

Voucher-School Competition, Incentives, and Outcomes: Evidence from Chile*

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Abstract

I investigate the effects of voucher-school competition on educational outcomes. In my model, parents decide between public schools and voucher schools (that is, private schools that receive a voucher for each enrolled student). The public schools have no direct incentive to produce quality, beyond meeting a minimum enrollment level and voucher schools face explicit competitive incentives. The model produces three empirical predictions: voucher-school competition 1) improves student outcomes; 2) may put stronger pressure on public schools to increase quality; and 3) has stronger effects when the minimum enrollment level is more binding. Since voucher school competition is endogenous to public school quality, I exploit the interaction of the number of Catholic priests in 1950 and the institution of the voucher system in 1981 as a potentially exogenous determinant of the supply of voucher schools. I document that the number of priests is determined historically and is correlated with the entry of both Catholic and non-Catholic voucher schools after the voucher reform. Moreover, I document that the number of priests per capita has little effect on educational outcomes before the reform and a positive effect after the reform. Next, using priests in 1950 as an instrument for voucher-school entry in a cross-section of students in 2002, I confirm the main predictions of my model: 1) an increase of one in the ratio of voucher-to-public schools increases tests scores by about 0.14 standard deviations; 2) the effects are similar for students attending public and voucher schools; and 3) the effects are smaller for public schools with less binding minimum enrollment levels.

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1 INTRODUCTION

Creating competition between schools is a cornerstone of voucher school proposals. Proponents have argued that by creating competition, vouchers create stronger incentives for public schools to increase quality. However, critics counter that school competition may increase student segregation and harm poor students. In parallel, a line of research on the effects of inter-school competition on student outcomes has not reached a consensus on the causal effects on academic outcomes. While some papers find positive and significant effects of school competition and school choice (e.g., Bayer and McMillan, 2005; Hoxby, 1994, 2000, 2005; Lavy, 2005; and Sandstrom and Bergstrom, 2005), other papers do not find significant effects (e.g., Hsieh and Urquiola, 2004; Rothstein, 2004, 2005).

This paper contributes to the literature by studying the effects of inter-school competition on the academic outcomes of Chilean students who attend publicly subsidized schools. Chile is the only developing country that has operated the complete K-12 sector under a “quasi-voucher” system for a long period of time (since 1981). Voucher schools (that is, private schools that receive a voucher for each enrolled student) currently serve above 40% of all students. However, voucher school enrollment varies widely across areas. While in 10% of the educational markets the voucher enrollment is more than 50%, about 20% of Chilean municipalities have no voucher schools in operation.

This paper first presents a Hotelling-type model (Hotelling, 1929), in which parents have heterogenous preferences for different schools, to analyze the effects on student outcomes of having two types of schools in a market: public schools with no direct incentives to produce quality beyond meeting a minimum enrollment level; and voucher schools that face explicit competitive incentives. In this context, the model predicts positive effects of voucher school entry on the quality offered by both voucher and public schools (level effects). The model also predicts that the size of the response of public schools to voucher school entry depends on the minimum enrollment level needed by a public school to operate and on the size of the school age population (interaction effects). Finally, the model suggests that voucher-school competition may put stronger pressure to improve quality on public schools than on voucher schools.

As a potentially exogenous determinant of voucher school competition in different markets, I exploit the interaction of the number of Catholic priests per person in 1950 in different areas of Chile with the establishment of the voucher system in 1981. I show that the number of priests per person is historically determined; and, Catholic priests are correlated with the entry of both Catholic and non-Catholic voucher schools after

1981. Enrollment in *formally* Catholic voucher schools increases from at most 5% of the school-age population before the voucher reform to about 14% in 2002.¹ In addition, I present evidence that the entry of non-Catholic voucher schools is also related to priests and present some hypotheses to explain this correlation. Moreover, before the 1981 reform, private school competition had no financial effects on public schools because revenues of public schools *did not depend* in any way on enrollment in private schools. Consistent with this, I also document that the number of priests per person had little effect on educational outcomes prior to 1981 and has a positive effect on outcomes after the voucher system was established. In other words, the potential validity of my identification strategy relies on the assumption that Catholic priests were present in the pre-voucher period, but that their effects on educational outcomes only became evident during the period when the voucher system was established. The evidence supports this view.

I estimate the *level effects* of the ratio of voucher-to-public schools on test scores in an educational market for a cross-section of students in 2002. This sample of students allows me to test the predictions of my theoretical model using data for the *post*-reform period. Because my reduced-form results imply that priests had little effect on educational outcomes before 1981, I use the number of priests in different areas in 1950 as a potentially valid source of exogenous variation in the supply of voucher schools during the *post*-reform period. I find that once I instrument for the ratio of voucher-to-public schools in different educational markets, the entry of one voucher school per public school in a market increases tests scores by about 0.14 standard deviations. The results are similar for students attending both public and voucher schools, using different measures of voucher school competition, and controlling for educational outcomes before the voucher reform. In contrast, the OLS estimates do not show a strong effect of voucher-school competition on test scores.

The data also support the existence of *interaction effects* of voucher school competition, as predicted by my theoretical model. Public schools located in municipalities that have relatively low proxies for minimum enrollment levels and high education deficits do not react strongly to voucher-school competition. These results constitute a more demanding test of the predictions of my model and are hard to be explained by alternative theoretical models that may explain the level effects of inter-school competition. Some of

¹Notice that by the Cannon Law of the Catholic Church, a school is formally recognized as Catholic when either (i) the Church directly appoints the school principal or (ii) the Church approves the appointment of the school principal. Therefore, many schools that are related to the Catholic Church are not considered *formally* Catholic.

these alternative theories are as follows: (1) There may be direct effects of competition on parents' or other schools' information; i.e., parents or schools use the information provided by competitors to improve quality (Hoxby, 1994). (2) There may be reputation effects: yardstick competition among teachers who care about their performance in comparison to other teachers (Juerges et al. 2004); this effect may be more relevant in markets with more comparison points.(3) There may be poaching: good teachers signal their unknown characteristics and good (voucher) schools learn and hire these good teachers. My results on the existence of the interaction effects of voucher-school competition are hard to reconcile with these alternative explanations and support the work of my model stressing the role of incentives on the behavior of public school agents.

This is not the first paper studying the effect of voucher school competition in the context of the Chilean voucher system. This paper contributes to this literature by providing new IV estimates using a potentially valid source of exogenous variation for voucher school entry (and providing a number of indirect tests to support its potential validity) and presenting a theoretical model that allows me to study the mechanism through which competition may affect the behavior of public schools. The contribution in term of having potentially valid instruments is relevant because previously used instruments include variables like population size, urbanization rates, or socioeconomic characteristics that likely do not meet the exclusion restrictions.

