three school types are quite similar, even though public schools suffered from a decline in total enrollment during the period. Socioeconomic composition of students in the three school types is as expected, with public schools having the lowest socioeconomic status students, voucher schools middle class students and elite private schools high socioeconomic status students.

With respect to teacher characteristics, almost the totality of teachers in all three school types hold a degree in education, but the percentage of educated teachers is slightly higher in public schools. Even so, the proportion of educated teachers increased somewhat for all three types of schools in 2008, when the differentiated voucher was introduced. The most experienced teachers are those in public schools. However, the average teacher experience (and age) fell in public schools in 2008, and it continued decreasing in the following years in public and, to a lower extent, voucher

[10] Approximately 42% of children were enrolled in kindergarten in the school where they attended 1st grade two years in advance, and approximately 55% were already enrolled in the same school on the year before starting 1st grade. However, most of the effect of the differentiated voucher in school choice comes from the 45% of students enrolling in a new school in 1st grade. Changes in school choice can also be observed for kindergarten levels but in a smaller magnitude than for 1st grade enrollment.

schools. This seems due to a change in teaching teams in public schools and, in a smaller scale, in voucher schools that started once the differentiated voucher was introduced, as can be observed with changes in the proportion of newly hired and terminated teachers.

The average teacher evaluation score,[11] that is compulsory for all teachers in public schools, increased in 2008 once the differentiated voucher program was introduced. This increase may have been caused by a rise in effort by teachers in response to the achievement goals set by the differentiated voucher program, the perceived higher school competition, or to a higher effectiveness of newly hired teachers in public schools.

The most immediate effect of the differentiated voucher program was the increase in per-student expenditures. This rose in public and voucher schools on average, with the largest increase in public schools.

Finally, average standardized scores are highest in elite private schools, followed by voucher schools, then public schools. This is consistent with the differences in socioeconomic characteristics of students among the three school types. However, while the differentiated voucher program increased public schools test scores, the effect on voucher school average test scores was more modest and even somewhat negative in the first year of the program.

5 Empirical Strategy

I use two sources of variation to analyze the effects of the differentiated voucher program on enrollment choices, school characteristics, and achievement. The first is the timing of the policy, and the second is exogenous variation on students' 1st grade enrollment year.

The differentiated voucher program was implemented in 2008 but, due to the information issues explained above, the distribution of information was slow. Consequently, enrollment responses were smooth over time, as shown in figure 2, since in practice, parents of eligible students faced a new increase in school choice as they became more informed. This implies that all students who enrolled in 1st grade in 2008 or later could have modified their school choices in response to the introduction of the differentiated voucher. Therefore, the cohorts that enrolled in 2008 or later will be considered "treated" cohorts.

The second source of variation originates in Chile's enrollment cutoff dates for 1st grade. The official enrollment cutoff in Chile is March 31: all students whose sixth birthday is later than March 31 should delay enrollment by one year. However, in practice, a decree from the Ministry of Education allows schools to apply later enrollment cutoffs with the latest possible being June 30. This cutoff

[11]The average teacher evaluation score is the score assigned to teachers in public schools by an institution associated with the Ministry of education based on the analysis of a recording of a class and the teaching materials prepared by the teacher, together with a self-evaluation, an evaluation by a peer teacher and by managers. It intends to evaluate the effectiveness of the teacher and this evaluation is compulsory for teachers in public schools since 2005. Teachers newly hired in public schools are not evaluated on the first year of experience.

is the most common in Chile, as shown in McEwan and Shapiro (2008), and is the one I will use in this paper.

The June 30 enrollment cutoff implies that, for example, students whose sixth birthday was between April 1 and June 30, 2007, had a positive probability of enrolling in 1st grade in 2007, while students whose sixth birthday was after June 30, 2007, had essentially zero probability.

As a result, the enrollment cutoff creates a discontinuity in enrollment probability and, consequently, in exposure to the differentiated voucher for students enrolling in 2007/2008. This set up can be used in a regression discontinuity Design to determine the effects of the differentiated voucher on enrollment choices and achievement.

Let $y_i(1)$ be the outcome of interest for student i if he was exposed to the increased school choice caused by the introduction of the differentiated voucher at the time of enrollment, and let $y_i(0)$ be the outcome if he was not exposed at time of enrollment. Ideally, I would compute the average impact of the increase in the number of free voucher schools on enrollment choices and test scores as: $\alpha = E(y_i(1) - y_i(0))$.

Since this is not possible, I will compare students whose sixth birthday was on or before the June 30 enrollment cutoff for 2007, 2008 and 2009 to students whose sixth birthday was after those enrollment cutoffs and hence had to delay enrollment to 2008, 2009 and 2010. Eligible students who had to delay enrollment were more informed and, in practice, exposed to an increase in the proportion of free voucher schools, thanks to the differentiated voucher.

Due to the two enrollment cutoffs within the same year, enrollment is not a deterministic function of date of birth for students who were born between April 1 and June 30. Consequently, date of birth affects the probability that a student is exposed to the increase in school choice at the time of enrollment in the following way: $1 = P(T = 1|B > 0) > P(T = 1|B \leq 0) > 0$, where T is the probability of being exposed to the increase in school choice for eligible students at time of enrollment, and B is the distance from the sixth birthday to the June 30th enrollment cutoff (see figure 3 for the 2007/2008 example).

This implies that the regression discontinuity design estimates that use the date of birth as the running variable are actually intent-to-treat (ITT) estimates. Assuming that birth dates are random and that student characteristics are continuous near cutoffs, [12] in the absence of other confounders, the regression discontinuity estimator would provide unbiased estimates of the effects on the outcome of interest of being born at either side of the cutoff. The intent-to-treat RD estimate for the

[12] Table A1 in the appendix shows that there are no significant differences in socioeconomic characteristics of students born at either side of the cutoff. However, Table A2 shows that density of births is not stable around the cutoff. Cesarean sections are widely used in Chile and not performed on weekends. In two of the five cohorts used, July 1 fell on a weekend, which could be causing the fall in density of births. Additionally, this policy was discussed for the first time in October 2005, therefore, since mothers of students that turned six around the 2007/2008 enrollment cutoff got pregnant in 2000/2001, it is impossible that there was manipulation of day of birth in response to the differentiated voucher program. Nevertheless, since the fall in density is similar for the pre-policy and post-policy periods, the full empirical strategy will account for the possible bias.

differentiated voucher effect is given by:

$$\alpha_{ITT,RD} = lim_{B\downarrow 0}E[y|B] - lim_{B\uparrow 0}E[y|B]$$

Which can be obtained by estimating the following equation through ordinary least squares:

$$y_i = \beta + \theta Post_i + f(B_i) + \epsilon_i \tag{1}$$

where B is the distance from the sixth birthday to the June 30 enrollment cutoff, $Post_i$ is an indicator variable that equals 1 if the student was born after the enrollment cutoff, and $f(B_i)$ is a flexible parametric specification that includes higher-order polynomials of sixth birthday and can vary on either side of the enrollment cutoff. My main specification uses a linear spline on sixth birthday distance to cutoff interacted with a dummy indicating whether the student falls to the left or the right of the cutoff. The coefficient θ in (1) represents the estimate of the intent-to-treat effect of the differentiated voucher, $\hat{\alpha}_{ITT,RD} = \hat{\theta}$.

It is possible that there existed pre-trends on enrollment choices, since as seen in the previous section, enrollment in public schools was already falling before the differentiated voucher. There may also be or that there are "age-at-test" or "enrollment age" effects. For example, McEwan and Shapiro (2008) show increases in fourth grade standardized test scores of more than 0.3 standard deviations due to the differences in age caused by the enrollment cutoffs. In this case, the regression discontinuity estimate from above would also capture these confounders, leading to biased estimates.

Assuming that the confounder is constant over time, the RD estimate for years prior to the differentiated voucher program would converge to λ, where λ is the pre-existing trend on enrollment or the "age-at-test" or "enrollment age" effect, while the RD estimate for the initial years of differentiated voucher existence would converge to $\lambda + \alpha$.

Thus, I take differences of the RD estimators to account for these possible confounders (Carneiro, Løken and Salvanes, 2015).[13] By estimating equation (1) for years prior to the differentiated voucher program was in place, I obtain $\hat{\theta}_{pre} \rightarrow \lambda$. Then, I obtain an estimate for $\hat{\theta}_{post} \rightarrow \lambda + \alpha$ through the estimation of (1) for the cohorts that enrolled once the differentiated voucher had been implemented, from 2008 on. Finally, I can estimate the effect of the reform as $\hat{\alpha}_{RD-D} = \hat{\theta}_{post} - \hat{\theta}_{pre}$.