Previous papers include Carnoy and McEwan (1998) who use a panel of schools from the early 1980s to the mid 1990s and find no effect of the share of voucher school enrollment on average test scores at the school level. Given that the entry of voucher schools may be endogenous, all the other papers in the literature present some instrumental variable approach to deal with the endogeneity problem. These papers could be classified according to the time period studied. Hsieh and Urquiola (2004) use the change in educational outcomes at the municipality level between 1982 and the early and mid 1990s and find no effect of the change in voucher school enrollment on outcomes. Even though the focus of that paper is on OLS estimates, Hsieh and Urquiola (2004) also present some IV estimates using the size of the population, urbanization rate, and the inter-quartile range of education in 1982 as instruments for voucher school enrollment. These results contrast with other papers analyzing the effect of school competition on test scores: Gallego (2002) using school level data for 1994-1997 and IV estimates (the instruments are urbanization rates and population size) finds a positive effect of voucher school enrollment on test scores, Contreras and Macias (2002) find a positive effect of competition (measured using a Herfindahl index) on pre-college tests for 1998 using

instrumental variables (population size, area, lagged Herfindahl index, and availability of private schools, among others). Auguste and Valenzuela (2003) is the paper most directly comparable to Hiseh and Urquiola (2004). They present both individual and market level regressions for the effect of voucher school enrollment on test scores using data for the late 1990s and find a positive and significant effect of voucher school entry on test scores. Differences in the time period studied are important to understand differences in results between the two papers. It is hard to argue that the system operating in the 1980s was a real voucher system from the point of view of several agents: (i) public school budgets were not affected by the voucher reform (in part because the decentralization of public schools was not completed until the late 1980s), (ii) employment of public school agents was quite rigid until the mid-1990s, (iii) test scores were not public until the mid/late 1990s, (iv) local governments were not elected democratically until 1992, and (v) the real value of the voucher decreased steadily during the 1980s and only recovered in the early 1990s. All these factors may explain why the effects are positive in the 1990s (when the educational system was operating under rules that are closer to the textbook version of a voucher system) and insignificant in the 1980s.² My paper presents additional evidence of positive effects of voucher school competition in the early 2000s.

The remainder of the paper is organized as follows. Section 2 briefly describes the Chilean education sector. Section 3 presents a theoretical model for framing the empirical analyses of the paper. Section 4 presents the data used in this paper. Section 5 describes the identification strategy. Section 6 presents the results of difference-in-difference regressions using data on educational outcomes before and after 1981. Section 7 presents estimates of the level effects of voucher-school competition on student outcomes using a cross-section of primary students in 2002. Section 8 presents estimates of interaction effects and section 9 briefly concludes. An appendix presents the proofs of the main theoretical results of the model.

2 INSTITUTIONAL SETTING: PRIMARY AND SECONDARY EDUCATION IN CHILE

Before 1981, the government in Chile was involved in the funding and provision of education, the supervision and regulation of curricula, the handling of human resources, and

²Another important difference between the 1990s and the 1980s is that test scores for the complete population are only available for the 1990s. The test scores available for the 1980s possibly cover a highly selected sub-sample of schools in some areas (personal communication with Erika Himmel who was in charge of the implementation of the early test scores). In addition, there are no pre-reform test scores available—notice that Aedo-Richmond (2000) argues that the reform started to be implemented about 1978.

investment.³ The 1981 educational reform: transferred public education from the central to the local governments (municipalities); established a per-student subsidy (voucher) to be received by voucher and public schools depending on enrollment; allowed parents to choose among any publicly-financed school; and allowed would-be schools to enter the market.⁴

Three types of schools emerged: publicly owned schools (managed by local governments), voucher schools (owned by private agents), and non-voucher schools.⁵ The first two types of schools receive vouchers; the non-voucher private schools do not receive public funds, charge high tuitions, and serve upper- income students. In 2004, voucher schools enrolled about 42% of students in 2002 up from an enrollment rate of 15% in 1981. Public school enrollment dropped from 78% in 1981 to 49% in 2002. The remaining enrollment corresponds to non-voucher private schools, which I do not include in my sample.

Public and voucher schools present important differences in terms of their incentive structures and the amount of non-voucher resources they receive. Voucher schools tend to behave like competitive firms, receiving revenues proportional to enrollment. While some voucher schools are operated by for-profit firms, other voucher schools are operated by non-profit organizations that raise additional funds in a relatively competitive market for donations to be spent in schools (Aedo, 1998).⁶ In contrast, public schools work under “softer” budget constraints: when needed, public schools that are losing students receive transfers, above and beyond the vouchers to pay their expenses (Sapelli, 2003). In addition, while vouchers were the only public intervention in the K-12 sector during the 1980s, governments during the 1990s channeled additional resources to “vulnerable” schools and increased non-voucher spending. My estimates are that about 30% of public expenditure in education for the average student is not related to the voucher (data for 2002). In terms of teacher regulations, the public school teachers face flat wage schedules and cannot be removed easily from their positions—only since the mid-1990s could public school teachers be moved to other schools in the same municipality (Mizala and

³While the reform was formally enacted in 1981, Aedo-Richmond (2000) suggests that the reform began to be implemented *de facto* around 1978.

⁴Sapelli (2003) presents a more detailed description of the Chilean voucher system.

⁵A small group of subsidized private schools did operate before the 1981 reform. These schools enrolled about 7% of the school-age population (estimates using data from the 2002 Social Protection Survey) and were financed with small public subsidies and private donations (Aedo-Richmond, 2000). Gregory Elacqua estimates that subsidized private schools enrolled about 12% of the students enrolled in schools in 1979 (personal communication). Considering that enrollment rate was about 75% in the same period, subsidized private schools enrolled about 9% of the school-age population.

⁶Gregory Elacqua estimates that about 63% (58%) of voucher school students were enrolled in for-profit schools in 1998 (1992). Notice that some for-profit schools are formally Catholic.

Romaguera, 2004). The number of teachers per student is 25% higher in public schools than in voucher schools (CENDA, 2002). And, public schools are highly unionized.⁷ I use these differences in the institutional environment that voucher and public schools face in the model in Section 3.