The RD-D estimate can also be obtained by interacting a "treated" term in regression (1), as follows:

$$y_i = \beta + \theta Post_i + \rho Treated_i + \alpha Post_i \times Treated_i + f(B_i) + u_i \tag{2}$$

where $Treated_i$ is an indicator equal to one if the student belongs to the cohort that enrolled in 2007/2008 or later, $f(B_i)$ is additionally interacted with $Treated_i$, and the other variables are

[13]Table A2 in the appendix shows that there is a fall in the density of students born after the enrollment cutoff. This fall, however, is stable over time, so the differences in RD estimates will account for this potential bias.

defined as above.

The coefficient on the interaction of the dummy for whether the student was born after the enrollment cutoff ($Post_i$) and the indicator for whether the student belongs to the cohort exposed to the program ($Treated$), $\hat{\alpha}$, estimates the intent-to-treat effect of the program.

I will focus my analysis on a 90-day window around the June 30 cutoff, with day 0 representing the last cohort "untreated". Results are robust to the use of alternative bandwidth sizes.

6 Complier Characteristics

The introduction of the differentiated voucher increased the number of free private schools for eligible students, as shown in Figure 1, and, consequently, incentivized eligible students to enroll in voucher schools accepting the differentiated voucher instead of public schools.

However, as discussed previously, there is indication that information on the differentiated voucher did not disseminate instantaneously. Information about eligibility was hard to understand or to access, since from 2010 on, the information was distributed online, what could prevent the poorest families from accessing it. This implies that less educated families may have had more trouble accessing and understanding eligibility information and therefore, have not been able to respond in their enrollment choices to the program. Additionally, as suggested by Carrasco et al. (2014), voucher schools may still have been selecting students, so not all eligible students may have faced the same school choice at time of enrollment.

This section takes into account these facts and investigates the characteristics of students who took advantage of the increased school choice to enroll in voucher instead of public schools.

Imagine the simplest case in which students can be "induced" to treatment or not, where this is denoted by the binary variable Z_i. Treatment is binary and represented by variable D_i, and X_i is an indicator for whether student i has predetermined characteristic X. Denote D_{0i} the value that D_i would have taken if $Z_i = 0$, if the student was not induced to treatment, and D_{1i} if $Z_i = 1$. Then, extending Abadie (2002), in this simple case I can compute the proportion of compliers that had characteristic X as:

$$P(X_i = 1 | D_{1i} > D_{0i}) = \frac{E[X_i D_i | Z_i = 1] - E[X_i D_i | Z_i = 0]}{E[D_i | Z_i = 1] - E[D_i | Z_i = 0]}$$

Following this logic, I can use two-stage least squares to compute the proportion of students with characteristic X that enrolled in voucher schools instead of public schools in response to the differentiated school voucher program with the following system:

$$D_i = \theta + \psi Post_i \times Treated_i + \phi Post_i + \eta Treated_i + g(B_i) + \nu_i \tag{3}$$

$$X_i \times D_i = \alpha + \beta Post_i + \rho Treated_i + \gamma D_i + f(B_i) + u_i \tag{4}$$

where D_i is an indicator variable equal to one if student i enrolled in a voucher school in 1^{st} grade, $Post_i$ an indicator variable that equals one if the student was born after the enrollment cutoff, $Treated_i$ an indicator variable for whether the student belongs to the "treated" cohorts, and $g(B_i)$ and $f(B_i)$ are linear splines on distance of sixth birthday to enrollment cutoff, interacted with whether the student was born to the right or left of the cutoff and interacted again with the $Treated_i$ indicator.

The coefficient γ in equation (4) gives the proportion of compliers with characteristic X. In this case, students "induced" into treatment would be those born after the enrollment cutoff in the "treated" cohorts, as they faced increased school choice.

Since information disseminated slowly, more parents learned about the increase in school choice every year following the introduction of the differentiated voucher. Therefore, students who turned six after the enrollment cutoff for 2007, 2008 and 2009 had more information and were more likely to benefit from the increased school choice and enroll in voucher instead of public schools than students born before the enrollment cutoff for these years. The slow dissemination of information is consistent with the increase in the proportion of compliers over the period, as shown in Figure 2. Thus, I will consider students born around the 2007, 2008 and 2009 enrollment cutoffs as students in the "treated" cohorts.

For this system to identify the characteristics of compliers, the *monotonicity assumption* needs to hold. That means, all students that were exposed to the increase in school choice had to change enrollment decisions in the same direction. Therefore, all students that responded to the increase in school choice had to increase the probability of enrolling in voucher schools only.

I provide suggestive evidence that this assumption holds by looking at the effect of the introduction of the differentiated voucher program on the probability of enrolling in different types of schools in Table 3. First of all, results show that even though almost 50% of the population was eligible, the probability of enrolling in a public school only fell in around 1.5%. This amount is the percentage of compliers in the population.

Regarding the monotonicity assumption, results show a significant decrease in the probability of enrolling in public schools in the post-policy cohort with respect to the pre-policy cohort and a corresponding increase in the probability of enrolling in voucher schools. These two coefficients are significant and very similar, indicating that almost all students that did not enroll in public schools enrolled in voucher schools instead. Row (C) shows no significant changes in the probability of enrolling in elite private schools, which additionally suggests that students were not exiting voucher schools to avoid differentiated voucher users. These results give support to the monotonicity assumption and suggest that the system of equations (3) and (4) should identify the characteristics of students that enroll in voucher schools instead of public schools.

Unfortunately, this approach cannot be used to estimate effects on test scores for students that switched enrollment decisions in response to the increased school choice. Since the differentiated voucher could have induced changes in schools through changes in student composition or increased funds, the *exclusion restriction* does not hold in this case. This means, the introduction of the differentiated voucher could be correlated directly with test scores, independently of changes in enrollment of the individual student.

Results for the characteristics of compliers can be found in column (1) of Table 4. Since standard errors are very large, partly due to the small first stage on voucher enrollment, the estimated proportions of students in each group add up to slightly more than one. Regardless, about 90% of compliers belong to the group of students with mothers that completed high school education, while the remainder of compliers had mothers with basic education or less. Additional complier characteristics can be found in Table A3 in the appendix.

When comparing these proportions to the proportions in the actual population in column (2), it can be observed that "compliers", students that switched enrollment decisions in response to the program, come overwhelmingly from the group of students with mothers that completed high school. These results suggest that, either due to information issues or to selection on the school side, compliers were the wealthiest eligible students in the school market.

As discussed above, another difficulty is that the proportion of eligible students is not stable over time, due to the change of the instrument and to gaming by citizens to gain access to other social benefits. Thus, eligibility information cannot be used to classify students.[14]

In view of the results in Table 4, I can use the classification of students by mother education level to define three groups of students depending on their responses to the differentiated voucher program: (1) students with mothers that completed basic education or less, who are eligible but are not highly represented in the group of compliers, (2) students with mothers that completed high school, who represent the majority of compliers and, (3) students with mothers that completed university that are mostly not eligible and in most cases were already enrolled in voucher and elite private schools.[15]

The proportion of students that belong to each group is fairly constant over time, as shown in Table 5. Thus, I will use these three categories of students to determine the effects of the differentiated voucher in the next section.

As can be observed in Table 6, all of these groups contain students in public and private schools together with compliers (as discussed for Table 5). However, enrollment patterns show that students with mothers that had basic education or less generally attend public schools, the group with mothers that completed high school contains students in public and private schools, together with

[14] The instrument used to determine eligibility was introduced in 2007, and it was not administered to students who could be eligible for the differentiated voucher until 2009.

[15] Summary statistics for students in each group in the post-policy period can be found in Table A4 in the appendix.

most compliers, and the majority of students with mothers that completed university are enrolled in private and elite private schools.

7 Results

This section presents three sets of results. The first illustrates the effect on 1st grade enrollment decisions of the increase in school choice caused by the introduction of the differentiated voucher program. The second looks at changes in school characteristics encountered by students. Finally, the third examines the effects of the differentiated voucher on standardized test scores.

Results are presented in two different ways, a figure and a table. First of all, differences in individual cohort RD estimates with respect to RD estimates for the last pre-policy cohort (2006/2007) and their 95% confidence intervals are presented for all three groups of mother education in a figure. Then, RD estimates pooling all pre-policy cohorts and all post-policy cohorts and differences in these RD estimates are presented in a table.

In the figure, each one of the differences in RD coefficients represents the increase/decrease in the outcome of interest for students who were born after the enrollment cutoff for that individual cohort once possible stable confounders, such as "age-at-test" effects, are taken into account. Difference in RD coefficients for cohorts that enrolled in 2007/2008, and subsequent cohorts, with respect to the RD coefficient for 2006/2007 estimate the effect of the differentiated voucher once the confounder has been accounted for. Therefore, if the difference in RD coefficient for the cohort that enrolled in 2007/2008 is positive and significant, that means that the effect on the outcome of the differentiated voucher is positive.