The closing of public schools is a second institutional feature of the Chilean system that I study in the model. The data suggest that about 8% of public schools stopped reporting test scores during the 1990s. The most likely reason for this is that these schools were closed or merged with other public schools. The closed schools tended to have fewer students than other public schools and to under-perform relative to other public schools. Interestingly, the teachers' union is now actively lobbying against the closing and merging of public schools. Moreover, the opinions of teachers reported in Bellei et al. (2003) suggest that teachers do not want to be moved from one public school to another. This evidence, in conjunction with the evidence on fixed wages, suggests that public school teachers earn significant rents from working in public schools.

3 MOTIVATING THEORY

I present a simple theoretical model for studying the potential effects of voucher-school competition on school quality. The model incorporates three groups of agents: parents deciding among different schools, voucher school owners, and public school agents.

3.1 AGENTS

\bar{L} parents are uniformly distributed over a linear neighborhood of length 1. The location of parents along the linear neighborhood refers to their preferences for public and voucher schools, which are located at the extremes of the city. In particular, let x denote location along the linear neighborhood, public schools are located at $x = 0$ and voucher schools at $x = 1$. This modelling approach formalizes the notion that public and voucher schools not only offer formal instruction (i.e., measured in test scores), but also instruction in other areas, such as religious education and civic values. I assume that parents have heterogeneous preferences about these school characteristics and that schools cannot choose their location along the linear city (i.e., public and voucher schools have intrinsic differences in the non-formal instruction they provide).⁸

⁷The teachers' union has strong political power and actively lobbies for additional benefits and against policies aimed at providing performance incentives.

⁸I could generate spatial differentiation in equilibrium by adding more structure into the cost functions (Tirole, 1988).

The utility of a parent located at x is given by:

$$U_{jx} = q_j - td_{jx}, \quad (1)$$

where q_j is quality offered by the school j and d_{jx} is the distance from parents located at x to school j . d captures the discrepancy between parents' preferred instruction and the instruction provided by school j . Therefore, t is a "transportation cost" that measures the disutility per unit of distance of sending children to a school that is not located at x . Parents choose the school that maximizes (1). If two voucher schools offer the same quality, then parents randomize among them.

There is only one public school in each neighborhood, but the number of voucher schools (N) is endogenously determined in the model, given some number of would-be voucher schools in an area (N^P). The number of would-be voucher schools may be limited, because school quality is a good whose reputation is important. School quality is provided after students are enrolled; therefore, voucher schools may "hold up" parents and not fulfill their initial offers of quality. In a context of incomplete contracts, only voucher schools with good reputation or that can signal that they are not opportunistic agents are able to enter the market and generate a positive demand. In addition, cultural and social factors may constrain the number of acceptable voucher schools.⁹

Owners of voucher schools decide simultaneously whether they enter the market and what quality they provide (q_V). Profits of voucher school i are given by:

$$\Pi_i = [(v - c^V(q_{V_i}))n_{V_i} - F], \quad (2)$$

where v is the per-student voucher, $c^V(\cdot)$ is the unitary cost of providing quality q_V , n_V is the number of voucher school students, and F is a fixed cost. I assume $c^{V'}(\cdot) > 0$ and that quality offered by voucher schools has to be above a minimum level q_V^M .

In terms of public schools, mayors (who manage public schools in a municipality) face an agency problem; in contrast to voucher schools, public schools cannot use variable wages and other forms of explicit incentives to implement their optimal choices. Thus, public school agents (teachers) decide the quality that public schools provide (q_P) by maximizing:

$$\{y - c^P(q_P) + R \mathbf{1}[n_p \geq \bar{n}]\}, \quad (3)$$

⁹Survey data from Chile suggest that, indeed, there are limitations in the supply of voucher schools. Lehmann and Hinzpeter (1997) report that in 1996 about half of the parents with children in public schools wanted to have their children in voucher schools. In 2001, while 39% of middle-income parents had their children in voucher schools, 66% preferred a voucher to a public school. Results for low-income parents are similar: while 21% of these parents had their children in voucher schools, about 50% preferred a voucher school.

where y is income of teachers, which is fixed, $c^P(\cdot)$ is the effort cost of providing quality q_P ($c^P(\cdot) > 0$), $\mathbf{1}[n_P \geq \bar{n}]$ is an indicator function that takes a value of one if $n_P \geq \bar{n}$ and a value of zero otherwise, n_P is the number of public school students, \bar{n} is the minimum enrollment level, and R is a positive constant that captures rents of public school agents that are lost if the public school closes. The public school closes when its enrollment is below the minimum enrollment level or its quality is below q_P^M .

The public school budget is:

$$[(v - o)n_P - F + NV],$$

where NV is a non-voucher transfer and o is a per student cost. I assume that only non-voucher transfers vary across public schools. The minimum enrollment level of each public school is the enrollment level associated with a balanced public school budget, which is given by:

$$\bar{n} = \frac{F - NV}{v - o}.$$

Since, in the model, only NV varies across public schools, \bar{n} is determined by changes in NV .¹⁰

3.2 EQUILIBRIUM

The timing of events is as follows:

1. First, a finite number N^P of voucher schools simultaneously decide whether they enter the market and the quality they provide (q_V).
2. Next, public school agents decide the quality they provide (q_P).
3. Finally, parents decide to which school to send their only child.

The symmetric subgame perfect equilibrium of this model is characterized by values for $q_P, q_{V_i}, N, n_P, n_V$, and n_{V_i} , such that:

- Quality offered by all voucher schools is the same, i.e., $q_{V_i} = q_V \forall V_i$.
- Parents maximize (1) by selecting among available schools.
- Public school agents maximize (3) by selecting public school quality.

¹⁰Non-voucher transfers could be understood as soft budget constraints. In this case, the model in Robinson and Torvik (2005) could be used to explain why in a political economy equilibrium, the central government can be willing to transfer public money to public school agents.

- $N \leq N^P$.
- $\Pi_i \geq 0$, and the N voucher schools that have entered the market maximize (2) by selecting voucher school quality.

To solve the symmetric subgame perfect equilibrium of the model, I use backwards induction, starting from parents' choices. Parents choose a school to maximize (1). Aggregating their decisions, I derive the demand for public and voucher schools, as stated in Result 1 (proofs of the theoretical results are presented in the Appendix):

Result 1 *Enrollment in the public school and voucher schools is, respectively:*

$$n_P = \begin{cases} \bar{L} & \text{if } N = 0 \\ \bar{L} \left(\frac{q_P - q_V}{2t} + \frac{1}{2} \right) & \text{if } N > 0 \end{cases},$$

$$n_{V_i} = \begin{cases} 0 & \text{if } N = 0 \\ \frac{\bar{L}}{N} \left(\frac{q_V - q_P}{2t} + \frac{1}{2} \right) & \text{if } N > 0 \end{cases} \quad \forall V_i.$$

School quality is determined by maximizing utility of public school agents, given Result 1. Note that maximization of Equation (3) implies that either the minimum quality or the minimum enrollment constraint is binding in equilibrium. Condition 1 states the case in which the minimum enrollment constraint binds.

Condition 1 (Minimum Enrollment Constraint Binding)

$$\left(\frac{\bar{n}}{\bar{L}} - \frac{1}{2} \right) \geq \frac{q_P^M - q_V}{2t}.$$

Condition 1 is quite intuitive and states that the minimum enrollment level is more likely to be binding when the minimum enrollment is high relative to the population and the difference between minimum public school quality and voucher school quality is large.

Result 2 presents the optimal public school quality.

Result 2 *1. If Condition 1 holds, optimal public school quality is given by:*

$$q_P = \begin{cases} q_P^M & \text{if } N = 0 \\ 2t \left(\frac{\bar{n}}{\bar{L}} - \frac{1}{2} \right) + q_V & \text{otherwise} \end{cases},$$

and, enrollment in public schools is given by:

$$n_P = \begin{cases} \bar{L} & \text{if } N = 0 \\ \bar{n} & \text{otherwise} \end{cases}.$$

2. If Condition 1 does not hold, optimal public school quality is given by:

$$q_P = q_P^M,$$

and, enrollment in public schools is given by:

$$n_P = \begin{cases} \bar{L} & \text{if } N = 0 \\ \bar{L} \left(\frac{q_P^M - q_V}{2t} + \frac{1}{2} \right) & \text{if } N > 0 \end{cases} .$$

The intuition of this result is that only one of the two constraints is binding in equilibrium. Thus, if there is no voucher school in the market, then public school agents offer the minimum quality, q_M^P . The same result emerges if the minimum enrollment level is not binding. In contrast, if the minimum enrollment constraint binds, then public school agents have to produce a (higher) quality level, such that the public school has exactly the number of students needed to satisfy the minimum enrollment level.

Finally, regarding the behavior of voucher schools, I first determine the number of voucher schools that have non-negative profits if they produce the minimum quality level (q_V^M), assuming no restriction on the number of would-be voucher schools. I denote this number of schools as N^* . I analyze below the case in which there are a limited number of would-be voucher schools.

Result 3 1. $N^* = 0$ if $n_V(v - c^V(q_V^M)) < F$.

2. $N^* > 0$ if $n_V(v - c^V(q_V^M)) \geq F$. N^* is given by:

$$N^* : \frac{n_V}{(N^* + 1)}(v - c^V(q_V^M)) < F \leq \frac{n_V}{N^*}(v - c^V(q_V^M)).$$

This result highlights an important property of the model. Namely, that N^* depends positively on the total enrollment in voucher schools which, in turn, depends negatively on public school quality (See Result 1). Therefore, this model predicts that the better the public schools in an area are, the lower is the number of voucher schools operating in that area. Even though the model is deterministic, when I move to the empirical analyses, I could extend the model to have some randomness (e.g., in enrollments) and get the result that there may be reverse causality from public school quality to the number of voucher schools in an area. Therefore, OLS estimates of the effect of voucher-school competition are downward biased. This bias suggests using instrumental variables to identify the causal effect of the number of voucher schools on public school quality.

Next, the actual number of voucher schools depends on the availability of would-be voucher schools in a market.

Result 4 *The number of voucher schools operating in a market is:*

$$N = \min(N^*, N^P).$$

Finally, the next result determines the optimal quality level offered by each voucher school.

Result 5 *If Condition 1 holds, quality offered by voucher schools is:*

$$q_V = \begin{cases} q_V^M & \text{if } N = 1 \text{ and } N^P = 1 \\ c^{V-1} \left(v - \frac{NF}{L-\bar{n}} \right) & \text{if } N \geq 1 \text{ and } N^P \geq 2 \end{cases}.$$

If Condition 1 does not hold, quality offered by voucher schools is:

$$q_V : \begin{cases} \frac{c^V(q_V)}{c^{V'(q_V)}} = 2t \frac{n_V}{L} & \text{if } N = 1 \text{ and } N^P = 1 \\ q_V = c^{V-1} \left(v - \frac{NF}{n_V} \right) & \text{if } N \geq 1 \text{ and } N^P \geq 2 \end{cases}.$$

This result highlights the role of competition in creating incentives for voucher schools to increase quality. In the case when $N = 1$ and $N^P = 1$, the single public school does not face potential competitors, chooses the minimum quality level (q_V^M) and earns rents in equilibrium. In contrast, when $N^P \geq 2$ and $N = 1$, the existence of potential entrants creates incentives for the incumbent voucher school to increase quality until profits are equal to 0. Similarly, when $N \geq 2$, the existence of potential competitors creates incentives for incumbents to offer a quality level such that profits are equal to 0 in equilibrium.

Results 1 through 5 allow me to characterize the equilibrium quality given different parameter values. This is presented in Proposition 1.

Proposition 1 (Equilibrium Public and Voucher School Quality) *If Condition 1 holds in equilibrium, public and voucher school quality are given by:*

$$q_P = \begin{cases} q_P^M & \text{if } N = 0 \\ 2t \left(\frac{\bar{n}}{L} - \frac{1}{2} \right) + q_V^M & \text{if } N = 1 \text{ and } N^P = 1 \\ 2t \left(\frac{\bar{n}}{L} - \frac{1}{2} \right) + c^{V-1} \left(v - \frac{NF}{L-\bar{n}} \right) & \text{if } N \geq 1 \text{ and } N^P \geq 2 \end{cases},$$

$$q_V = \begin{cases} q_V^M & \text{if } N = 1 \text{ and } N^P = 1 \\ c^{V-1} \left(v - \frac{NF}{L-\bar{n}} \right) & \text{if } N \geq 1 \text{ and } N^P \geq 2 \end{cases}.$$

If Condition 1 does not hold in equilibrium, public and voucher school quality are given by:

$$q_P = q_P^M \quad \forall N,$$

$$q_V : \begin{cases} \frac{c^V(q_V)}{c^V(q_V)} = 2tn_V & \text{if } N = 1 \text{ and } N^P = 1 \\ q_V = c^{V^{-1}} \left(v - \frac{NF}{n_V} \right) & \text{if } N \geq 1 \text{ and } N^P \geq 2 \end{cases}.$$

To focus on the most interesting cases for the purposes of this paper and to reduce the number of possible cases, I discuss mainly the case in which the minimum enrollment constraint binds in equilibrium (Condition 1). This seems the most plausible case for Chile.¹¹ When Condition 1 is violated, public school quality does not depend on the number of voucher schools. In turn, voucher school quality is an increasing function of the number of voucher schools in the market. When Condition 1 holds, the minimum enrollment level is binding; therefore, public school quality also depends on the number of voucher schools in the market, because public schools respond to voucher school quality in order to achieve the minimum enrollment level.