With regard to the table, the corresponding table presents RD coefficients of the outcome of interest and differences in the RD coefficients for all three groups of mother education. Column (1) presents estimates of the confounders, that means, RD coefficients pooling all pre-policy cohorts (students within 90 days of the enrollment cutoff for years 2005 and 2006), column (2) RD coefficients using all post-policy cohorts (students within 90 days of the enrollment cutoff for years 2007, 2008 and 2009) and columns (3) shows the RD-D estimates, the difference between the post-policy RD estimate with respect to the pre-policy RD estimate.

As mentioned in the empirical strategy section, all the reported differences in regression discontinuity estimates are differences in intent-to-treat (ITT) estimates, since the probability of enrolling in the next year does not sharply increase from 0 to 1 for students born after the enrollment cut-off. This probability, that would correspond to the first stage in a fuzzy regression discontinuity design, increases by around 0.4 for students born after the enrolment cutoff. Therefore, if we were interested in the average treatment on the treated (ATT) effects, these results would be roughly similar to the presented estimates multiplied by one over 0.4, that means, by 2.5.

7.1 Enrollment choices

One of the immediate effects of the differentiated voucher program was an increase in the number of free voucher schools for eligible students in 2008, shown in Figure 1. However, as discussed above, due to informational problems, enrollment responses are likely to have happened also in later years, as parents slowly learned about the differentiated voucher program, eligibility and school participation.

In response to the increase in school choice, Figure 4 and Table 7 show that there was a decrease in the probability of enrolling in public schools with respect to the pre-policy cohorts for students with mothers that had basic education or less and students with mothers that completed high school education of around 1.6%. Given the magnitude of the program, this result is perhaps surprising: even though around 50% of the population was eligible, only around 1.5% of all students switched enrollment decisions in response to the differentiated voucher program in the first three years of the program. However, as the differentiated voucher was a reform to the existing voucher system, it is possible that most eligible students with a strong preference for voucher schools were already enrolling in voucher schools.

Additionally, this fall was significant only for students with mothers that completed high school, which is expected, 90% of students that switched enrollment decisions belonged to this group. Students with mothers that completed high school were more likely to respond in their enrollment decisions than students with less educated mothers for two reasons: (1) better understanding and access to differentiated voucher program and eligibility information, and (2) student selection by voucher schools, even though it was forbidden, as argued by Carrasco et al. (2014).

For this group, the fall in enrollment in public schools already occurred in the first year of the program, but enrollment in public schools fell at about the same rate in the following year and even more rapidly two years after the introduction of the differentiated voucher. This persistent effect in the decrease in enrollment in public schools is consistent with the slow distribution of information over time.

Students that switched enrollment decisions in response to the differentiated voucher program may have enrolled in schools with different characteristics. Using a parallel technique to the previous section, I instrument enrollment in voucher and public schools, in a two-stage least squares system, to compare public schools where students would have enrolled in the absence of the differentiated voucher program (counterfactual public schools) to voucher schools where students actually enrolled (destination voucher schools) at baseline.

Formally, I run the following two-stage least squares system:

$$D_{it} = \theta + \psi Post_i \times Treated_i + \phi Post_i + \eta Treated_i + g(B_i) + \nu_i \tag{5}$$

$$S_i \times D_{it} = \alpha + \beta Post_i + \rho Treated_i + \gamma D_{it} + f(B_i) + u_i \quad (6)$$

where D_it is the probability of enrolling in school of type t, S_i is the school characteristic of interest, and $Post_i$, $Treated_i$ and $g(B_i)$ and $f(B_i)$ are as defined above. The coefficient γ in equation (6) gives the average of characteristic S for voucher schools where compliers enrolled or for counterfactual public schools, public schools where compliers ceased to enroll.

This method cannot be used to look at current school characteristics since the *exclusion restriction* may not hold for current characteristics. If schools experience changes in characteristics in response to compliers leaving public schools and enrolling in voucher schools, to the increased funds or to more school competition, then the introduction of the differentiated voucher program would be directly correlated with school characteristics. Thus, the two stage least squares system would not only be estimating the changes in school characteristics due to changes in complier choices.

Table 8 shows that, at baseline, students that enrolled in voucher schools instead of public schools thanks to the differentiated voucher, enrolled in smaller voucher schools that had, on average, class sizes about five fewer students. These schools had higher test scores and better socioeconomic composition, with a larger average socioeconomic index, about 20% fewer students with less educated mothers, and around 13% more students with highly educated mothers. Schools where students enrolled, however, had around 10% fewer teachers with a completed degree in education with respect to the public schools where they would have enrolled, and teachers had on average around five years less experience and were approximately ten years younger. Finally, schools where students enrolled had higher teacher per student ratios at baseline. Therefore, excluding teacher characteristics, due to the introduction of the differentiated voucher, compliers enrolled in higher quality voucher schools at baseline, in terms of peers and test scores, with respect to the public schools they would have enrolled if the differentiated voucher had not been introduced.

It is possible however, that even though compliers, students that changed their enrollment decisions, enrolled in higher quality schools at baseline, the schools where they actually enrolled were low quality voucher schools. This is analyzed in Table 9, that shows information on the position at baseline of public schools where students would have enrolled and voucher schools where students did enroll in the distribution of some characteristics relative to the other schools of the same type in the municipality.

In the absence of the differentiated voucher, compliers would have enrolled in public schools with large class sizes and enrollment with respect to other public schools in the market. Thanks to the increase in school choice, they ended up enrolling in voucher schools with small class sizes and enrollment with respect to voucher schools. These suggest that compliers may have stopped enrolling in large public schools to enroll in small and undersubscribed voucher schools.

With regard to school quality at baseline, both counterfactual public schools and destination voucher schools had test scores below the median for their type in the municipality. This means that compliers enrolled less in low quality public schools to enroll more in low quality voucher schools. However, even though the counterfactual public schools and destination voucher schools were low quality with respect to other schools, compliers enrolled in voucher schools with higher test scores at baseline with respect to counterfactual public schools, as discussed for Table 8.

Socioeconomic characteristics of counterfactual public schools and destination voucher schools are not particularly different from socioeconomic characteristics of other public and voucher schools in the market. But these schools do look different in terms of teacher education since both counterfactual public schools and destination voucher schools, had a lower percentage of teachers with a degree in education with respect to other schools of the same type. Finally, voucher schools where compliers enrolled were "cheap" voucher schools, since they were in the bottom half of the distribution of copays in the area.

In conclusion, the increase in school choice caused by the introduction of the differentiated voucher program reduced public school enrollment by around 1.6%. Students switching enrollment decisions enrolled in voucher schools with better socioeconomic characteristics and test scores at baseline with respect to public schools where they would have enrolled in the absence of the program. However, they decided not to enroll in low achieving public schools to enroll in undersubscribed, low-copay, low achieving voucher schools.

7.2 School characteristics

The previous section discussed changes in enrollment decisions due to the increased school choice caused by the differentiated voucher program, and changes in school characteristics at baseline due to the decision to enroll in a voucher school instead of a public school. Since it is possible that voucher and public schools experience changes in their characteristics due to compliers changing enrollment decisions, to the increased school resources or to increased competition, this section looks at the current school characteristics that students encountered in the year they enrolled. Changes in school characteristics caused by enrollment responses of compliers, however, are likely to be small, as only about 1.6 percent of students in the lowest groups of mother education responded to the policy.

Unfortunately, the differentiated voucher program is likely to have caused a direct effect on current school characteristics, violating the *exclusion restriction*. Therefore, it is not possible to characterize counterfactual public schools and destination voucher schools using two stage least squares, as in the previous section.

For this reason, this section analyzes changes in school characteristics on average for each of the three groups of students by mother education, pooling together students enrolled in public schools, students enrolled in voucher schools and students that switched enrollment in response to the differentiated voucher.

However, given the enrollment patterns in each of the three groups (shown in table 6) and since 90% of compliers belong to the group of students with mothers that completed high school education, students with mothers with less than high school will generally remain in public schools, students with mothers that completed high school include most compliers and students in voucher and public schools, and students with mothers that completed university include students that were usually already enrolled in voucher or elite private schools.

Since the proportion of students that switched enrollment decisions was small, around 1.6%, on average there were no significant changes in average socioeconomic index in schools where students of each group enrolled in 1st grade, as shown in Figure 6 and Table 11. Public schools where compliers would have enrolled in the absence of the program were barely affected, as were voucher schools where compliers did actually enroll. Table 8 showed an improvement in socioeconomic characteristics of schools at baseline for compliers, but since they are so few, these effects are not visible on average, and are probably cancelled out with the very light decrease in socioeconomic characteristics of voucher schools where they enrolled.

With regard to class size, Table 8 showed that compliers enrolled in voucher schools that had on average class sizes that were about 5 students smaller at baseline. Again, since they were so few, it is unlikely that they affected class sizes in voucher schools where they enrolled or in public schools where they would have enrolled.