Proposition 1 allows me to study the effects of increases in N^P on public and voucher school quality. These comparative static exercises are closely related to my empirical analysis in this paper, which uses a potentially valid source of exogenous variation of N . In the remainder of the model, I only consider the case in which $N \leq 2$, which is the relevant interval for Chile, because the ratio of voucher-to-public schools is less than 2 in 95% of the educational markets.

Corollary 1 (Level Effects) *If Condition 1 holds in equilibrium and $N \leq 2$, an increase in N^P that increases N has a positive effect on equilibrium voucher and public school quality.*

If Condition 1 holds in equilibrium and $N = 1$, an increase in N^P from 1 to 2 has a positive effect on equilibrium voucher and public school quality.

Intuitively, when N increases from 0 to 1, the public school increases the quality offered because the minimum enrollment constraint becomes binding. When N increases from 1 to 2, the incumbent voucher school has to increase its quality until rents are dissipated, because the entering voucher school offers a higher level of quality. In this

¹¹Condition 1 is supported by the data. The Chilean data suggests that: $-0.06 \approx \left(\frac{\bar{n}}{L} - \frac{1}{2} \right) > \frac{q_P^M - q_V}{2t} \approx \frac{-0.16 - 0.03}{1.61} \approx -0.12$. I estimate t from a regression of $\frac{n^P}{L}$ on $q_P - q_V$. I approximate q_P^M using the average test scores of public schools when $N = 0$, and q_V using the average test scores for voucher schools in markets with $N = 1$.

case, the public school has to respond to the increase in voucher school quality in order to meet the minimum enrollment constraint. The second case stated in Corollary 1 highlights the effects of increasing potential competition when the market is such that only one voucher school operates. In this case, potential competition creates incentives for the incumbent voucher school to increase quality until profits are dissipated.

Corollary 2 presents another interesting theoretical implication of an increase in N that is caused by an increase in N^P . This corollary resembles an empirically relevant case for Chile because public schools in about 85% of the educational markets face competition from at most one voucher school and, as previously mentioned, the ratio of voucher to public schools is less than 2 in 95% of the educational markets. Thus, this corollary produces theoretical predictions related to the variation I observe in the data.

Corollary 2 (Public vs. Voucher School Response to Competition) *Let q_j^N denote equilibrium quality of school j when the number of voucher schools in a market is N . Define z_P and z_V :*

$$\begin{aligned} z_P &\equiv q_P^1 - q_P^0, \text{ and} \\ z_V &\equiv q_V^2 - q_V^1 \end{aligned}$$

If Condition 1 holds in equilibrium and N increases initially from 0 to 1 and next from 1 to 2 as a consequence of an increase in N^P :

- 1. If $z_P > z_V$, public school quality responds more strongly than voucher school quality to an increase in voucher school competition.*
- 2. If $z_P = z_V$, public school quality and voucher school quality respond the same to an increase in voucher school competition.*
- 3. If $z_P < z_V$, public school quality respond less strongly than voucher school quality to an increase in voucher school competition.*

The comparative static exercise in Corollary 2 implies that voucher school competition could put stronger pressures to increase quality on public schools than on voucher schools. Theoretically, there is no restriction to the relative response of both voucher schools to the comparative static exercise presented in Corollary 2. For instance, public school quality may be more responsive when the difference between minimum voucher school quality (q_V^M) and minimum public school quality (q_P^M) is sufficiently large, which produces a tremendous increase in public school quality in order to meet the minimum

enrollment level. On the contrary, if $q_V^M - q_P^M$ is small or the minimum enrollment level is sufficiently small, then voucher schools' response to competition may be greater. The empirical results in this paper suggest that both types of schools respond similarly to voucher school competition.

Finally, Proposition 1 implicitly states that the response of the public school to an increase in the number of voucher schools produced by an increase in N^P depends on how binding the minimum enrollment constraint is. The minimum enrollment constraint is more binding when the school age population is large or when non-voucher transfers are large. Corollary 3 states this result.

Corollary 3 (Interaction Effects) *If Condition 1 holds in equilibrium and N increases from 0 to 1 as a consequence of an increase in N^P , then the lower the minimum enrollment level (the more the non-voucher transfers there are), the lower is the response of the public school to the entry of a voucher school in the market.*

The predictions of Corollary 3 are quite intuitive. Public schools with more stringent incentives in the form of harder enrollment levels have to increase quality more when a voucher school enters the market. This corollary clearly illustrates the working of the model in terms of the mechanism that makes voucher schools increase quality when facing voucher school competition.

In summary, the most important empirical prediction of the theoretical framework presented in this section is that public and voucher school quality should increase as the number of voucher schools in a market increases exogenously. In addition, there should be interaction effects: the public school response to exogenous changes in voucher school competition depends on how binding the minimum enrollment is. This result illustrates the theoretical mechanism at work in the model, which is basically related to the implicit incentives that the minimum enrollment constraint gives to public school agents. In addition, the theory predicts that the response of public schools to an increase in the number of voucher schools in a market may be greater than the response of voucher schools if the minimum public school quality is sufficiently low. Finally, the theory also suggests that the number of vouchers in a market is endogenous to public school quality. This suggests the use of instrumental variables in the empirical analyses of this paper.

4 DATA

I use several datasets in this paper. Table 1 presents the variables used, the level at which each variable is collected, and the descriptive statistics of each variable. I use

data on students' educational outcomes, their backgrounds, parent preferences, school characteristics, and the characteristics of the area where they attend school from the dataset of the 2002 SIMCE (*Sistema de Medición de la Calidad de la Educación*) test, which was administered to 4th graders. This test has been given nationwide since 1988 to more than 90% of students in a different grade each year (4th, 8th, or 10th graders). I use the average of the Math and Spanish portions of the test (standardized to have an average of 0 and a standard deviation of 1) as my measure of academic outcomes. I use income per household member and mother's education to measure the socioeconomic background of students.¹²

Second, I use the CASEN (*Encuesta de Caracterización Socioeconómica*) 2000 survey, which collects information on socioeconomic variables for a representative cross-section of the population. I use a high school graduation dummy as a measure of educational attainment for members of different cohorts that attended school in different places. Third, I use the 2002 Social Protection Survey (called "Labor History and Social Security"), which collects life-time information for a sample of individuals. I use information on high school graduation rates at the market level for individuals attending school before the 1981 reform, the migration decisions of parents with school-age children in 2002, and information on the type of school attended (public, subsidized private, and paid private).

I measure the degree of voucher school competition as the ratio of voucher schools to public schools in each educational market. I use 297 municipalities and the Metropolitan Area of Santiago as proxies for local educational markets. Municipalities are separate educational markets because, with the exception of municipalities in the Metropolitan Area of Santiago, most students attend schools in the town where they live (Hsieh and Urquiola, 2004; and Sapelli and Vial, 2002). Data on the availability of schools in each market come from the Ministry of Education files.

Data on religious variables at the diocese level related to my identification strategy come from the yearly publication by the Vatican called *Anuario Pontificio* (the number of priests, the share of Catholics, and the ratio of order to total priests in each Chilean diocese).¹³

¹²I use five categories to measure mother's education (having attained at most primary education, secondary general education, secondary technical education, post-secondary technical education, and college or postgraduate education).

¹³In particular, I use data on priests per-capita for 1950 from *Anuario Pontificio*. I estimate the number of priests in the different dioceses in 1950 by considering the territorial division existing in the 1990s (which includes 26 dioceses) and the number of priests in 1950. I make this adjustment because some dioceses (namely Santiago) included disproportionately big areas of population in 1950. Between the 1960s and the 1990s, new dioceses appeared when some dioceses were split up—so the number of

I also use other sources of data in some empirical exercises. Data on Catholic schools come from the school directory of the Chile Catholic Church (<http://www.feducech.cl/> and <http://www.iglesia.cl/>). Data on municipal variables such as expenditures per student and the size of public schools come from the Chilean Municipal Dataset (available at <http://www.sinim.cl/>). Finally, I use information on electoral outcomes at the municipality level from the Chilean Electoral Office, when analyzing the interaction effects of inter-school competition.

5 IDENTIFICATION STRATEGY

One major challenge for an empirical analysis of the relationship between voucher school competition and educational outcomes is the potential endogeneity of the number of voucher schools. In this section, I argue that the interaction of the number of Catholic priests per person in 1950 and the school reform of 1981 allows me to identify the exogenous variation in the number of voucher schools in different educational markets.

The potential endogeneity between the number of voucher schools and public school quality can be illustrated using the model in Section 3, in a context with randomness. Increases in minimum quality (q_P^M) or minimum enrollment (\bar{n}) decrease the number of voucher schools operating in an area and have a positive effect on quality offered by public schools. Thus, entry into the market is endogenous to public school quality; therefore, simple correlations or OLS estimates will produce *downward* biased estimates of the causal effect of voucher-school competition on educational outcomes. Alternatively, OLS estimates could be biased upward if voucher school entry responds to some unobserved (to the econometrician) characteristic of the market that has a positive effect on school quality.

My identification strategy exploits the interaction of the (log of the) number of Catholic priests per person in 1950 and the 1981 reform to identify the exogenous variation in the number of voucher schools in an area, after controlling for the share of Catholic population.¹⁴ The basic motivation for this identification strategy is two-fold. On the one hand, there are direct effects of priests on Catholic schools. The involve-

dioceses increased from 19 to 26. I assume that the distribution of priests *within* the split dioceses is given by the distribution when the new dioceses were created (the distribution of priests within dioceses in the following periods is quite stable). In all the empirical applications, I cluster standard errors at the 1950 dioceses level.

¹⁴By controlling for the share of the Catholic population, I take into account potential direct effects of this variable on educational results (as suggested by recent research on the effects of religious affiliation on income, education, and other social and economic variables, e.g., Barro and McCleary, 2003 and Gruber, 2005).

ment of priests in educational activities is understood as a key element of their religious mission (Garrone, 1977). However, although Catholic priests were involved in schools before the reform (my estimates are that at most 5% of the school-age population attended Catholic schools that were publicly subsidized),¹⁵ there is a big increase in the enrollment in Catholic voucher schools after the reform, increasing to a level close to 14% of the school-age population in 2002. This increase takes place along three margins: (i) new Catholic schools were installed, (ii) existing Catholic schools increased in enrollment, and (iii) former paid Catholic schools became voucher schools after the reform.¹⁶ ¹⁷ The main reason for this big increase in enrollment in Catholic voucher schools is that only after the reform did Catholic schools start to receive vouchers (the voucher represented an increase of about 160% in the value of the subsidy received by Catholic schools from the government),¹⁸ allowing priests to establish new schools or to expand enrollment among middle- and lower-class students.

Priests are important actors in Catholic schools. These schools can be owned directly by the Church, by religious orders, or by people supported by the Church, but they always have at least one priest acting as a chaplain. Currently, priests tend to focus on pastoral ministries (e.g., being chaplains and teaching religious education classes) and on the management of schools. In terms of time requirements of being a priest in a school, priests have to spend a significant amount of time working with students, teachers, and parents. Priests working in schools receive wages that are comparable to those of other teachers. Pasalacqua (2004) reports that about 5% of the teaching staff and 10% of the

¹⁵These estimates are computed as follows: the Social Protection Survey implies that 7% of the members of pre-voucher cohorts attended subsidized private schools. Espinola (1993, quoted in Hsieh and Urquiola, 2004) reports that 53% of pre-reform subsidized private schools were Catholic. If Catholic and non-Catholic schools have the same size, then I estimate that 3.5% of the school-age population attended Catholic subsidized schools before the reform. However, I know that today Catholic schools tend to be bigger than non-Catholic schools. Then, using the ratio of size between Catholic and non-Catholic schools in 2002, I estimate that about 4.7% of the school-age population before the reform was in Catholic subsidized schools.

¹⁶Unfortunately, there are no systematic data on enrollment in Catholic schools before and after the reform. My estimates, using data from Pasalacqua (2004), are that 25% of enrollment in Catholic voucher schools in 2002 corresponds to brand new Catholic schools and between 15 and 25% of the enrollment corresponds to schools that became voucher schools after the reform.

¹⁷Anecdotal evidence from one of the most important Catholic groups in Chile (the Marist brothers) may help to understand the increase in enrollment in Catholic voucher schools after the reform. Enrollment in Marist schools was 5,000 students in 1980, with about 10% of these students in subsidized schools. In contrast, enrollment was 14,800 in 2002, with 40% corresponding to voucher schools. About two thirds of enrollment in voucher schools corresponds to schools established after the reform (Personal communication with Br. Aldo Pasalacqua).