Figure 6 and Table 11 look at the average effects on current average class size for students in each of the three groups of mother education. Average class size decreased, but insignificantly, for students with mothers that had basic education. These students were primarily enrolled in public schools, where class size fell somewhat, as discussed in the descriptive statistics, but not significantly. Students with mothers that completed high school experienced significant decreases in class size and found, on average, classes that were around half a student smaller. This fall in class size is due to the enrollment by compliers in schools with smaller class sizes, together with the very small decrease in class sizes for students in this group left behind in public schools. Finally, students whose mother completed university education did not experience changes in class size.

Another large difference in characteristics at baseline between counterfactual public schools and voucher schools where compliers actually enrolled were teacher characteristics. Particularly, teachers in voucher schools where compliers enrolled had, on average, five years less experience than teachers in public schools where these students would have enrolled. Consistently, panel B in figure 7 and row (C) in Table 12 show a significant decrease in teacher years of experience for students with mothers that completed high school, the group that includes most compliers.

Unexpectedly, there is also a fall in teacher years of experience for students with uneducated mothers, which is larger than for students with mothers that completed high school. This suggests that, additionally, there was a decrease in average teacher experience in public schools in 2008, as was already visible in the summary statistics Table 2.

This seems related to a replacement of highly experienced teachers, teachers with, on average, 25 years of teaching experience, with less experienced teachers, that had, on average, 10 years of teaching experience, particularly in public schools, as suggested by Figure 8 and Table 13, and the summary statistics Table 2. Figure 8 and Table 13 illustrate increased hiring of teachers in the first year of the program particularly in schools where most students with uneducated mothers were enrolled. When considering the whole treatment period, this effect is significant and largest for students with mothers that completed high school, since descriptive statistics in Table 2 suggest increased hiring in 2009 and 2010 in voucher schools.

This is weak evidence that there were responses on the school side and that schools where these students were enrolling responded to the increased competition or to the introduction of achievement goals by restructuring their teaching teams.

To summarize, on average there were no changes in peer characteristics, but students with mothers that completed high school had smaller class sizes and less experienced teachers. Students with uneducated mothers also had a decrease in average teacher years of experience, which seems related to responses to the differentiated voucher program on the school side, particularly from public schools, and to a replacement of highly experienced teachers by less experienced teachers.

7.3 Test scores

Figure 9 and Table 14 show the effect on average 4^{th} grade test scores in a standardized exam for students in each group of mother education. Test scores for students with uneducated mothers that enrolled in 1^{st} grade in 2008 and later, and took the standardized exam in 2011 or later, increased significantly, by around 0.08 standard deviations. These students are the ones that generally stayed in public schools and that had a decrease in average years of teaching experience in their schools as a result of changes in teaching teams. This result suggests that students with uneducated mothers could have benefited from the increased perceived competition by public schools, and that the introduction of less experienced teachers could be a possible channel through which public schools were responding.

With regard to students with mothers that completed high school education, on average there were no effects on test scores. This group includes most students that switched enrollment decisions in response to the differentiated voucher. These students enrolled in schools with better peer characteristics and achievement at baseline, and lower class sizes, and younger and less experienced teachers. Nevertheless, they decided not to enroll in low achievement public schools to enroll in low achievement voucher schools. Consequently, the improvement in observable characteristics of schools may not have been sufficient to increase test scores for these students. Additionally, as compliers were so few, it is possible that their test scores increased or decreased somewhat but that these effects are not large enough to be visible on average for the group of students with mothers that completed high school education.

In the case of students in this group already enrolled in voucher schools, changes in school characteristics were very small, given the proportion of compliers, so their test scores may have stayed constant. Finally, regarding students in this group enrolled in public schools, even though socioeconomic characteristics in these schools could not significantly change, they did experience a change in teaching teams. Since their initial test scores were already higher than for students with uneducated mothers, it is likely that changes in test scores were smaller. However, if we believe that there may have been some positive effect on test scores for that group, that would imply that there was some small decrease in test scores for compliers or for students that were already enrolled in voucher schools, as summary statistics in Table 2 suggest. Nevertheless, none of these possible effects on test scores is sufficiently large to lead to significant effects on test scores, therefore, there were no observable effects on test scores for students with mothers that completed high school education.

Finally, test scores for students with highly educated mothers did not change either. In this case this is expected, since students in this group did not have any significant change in school characteristics or in enrollment decisions.

In short, there were no obvious direct effects on test scores for students that took advantage of the increased school choice and enrolled in voucher schools instead of public schools. In contrast, there were positive effects on test scores for the poorest students, those with uneducated mothers, that could be related to the change in teaching teams in public schools that took place in 2008. Therefore, on aggregate, the effects on test scores were positive but very small and insignificant, and led by responses to the program by public schools instead of by re-sorting of students.

8 Conclusion

Even though the effects of school choice on educational outcomes have been broadly studied, particularly for students enrolling in better schools, there is still limited evidence on the effects of large-scale programs. Large-scale programs could affect the sorting of students, or induce responses on the school side to increases in competitive pressure, leading to different effects on achievement for students switching enrollment, and affecting all students in the market. For that very reason, it is generally difficult to measure the effects of large-scale school choice programs, since there is no group of students unaffected by the program.

The literature has generally looked at aggregate effects of such programs (e.g., Hsieh and Urquiola), or used structural estimation (e.g., Neilson, 2013) to determine the effects on educational outcomes. In this paper, I combine two sources of variation that allow me to identify: (1) the proportion and characteristics of students switching enrollment decisions in response to an increase in school choice caused by a large-scale program, (2) the characteristics at baseline of schools where students switching enrollment decisions enrolled and the characteristics of schools where they would have enrolled in the absence of the policy and (3) changes in enrollment decisions, current school characteristics and test scores for all students in the population, divided in groups that were affected differently by the program.

My first result is that, despite the magnitude of the program, the impact on re-sorting of students was small. Only around 1.5% of students switched enrollment decisions. However, this program was a reform to the existing voucher system in Chile, therefore, it is likely that most of the re-sorting had already occurred before the policy.

Additionally, students that switched enrollment decisions were among the wealthiest eligible students, which is consistent with "cream-skimming" in the presence of selection by private schools and with imperfect information, especially for the poorest families. Both seem to be the case in Chile. Therefore, a small implication is that for such a policy to re-sort the poorest students, information should be clear, with all population understanding the program and their eligibility status, and non-selection by private schools should be enforced.

My second result shows that compliers, students switching enrollment decisions, enrolled in schools that had better observable characteristics at baseline than schools where they would have enrolled in the absence of the policy. Regarding current characteristics, schools where the group of students that included most compliers enrolled had smaller class sizes and less experienced teachers (in most cases with at least five years of teaching experience). Despite this improvement in school characteristics, there are no effects on average test scores for the group of students with most compliers. This result would be consistent with either small positive or negative effects on average test scores for compliers, and is in line with the results of some literature on the effects of attending a better school (e.g., Abdulkadiroglu et al., 2011; Dobbie and Fryer, 2014). Additionally, this result fits well with Neilson's (2013) result that most of the effect on test scores of the differentiated school voucher in Chile came through indirect channels, instead of through re-sorting of students.

Finally, a third, perhaps surprising result is that test scores increased for the group of students most likely to stay in public schools. This result could be due to an increase in competitive pressure, as argued by Neilson (2013), and a subsequent increase in quality in public schools (e.g., Figlio and Hart, 2014). My analysis uncovers one potential channel through which public schools could be responding: there is an increase in hiring in public schools in the first year of the program that resulted in lower average experience of teachers in public schools.

Further research is needed to understand what were the actual underlying mechanisms behind the increase in test scores in public schools. Understanding the reasons why public schools succeeded in improving achievement is essential to design strategies to increase learning in all school types.

Overall, the effect of the differentiated voucher program on test scores was positive, but small and not significant. However, it did increase test scores for the poorest students in the population, closing the test score gap. This policy increased public expenditure in education by 8%, close to 0.3% of Chile's GDP. An open question is whether the same test score effects could have been achieved through increased resources and monitoring of public schools, instead of an increase in the school voucher, which would have reduced the cost of the policy.

Even though the particular effects of the program may be specific to Chile, there is a conclusion that can be generalized. Public schools seem to have responded to the increase in potential competition. Consequently, the differentiated voucher program was successful in increasing achievement in public schools, despite the small effects on re-sorting of students. Therefore, education policies may have effects beyond those for targeted students. These general equilibrium effects need to be taken into account when designing policies.

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Tables and Figures

Figure 1: Changes in school choice: Proportion of voucher schools that are free for eligible students

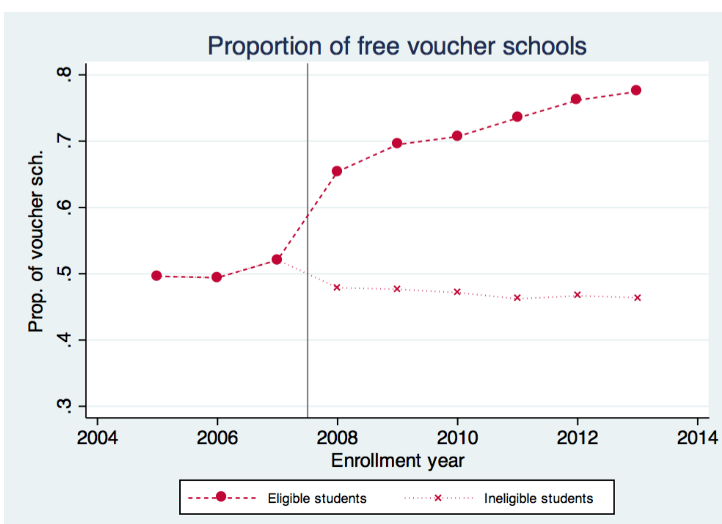
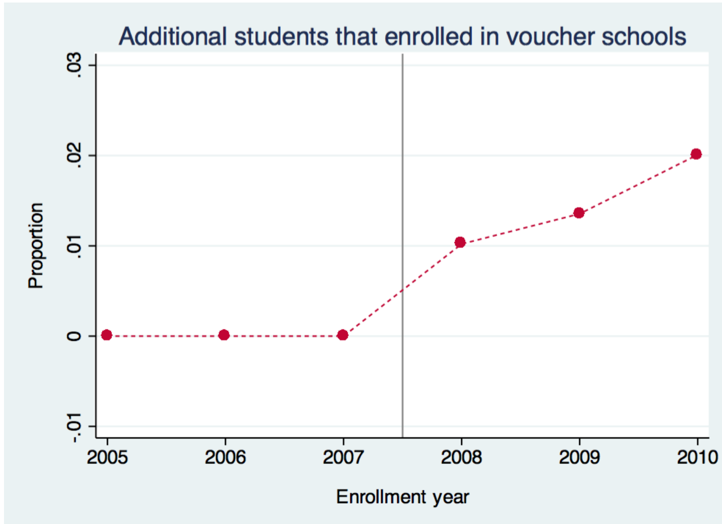


Figure 2: Changes in school choice: Slow distribution of information



Notes: This graph represents the proportion of students that enrolled in voucher schools instead of public schools in response to the introduction of the differentiated voucher. Each observation represents the RD coefficient of the probability of enrolling in a voucher school for students born after the enrollment cutoff using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff.

Table 1: Sample summary statistics by enrollment year

School year	2005	2006	2007	2008	2009	2010
Total students in 1st grade	260,724	251,602	256,040	248,921	247,575	241,203
Enrolled in public schools	0.488	0.468	0.450	0.430	0.416	0.397
Enrolled in voucher schools	0.447	0.465	0.482	0.499	0.513	0.528
Average 4th grade standardized score	0.005	0.062	0.145	0.167	0.206	0.175
Total number of schools	8,771	8,697	8,680	8,685	8,665	8,598
Proportion of public schools	0.606	0.596	0.589	0.583	0.576	0.570
Proportion of voucher schools	0.343	0.355	0.362	0.368	0.374	0.381
Proportion of voucher participating schools	0	0	0	0.483	0.581	0.612

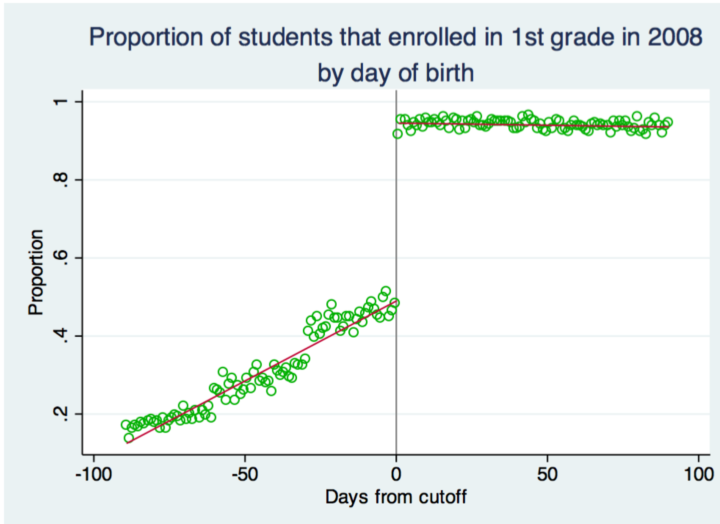
Notes: The chart above lists the descriptive statistics for the sample of students enrolling in first grade in each year. Test scores are comparable over time and normalized with respect to test scores in 2005.

Table 2: School summary statistics by enrollment year

School year	2005	2006	2007	2008	2009	2010
Panel A: Public schools						
Number of students in class (1^{st})	30.5	30.0	30.0	29.3	28.8	28.0
Number of teachers per student	0.043	0.044	0.046	0.047	0.049	0.052
Number of students in school (1^{st}-4^{th})	271.4	238.7	223.5	220.2	208.4	201.6
Average school socioeconomic index (standard dev.=100)	-44.2	-43.3	-45.3	-48.2	-47.6	-51.2
Proportion of mothers with university ed. (1^{st})	0.028	0.031	0.032	0.035	0.037	0.038
Proportion of mothers with basic ed. or less (1^{st})	0.345	0.332	0.341	0.355	0.345	0.321
Teachers with a degree in education (%)	95.6	96.1	96.0	96.8	97.1	97.6
Teaching experience in years	22.9	23.4	23.9	21.8	20.8	20.7
Teacher age	49.2	49.3	49.7	48.1	47.5	47.4
Proportion of teachers hired on year	0.087	0.097	0.080	0.145	0.147	0.133
Proportion of teachers terminated on previous year	0.076	0.104	0.081	0.170	0.130	0.126
Average teacher evaluation scores	2.556	2.581	2.598	2.648	2.621	2.592
Male teachers	0.265	0.265	0.261	0.268	0.268	0.27
Per student expenditure of extra voucher funds (1^{st})	0.0	0.0	0.0	34.9	222.1	407.6
Standardized 4^{th} grade average scores	-0.251	-0.189	-0.091	-0.054	-0.016	-0.055
Panel B: Voucher schools						
Number of students in class (1^{st})	34.4	34.3	34.8	34.6	34.3	34.2
Number of teachers per student	0.04	0.04	0.041	0.041	0.042	0.043
Number of students in school (1^{st}-4^{th})	323.5	285.9	272.2	272.7	257.7	274.9
Average school socioeconomic index (standard dev.=100)	16.4	17.4	16.0	11.5	11.0	6.8
Proportion of mothers with university ed. (1^{st})	0.091	0.095	0.101	0.118	0.118	0.125
Proportion of mothers with basic ed. or less (1^{st})	0.146	0.139	0.143	0.154	0.152	0.138
Teachers with a degree in education (%)	90.8	92.2	91.7	94.2	95.3	96.2
Teaching experience in years	13.4	13.7	13.5	13.5	13.3	13.2
Teacher age	41.6	41.4	41.2	41.2	41.0	40.7
Proportion of teachers hired on year	0.162	0.174	0.176	0.177	0.191	0.196
Proportion of teachers terminated on previous year	0.101	0.126	0.131	0.139	0.140	0.144
Male teachers	0.253	0.248	0.246	0.242	0.241	0.239
Per student expenditure of extra voucher funds (1^{st})	0.0	0.0	0.0	36.0	180.5	300.2
Standardized 4^{th} grade average scores	0.137	0.185	0.251	0.234	0.269	0.223
Panel C: Elite private schools						
Number of students in class ($1^{s}t$)	26.1	26.2	26.4	26.4	26.0	26.2
Number of teachers per student	0.072	0.071	0.071	0.071	0.07	0.07
Number of students in school (1^{st}-4^{th})	283.5	253.0	242.9	260.1	232.9	253.0
Average school socioeconomic index (standard dev.=100)	202.0	201.3	197.9	191.3	191.1	181.5
Proportion of mothers with university ed. (1^{st})	0.507	0.45	0.493	0.625	0.645	0.666
Proportion of mothers with basic ed. or less (1^{st})	0.002	0.002	0.002	0.002	0.003	0.005
Teachers with a degree in education (%)	94.7	94.7	94.7	95.2	95.9	96.2
Teaching experience in years	14.1	14.6	14.7	14.8	15.0	15.1
Teacher age	42.0	42.0	42.0	42.1	42.2	42.1
Proportion of teachers hired on year	0.177	0.138	0.134	0.137	0.133	0.128
Proportion of teachers terminated on previous year	0.120	0.115	0.121	0.120	0.116	0.101
Male teachers	0.226	0.223	0.217	0.228	0.228	0.225
Per student expenditure of extra voucher funds (1^{st})	0.00	0.00	0.00	0.00	0.00	0.00
Standardized 4^{th} grade average scores	0.951	0.945	0.925	0.891	0.903	0.852

Notes: The chart above lists the descriptive statistics of average school characteristics for each school type and year. Average test scores are shown by enrollment year in 1^{st} grade. They are comparable over time and normalized with respect to test scores in 2005.