¹⁸This value is computed as follows. The initial value of the voucher was 30% higher than expenditure per student in public schools before the reform. Before 1981, private schools received on average 50% of public schools expenditure per-student (Hsieh and Urquiola, 2004). Therefore, the nominal value of the voucher increased by 160%.

non-teaching staff in Catholic voucher schools are religious personnel (including not only priests, but also brothers and nuns).

In addition, there may be effects of priests on the establishment of non-Catholic schools. First, as previously discussed, the formal definition of a Catholic school is restrictive; therefore, there may be some schools that are somewhat informally related to the Church.¹⁹ Second, some non-Catholic voucher schools may have been established by former teachers of Catholic schools (or even priests/nuns that retired from their religious orders). A slight variation of this mechanism is non-Catholic voucher schools that establish religious practices, names and curricula in their schools to try to mimic Catholic schools in the same area. And, third, the propensity of parents to send their children to private schools may be affected by the presence of old Catholic schools (and, therefore, priests) in the same area. I do not have systematic evidence of these three channels, but I present evidence in the next two sections that (i) priests are correlated with the entry of non-Catholic schools, and (ii) priests do not affect the propensity to attend Catholic vis-à-vis non-Catholic voucher schools at the individual level.

In addition, there is a fundamental change in the incentive scheme related to the 1981 reform. Even if enrollment in Catholic schools were constant after the reform, the effect of priests on the behavior of public schools changes dramatically: from a system where public school funds did not depend at all on enrollment in private schools to a system where total funds are fixed and are allocated proportionally to enrollment. The actual degree of school choice should have changed dramatically during the reform period even if the enrollment in private schools were the same. This further motivates using the interaction of priests in 1950 and the establishment of the voucher system as an instrument for voucher school competition and expecting the effects of priests to be significantly bigger over the voucher period.

Finally, the number of priests per person is historically determined and varies widely across Chilean dioceses, despite the majority of the population being Catholic.²⁰ While the average diocese has a ratio of about 0.15 priests per 1,000 people, the diocese with the highest ratio (0.23 priests per 1,000 people) has more priests per person than most

¹⁹Again, I have no systematic data to quantify this hypothesis, but two examples may help understanding the magnitude of this phenomenon. About 40% of enrollment in voucher schools related to the Jesuits (through *Red Educacional Ignaciana* and *Fe y Alegria Chile*) is not counted as enrollment in Catholic schools. Most of these schools were established after the reform. Similarly, enrollment in the (two big) Opus Dei voucher schools in Santiago is not counted as in Catholic schools because Opus Dei schools are not related to the local bishop.

²⁰In the Catholic Church, a diocese is an administrative territorial unit, composed of many parishes and governed by a bishop. Technically, each diocese is independent of the others and the bishop only responds to the Pope.

Latin American countries; and, the diocese with the lowest ratio (0.06 priests per 1,000 people) is comparable to what is observed in a poor (and non-Catholic) country such as Kenya. The variation in the number of priests across Chilean dioceses has to do mainly with the fact that religious orders are more numerous in some areas than others.

Religious orders established themselves in a non-uniform way in different dioceses in the past. The allocation of orders to different dioceses was related mainly to the desire to bring priests to some Chilean areas beginning in the mid nineteenth to the mid twentieth centuries (Aliaga, 1989; Araneda, 1986; Barrios, 1992). Some areas ended up with more order priests because the bishops of some dioceses either belonged to orders themselves or were more open to receiving order priests. While 71% of the order priests in Chile in 2002 belonged to orders that entered the country between 1810 (the year of independence) and the 1950s, only 5% of these priests belonged to orders that entered the country after the 1950s.²¹ In general, there are more order priests than non-order priests, conditional on the establishment of order in a place. Therefore, dioceses where religious orders work tend to have more priests. The historical roots of the presence of orders in different areas creates a positive correlation between the number of priests today and in the past: the correlation between the number of priests per capita during the 1990s and the 1950s is 0.78.

Table 2 illustrates the importance of orders in explaining the cross-diocese variation in (the log of) priests per capita in 1950. I use the ratio of order priests to the total number of priests as a proxy for the presence of orders in different dioceses. Results in columns 3 and 4 support the claim that the variation of priests per capita is related to the presence of orders in different dioceses.

I use priests per capita in 1950 as the main instrument for voucher school entry in different areas during the voucher period, and the ratio of order-to-total priests as an alternative instrument in some regressions. The next section empirically studies the validity of this identification strategy.

6 REDUCED FORM ESTIMATES: DIFFERENCE-IN-DIFFERENCE ANALYSIS AND ROBUSTNESS CHECKS

To validate the identification strategy discussed in the previous section, I need to show that priests are not related to educational outcomes before the voucher reform and are related to educational outcomes after the reform. Table 3 presents the basic evidence supporting this identification strategy. In particular, I focus on three different cohorts.

²¹These numbers were computed using information from the 2002 directory of the Catholic Church in Chile.

People older than 37 in 2000 (the year the CASEN survey was collected) attended school before the reform was implemented; people between 26 and 37 years attended school between 11 years and one year after the reform was implemented; and those less than 26 received their complete K-12 education after the reform was implemented. Because I do not have data on test scores before the reform, I use high school graduation as a proxy for school quality.

The results in Table 3 suggest that the number of priests has no relationship to high school graduation rates for people attending school before 1981 (column 1). For the second group (i.e. those receiving only a share of their primary and secondary education after 1981), the effect of priests is slightly bigger but still not significant. Finally, for those receiving their entire education after 1981, priests have a positive and marginally significant effect on educational outcomes. Overall, this evidence supports the idea that priests are correlated with educational outcomes only for the cohorts that attended school after the 1981 reform.

Figure 1 presents a more detailed exercise to evaluate the differentiated effects of priests on educational outcomes for cohorts that have different degrees of exposure to the 1981 reform. This figure plots the relation between high school graduation and priests in the decade closer to school attendance for individuals of different ages in 2000. This exercise also allows me to study whether the effect of the reform varies for individuals of different ages. The results suggest that priests are only correlated with the level of education for cohorts that attended school after the reform was implemented. As importantly, the effect of priests on high school attainment is increasing in the number of years that people attended school after the reform.