Figure 3: Probability of enrolling in the next academic year by distance from the date of birth to the June 30th enrollment cutoff



Notes: Each circle above represents the proportion of students that turned six years of age on that day and enrolled in 2008 instead of 2007 within 90 days of the June 30, 2007 enrollment cutoff.

Table 3: Check of the monotonicity assumption - Probability of enrolling in each type of school (All students)

	Difference in ITTs
	(1) Post-Pre
(A) Voucher schools	0.0143***
	(0.0054)
(B) Public schools	-0.0146**
	(0.0061)
(C) Elite private schools	0.0004
	(0.0037)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows the differences in the RD coefficients for the post-policy period (2008-2010) with respect to the pre-policy period (2005-2007) including a full set of cohort dummies.

Table 4: Complier characteristics - Proportion of compliers with each level of mother education (post-policy period)

	(1) Compliers	(2) Population post-policy period
Mother has basic education or less	0.145	0.22
	(0.244)	[0.41]
Mother has high school education	0.889	0.65
	(0.286)	[0.48]
Mother has university education	0.047	0.13
	(0.235)	[0.34]
Average socioeconomic index	-46.82	0.27
	(84.74)	[99.8]

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses and the standard deviations are in brackets. Each coefficient represents a separate regression. Enrollment in voucher school is instrumented with the interaction of the dummy of turning six after the enrollment cutoff and the indicator for belonging to the treated cohorts. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows the complier characteristics including all years in the sample and a full set of cohort dummies. Column (2) shows the proportion of students in each category in the population for the post-policy years (2008-2010).

Table 5: Proportion of students by mother's education and year

	2005	2006	2007	2008	2009	2010
Mothers with basic education or less	0.26	0.24	0.23	0.23	0.22	0.19
Mothers with high school education	0.63	0.64	0.64	0.64	0.65	0.66
Mothers with university education or more	0.11	0.12	0.12	0.13	0.13	0.14
Average years of mother education	11.30	11.50	11.55	11.59	11.55	11.89
Number of observations	260,724	251,602	256,040	248,921	247,575	241,203

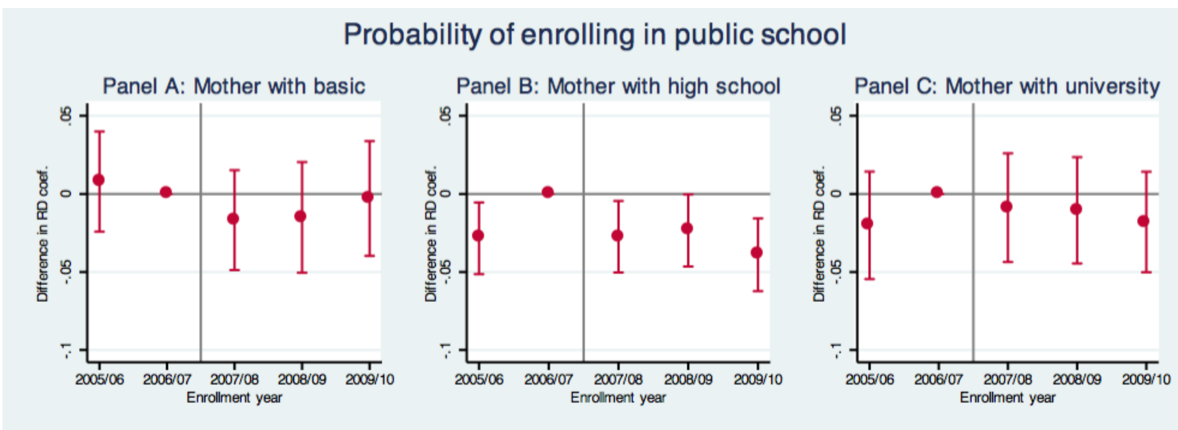
Notes: Includes students in 1st grade.

Table 6: Enrollment patterns by mother's education and year

	2005	2006	2007	2008	2009	2010
Panel A: Mothers with basic education or less						
Public schools	0.72	0.69	0.69	0.66	0.64	0.63
Voucher schools	0.28	0.31	0.31	0.34	0.36	0.37
Elite private schools	0.00	0.00	0.00	0.00	0.00	0.00
Panel B: Mothers with high school education						
Public schools	0.44	0.42	0.41	0.39	0.38	0.35
Voucher schools	0.52	0.55	0.56	0.58	0.59	0.61
Elite private schools	0.04	0.03	0.03	0.03	0.03	0.04
Panel C: Mothers with university education						
Public schools	0.15	0.15	0.14	0.12	0.12	0.11
Voucher schools	0.48	0.52	0.52	0.51	0.51	0.52
Elite private schools	0.37	0.33	0.34	0.36	0.36	0.37

Notes: Includes students in 1st grade.

Figure 4: School choices: cohort RD coefficients - RD coefficient for 2006/07



Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 7: School choices: Probability of enrollment in public schools by mother education level

	ITT estimates		Difference in ITTs
	(1)	(2)	(3)
	Pre-policy	Post-policy	Post-Pre
(A) All students	-0.0123**	-0.0270***	-0.0146**
	(0.0051)	(0.0048)	(0.0061)
(B) Mother with basic education or less	0.0018	-0.0137*	-0.0160
	(0.0082)	(0.0081)	(0.0111)
(C) Mother with high school education	-0.0118*	-0.0271***	-0.0156**
	(0.0063)	(0.0057)	(0.0078)
(D) Mother with university education	-0.0107	-0.0133*	-0.0025
	(0.0089)	(0.0069)	(0.0111)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Table 8: School characteristics at baseline for compliers in post-policy period

	(1) Counterfactual public	(2) Destination voucher	(3) Difference
Class size	34.50	29.55	-4.95
	(4.58)	(3.94)	
Total enrollment	337.1	106.6	-230.5
	(81.4)	(129.8)	
Standardized 4th grade average score	-0.427	-0.006	0.421
	(0.169)	(0.246)	
Socioeconomic index (standard dev.=100)	-33.25	34.06	67.31
	(16.83)	(31.92)	
Proportion of mothers with basic or less	0.298	0.099	-0.199
	(0.094)	(0.097)	
Proportion of mothers with university	0.025	0.157	0.132
	(0.018)	(0.061)	
Teachers with education degree (%)	97.81	88.67	-9.14
	(2.86)	(4.38)	
Average teacher experience in years	21.52	16.48	-5.04
	(2.12)	(2.57)	
Average teacher age	46.22	35.96	-10.26
	(2.65)	(2.39)	
Average teacher per student	0.031	0.062	0.031
	(0.009)	(0.011)	

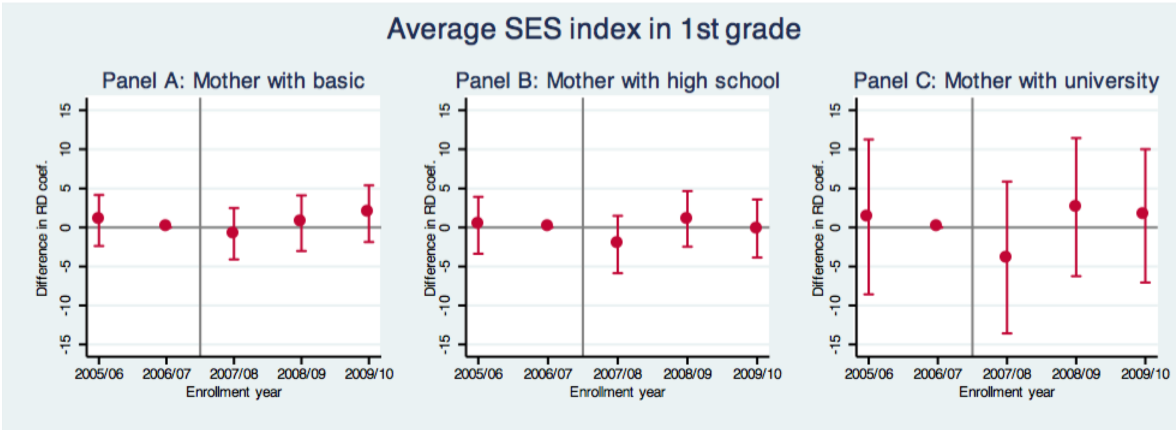
Notes: Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. Enrollment in voucher and public school are instrumented with the interaction of the dummy of turning six after the enrollment cutoff and the indicator for belonging to the treated cohorts. The regressions above use a window of 90 days, include all years and a full set of cohort dummies. They also include a linear spline of distance from birthday to enrollment cutoff.

Table 9: School characteristics at baseline for compliers in post-policy period with respect to schools of the same type in the municipality

	(1) Counterfactual public schools	(2) Destination voucher schools
(A) Class size		
Below the median	0.372	0.811
	(0.220)	(0.224)
Above the median	0.628	0.189
	(0.220)	(0.224)
(B) Total enrollment		
Below the median	0.317	0.751
	(0.239)	(0.237)
Above the median	0.683	0.249
	(0.239)	(0.237)
(C) Standardized 4$^{\text{th}}$ grade average score		
Below the median	0.723	0.806
	(0.213)	(0.222)
Above the median	0.277	0.194
	(0.213)	(0.222)
(D) Socioeconomic index (%)		
Below the median	0.554	0.565
	(0.216)	(0.224)
Above the median	0.446	0.435
	(0.216)	(0.224)
(E) Proportion of mothers with basic or less		
Below the median	0.465	0.606
	(0.207)	(0.223)
Above the median	0.535	0.394
	(0.207)	(0.223)
(F) Proportion of mothers with university		
Below the median	0.614	0.589
	(0.207)	(0.222)
Above the median	0.386	0.411
	(0.207)	(0.222)
(G) Teachers with education degree (%)		
Below the median	0.923	1.060
	(0.183)	(0.239)
Above the median	0.077	-0.060
	(0.183)	(0.239)
(H) Copay amount		
Below the median	-	0.858
	-	(0.243)
Above the median	-	0.142
	-	(0.243)

Notes: Standard errors are clustered by date of birthand are in parentheses. Each coefficient represents a separate regression. Enrollment in voucher and public school are instrumented with the interaction of the dummy of turning six after the enrollment cutoff and the indicator for belonging to the treated cohorts.The regressions above use a window of 90 days, include all years and a full set of cohort dummies. They also include a linear spline of distance from birthday to enrollment cutoff.

Figure 5: Peer characteristics: cohort RD coefficients - RD coefficient for 2006/07



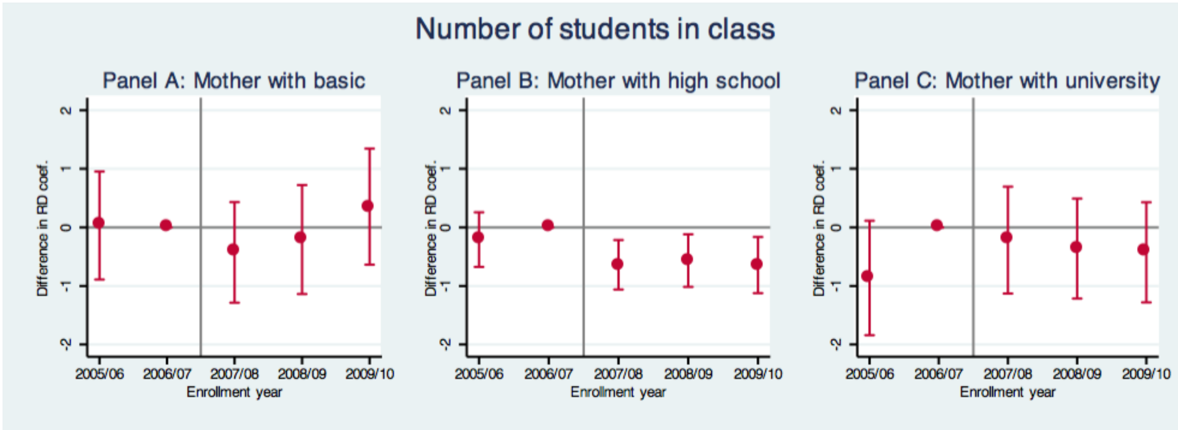
Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 10: School characteristics: Average socioeconomic index in 1st grade (normalized nationally within grade - mean 0, standard deviation 100)

	ITT estimates		Difference in ITTs
	(1) Pre-policy	(2) Post-policy	(3) Post-Pre
(A) All students	4.479***	4.380***	-0.097
	(1.034)	(0.886)	(1.358)
(B) Mother with basic education or less	1.097	1.040	-0.070
	(0.834)	(0.813)	(1.160)
(C) Mother with high school education	3.682***	3.076***	-0.587
	(0.937)	(0.810)	(1.218)
(D) Mother with university education	7.191***	6.555***	-0.626
	(2.520)	(1.948)	(3.150)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Figure 6: School characteristics: cohort RD coefficients - RD coefficient for 2006/07



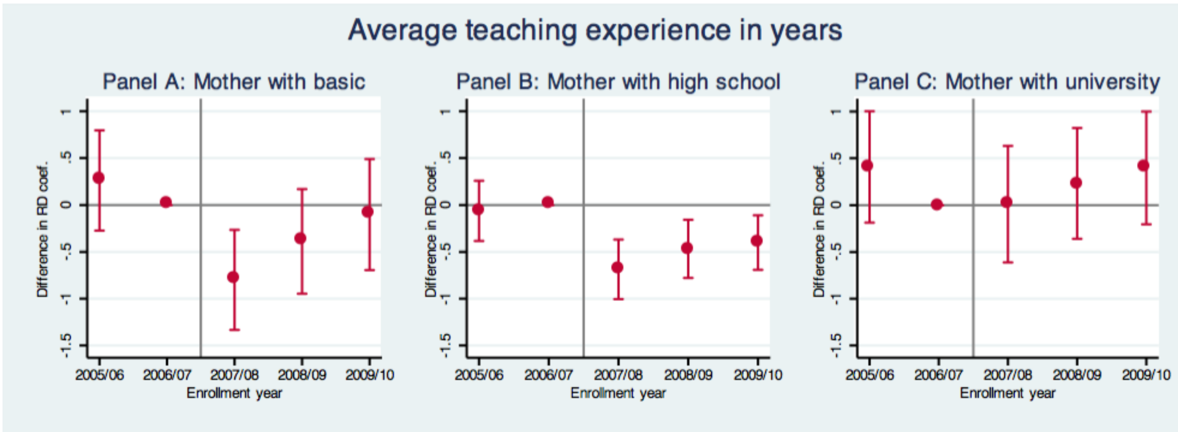
Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 11: School characteristics: Number of students in the class by mother education level

	ITT estimates		Difference in ITTs
	(1) Pre-policy	(2) Post-policy	(3) Post-Pre
(A) All students	0.471***	0.137*	-0.332***
	(0.099)	(0.079)	(0.121)
(B) Mother with basic education or less	0.472**	0.321	-0.154
	(0.239)	(0.212)	(0.315)
(C) Mother with high school education	0.493***	-0.032	-0.515***
	(0.121)	(0.097)	(0.147)
(D) Mother with university education	0.231	0.321*	0.091
	(0.249)	(0.193)	(0.315)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Figure 7: School characteristics: cohort RD coefficients - RD coefficient for 2006/07



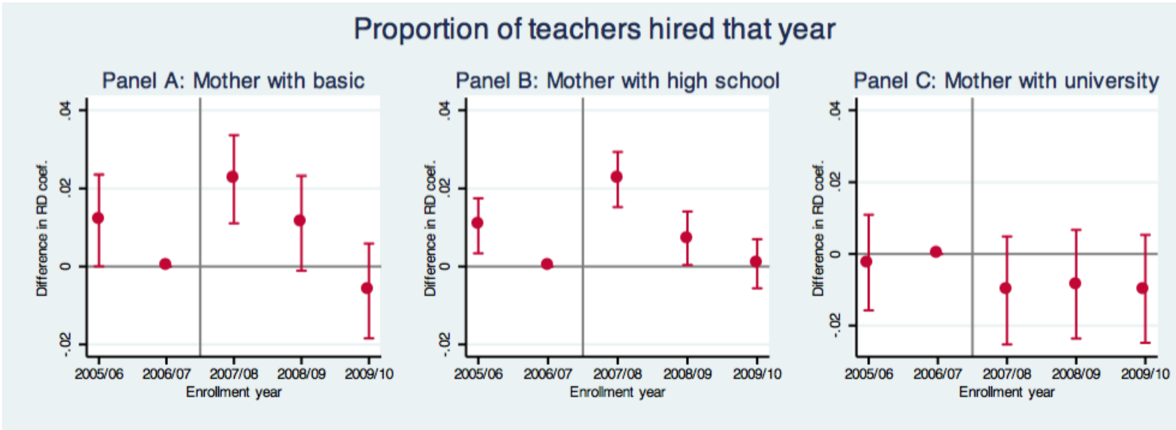
Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 12: School characteristics: Average teacher experience in years in the school by mother education level

	ITT estimates		Difference in ITTs
	(1) Pre-policy	(2) Post-policy	(3) Post-Pre
(A) All students	0.073	-0.343***	-0.411***
	(0.068)	(0.099)	(0.083)
(B) Mother with basic education or less	0.117	-0.468***	-0.590***
	(0.138)	(0.150)	(0.177)
(C) Mother with high school education	0.143*	-0.361***	-0.494***
	(0.082)	(0.102)	(0.104)
(D) Mother with university education	0.058	0.068	0.010
	(0.153)	(0.118)	(0.191)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Figure 8: School choices: cohort RD coefficients - RD coefficient for 2006/07



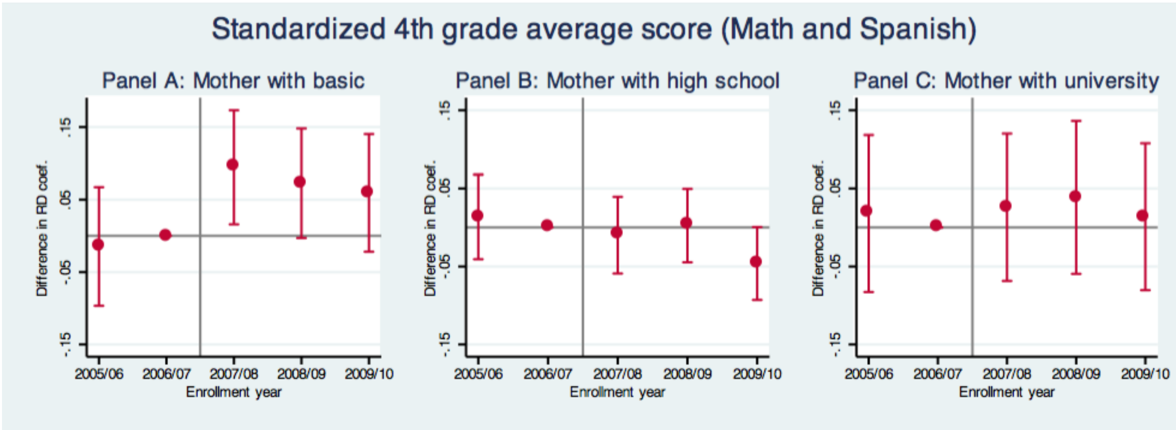
Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 13: School characteristics: Proportion of teachers hired in the current year

	ITT estimates		Difference in ITTs
	(1) Pre-policy	(2) Post-policy	(3) Post-Pre
(A) All students	0.0000	0.0041**	0.0041**
	(0.0013)	(0.0019)	(0.0018)
(B) Mother with basic education or less	0.0028	0.0070**	0.0043
	(0.0031)	(0.0032)	(0.0041)
(C) Mother with high school education	-0.0002	0.0052***	0.0053**
	(0.0019)	(0.0020)	(0.0025)
(D) Mother with university education	0.0051	-0.0031	-0.0082*
	(0.0035)	(0.0034)	(0.0048)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Figure 9: School characteristics: cohort RD coefficients - RD coefficient for 2006/07



Notes: Each observation represents the difference in the RD coefficient with respect to the RD coefficient for the last pre-policy cohort (2006/07) together with its 95% confidence interval using a window of 90 days around the enrollment cutoff and including a linear spline of distance from birthday to enrollment cutoff. Each RD coefficient can be interpreted as the increase/decrease in the outcome for students born after the enrollment cutoff.

Table 14: School characteristics: Average English and Spanish standardized 4$^{\text{th}}$ grade test scores

	ITT estimates		Difference in ITTs
	(1) Pre-policy	(2) Post-policy	(3) Post-Pre
(A) All students	0.199***	0.201***	0.003
	(0.016)	(0.008)	(0.015)
(B) Mother with basic education or less	0.147***	0.228***	0.084***
	(0.025)	(0.017)	(0.027)
(C) Mother with high school education	0.233***	0.205***	-0.010
	(0.017)	(0.009)	(0.017)
(D) Mother with university education	0.100***	0.117***	0.017
	(0.027)	(0.017)	(0.031)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. The regressions above use a window of 90 days. They include a linear spline of distance from birthday to enrollment cutoff. Column (1) shows RD estimates using student observations within 90 days of the enrollment cutoff for years 2005 and 2006, while column (2) for years 2008, 2009 and 2010. Column (3) shows the differences in the RD coefficients for column (2) with respect to column (1) including a full set of cohort dummies.

Supplemental Figures and Tables

Table A1: RD coefficient for changes on student socioeconomic characteristics around the June 30th cutoff

	(1) Jump at cutoff
(A) Socioeconomic index	0.011 (0.009)
(B) Mother with basic education or less	-0.001 (0.003)
(C) Mother with high school education	0.005 (0.006)
(D) Mother with university education	0.006* (0.003)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birthand are in parentheses. These regressions include all cohorts. They use window of 90 days and include a linear spline of distance from birthday to enrollment cutoff.

Table A2: RD coefficient for changes on density of birthday around the June 30th cutoff

	Jump at cutoff	
	(1) Pre-policy	(2) Post-policy
(A) Log share of students	-0.102*** (0.031)	-0.058* (0.033)

Notes: *** p<0.01, ** p<0.05, * p<0.1. Standard errors are clustered by date of birthand are in parentheses. These regressions include all cohorts. They use window of 90 days and include a linear spline of distance from birthday to enrollment cutoff.

Table A3: Complier characteristics - family income and socioeconomic index distributions

	(1) Municipality distribution	(2) National distribution
Panel A: Family income		
1^{st} quartile	0.222	0.144
	(0.342)	(0.353)
2^{nd} quartile	0.754	0.553
	(0.377)	(0.297)
3^{rd} quartile	-0.099	0.368
	(0.337)	(0.298)
4^{th} quartile	0.154	-0.412
	(0.368)	(0.547)
Panel B: Socioeconomic index		
1^{st} quartile	0.209	0.334
	(0.282)	(0.292)
2^{nd} quartile	0.882	0.290
	(0.459)	(0.332)
3^{rd} quartile	-0.173	0.406
	(0.373)	(0.327)
4^{th} quartile	0.305	-0.246
	(0.347)	(0.486)
Average	-46.82	-46.82
	(84.74)	(84.74)

Notes: Standard errors are clustered by date of birth and are in parentheses. Each coefficient represents a separate regression. Enrollment in voucher and public school are instrumented with the interaction of the dummy of turning six after the enrollment cutoff and the indicator for belonging to the treated cohorts.The regressions above use a window of 90 days, include all years and a full set of cohort dummies. They also include a linear spline of distance from birthday to enrollment cutoff.

Table A4: Descriptive statistics by mother education level - Enrolled in post-policy period

	Mothers with basic education	Mothers with high school education	Mothers with university education
Panel A: Characteristics			
Proportion of actual eligible students	0.58	0.34	0.11
	(0.49)	(0.47)	(0.31)
Average socioeconomic index	-114.4	6.0	166.5
	(36.5)	(64.3)	(59.3)
Attend urban school	0.72	0.91	0.97
	(0.45)	(0.28)	(0.17)
Average category of family income	2.4	4.1	9.0
	(1.5)	(2.7)	(3.6)
Median monthly family income in category (2013 USD)	220	515	1,619
Panel B: National SES distribution			
1^{st} quartile	0.833	0.109	0.000
	(0.373)	(0.312)	(0.000)
2^{nd} quartile	0.159	0.342	0.001
	(0.366)	(0.474)	(0.028)
3^{rd} quartile	0.006	0.362	0.030
	(0.075)	(0.481)	(0.172)
4^{th} quartile	0.002	0.200	0.969
	(0.040)	(0.400)	(0.174)
Panel C: Municipality SES distribution			
1^{st} quartile	0.772	0.143	0.006
	(0.419)	(0.350)	(0.080)
2^{nd} quartile	0.198	0.319	0.056
	(0.398)	(0.466)	(0.231)
3^{rd} quartile	0.027	0.337	0.148
	(0.163)	(0.437)	(0.355)
4^{th} quartile	0.003	0.234	0.885
	(0.056)	(0.423)	(0.319)
Panel D: Enrollment choices			
Proportion enrolled in public schools	0.65	0.37	0.12
	(0.48)	(0.48)	(0.32)
Proportion enrolled in voucher schools	0.35	0.59	0.52
	(0.48)	(0.49)	(0.50)
Proportion enrolled in elite private schools	0.00	0.04	0.36
	(0.03)	(0.19)	(0.48)
Panel E: School characteristics at baseline			
Average copay in schools in 2005 (2013 USD)	2.5	12.2	31.1
	(8.0)	(19.8)	(31.1)
Average Math test scores in school in 2005	-0.23	0.08	0.58
	(0.43)	(0.47)	(0.46)
Number of observations	124,205	373,142	76,359

Notes: Standard deviations are in parentheses. The descriptives above include all students in 1^{st} grade in the post-policy years (2008-2010). The average socioeconomic index is a weighted average of mother years of education and family income normalized by municipality with mean equal to 100.