Overall, these results demonstrate the claim that priests only are correlated with educational outcomes after the 1981 reform, and they confirm the rationale presented in Section 5. Having established this central result, I present a number of additional exercises to validate my identification strategy. Columns (1) and (2) in Table 4 presents estimates of the relationship between priests per capita and the ratio of order-to-total priests in 1950 and the ratio of voucher-to-public schools in each market in the voucher period. Priests and the ratio of order-to-total priests both have a positive and significant effect on the number of voucher schools per public school. The effect of Catholic affiliation is also positive and significant, as expected.²² Column (3) presents the same regression but using voucher school enrollment as the measure of voucher school entry

²²Results for other variables included in these regressions are similar to other papers in the literature: mean (standard deviation of) education and income have positive (negative) effects on the availability of voucher schools, and more populated areas have more voucher schools.

(as in all the other papers in the literature). Again, priests have a positive and significant effect on voucher school enrollment.

Column (4) presents estimates of the effect of priests on the *change* in public school enrollment from the pre-reform period. I was able to compute public enrollment rate for 52 geographical areas for 1975 from MINEDUC (1975)—the geographical classification corresponds to the split between urban and rural of 26 provinces covering the complete Chilean territory. I define the change in enrollment in public schools as enrollment today minus enrollment in 1975 in the area where the school is located. Results imply that public school enrollment decreased more in areas with more priests, confirming my argument in Section 5. The last three columns study the correlation between priests and Catholic and non-Catholic voucher schools. The results imply that priests are correlated with both the entry of Catholic and non-Catholic voucher schools. Moreover, the ratio of Catholic to non-Catholic schools does not seem to be affected by priests. Thus, these results confirm my argument of the potential effects of priests on the entry of non-Catholic voucher schools.

I present additional evidence of the differential effect of priests after and before the voucher reform in Table 5. This table studies the effect of priests on the attendance to voucher schools for members of cohorts that attended school after and before the voucher reform. Data come from the 2002 Social Protection Survey. I study whether priests have a different effect on the likelihood of attending a voucher school before and after the reform, controlling for a dummy for urban areas, and region and age dummies. Results both coming from linear probability and probit models suggest that priests are more related with the decision to attend a voucher school after the reform, as expected. Results for the effect of priests on private school attendance before 1981 are inconclusive: the linear probability model suggests a positive and significant effect, but the probit model suggests an insignificant effect. Overall, evidence in this table confirms the hypothesis that priests are more important to explain voucher school attendance over the voucher period.

One potential concern for my identification strategy is that priests may have affected education outcomes after the reform through other channels than voucher-school competition. In this context, I study whether immigration decisions of families with school-age children are correlated with the presence of priests in different areas. If immigration rates of families with children are higher in areas with more priests, then an alternative explanation may be sorting of families based on taste/motivation for education. I do not expect this channel to be important, given the available evidence showing

that migration in Chile is low because of public housing policies (Soto and Torche, 2004; Tironi, 2003). The results in Table 6 confirm this presumption and show that both micro estimates of in-migration decisions of families with children and macro estimates of immigration rates at the region level do not support the view that in-migration rates are higher in areas with more priests.

Overall, I document that the number of priests per person is historically determined; prior to 1981, it has little effect on educational outcomes. I also show that Catholic priests affected educational outcomes after the voucher system was established and are correlated with several proxies of the levels of and changes in voucher school entry. These results suggest that I have a potentially valid source of exogenous variation in the supply of voucher schools in different areas during the voucher period. Using these results, the next section estimates the level effects of voucher-school competition on student test scores in a cross-section of students in 2002.

7 ESTIMATING LEVEL EFFECTS

In this section, I present the results of regressions using information on test scores from a cross-section of students in the voucher period. This approach has several advantages over the reduced form estimates I presented before. First, I have detailed information on the degree of voucher-school competition in the educational market where the student attends school. Second, I have a more direct measure of school outcomes (test scores) than in the previous exercises (high school graduation), which allows me to estimate more precisely the effect of voucher-school competition on test scores. Third, I am able to study whether the interaction effects predicted by the model are supported by the data. Since the results in Section 6 suggest that priests only affect educational outcomes after the reform, the number of priests per capita prior to 1981 is a valid instrument for voucher-school competition during the reform (as well as for the interaction of priests with the reform). Thus, I estimate the impact of voucher-school competition on student test scores by running a regression of the form:

$$q_{im} = \pi R_m + X'_{im}\alpha + M'_m\beta + Y'_m\rho + \varepsilon_{im}. \quad (4)$$

Subscript i refers to students and m to educational markets. q is test scores, R is the ratio of voucher to public schools in market m , X is a vector including pre-school characteristics of students (mother's education and log of income per household member), M is a vector including the mean and standard deviation of mother's education and income at the market level, Y is a vector including exogenous variables (Catholic popu-

lation, total school age population, urbanization rate, and region dummies), and ε is a student-specific error term.²³

Following the model presented in Section 3, I use the ratio of voucher-to-public schools as my measure of voucher-school competition— R_m in equation (4)—at the market level. When I compute the number of voucher schools per public school at the market level, I obtain the average availability of voucher schools per public school in each neighborhood (assuming that one public school exists in each neighborhood, which is reasonable in the case of Chile).

I estimate equation (4) using the log of Catholic priests per person in 1950, or the ratio of order-to-total priests (only in some regressions to save space), as my instrument for R_m . In addition, as discussed in Section 5, the ratio of order-to-total priests corresponds to a more basic source of variation in the number of priests in different areas in Chile. Thus, I also present IV estimates using the ratio of order-to-total priests as an alternative instrument (in one specification I use both variables as instruments for voucher-school competition). I use variables measured in 1950, which corresponds to the end of the period of entry of Catholic orders into Chile.

7.1 TEST SCORE REGRESSIONS

I first estimate equation (4) using the complete sample of students attending public and voucher schools in the 2002 SIMCE dataset. Table 7 presents OLS estimates (columns 1-2) and IV estimates of equation (4) using log of priests in 1950 (columns 3-4) and the ratio of order-to-total priests (columns 5-6) as my instruments for R_m . In each case, I present first a parsimonious representation of the regression without including controls and only including my measure of voucher-school competition. Next, I include market- and student-level controls. The IV estimates are larger than the OLS estimates as suggested by my model, because school entry may be endogenous to quality. While the OLS estimates are -0.02 and 0.04, the IV estimates are in the interval between 0.13 and 0.17.²⁴ The IV point estimates are always positive and significant. These results imply that the effects of voucher-school competition on test scores are also economically relevant. An increase of one voucher school per public school in a market is associated with an increase in test scores of between 0.13 and 0.17 standard deviations. This is

²³Since I include multiple observations of variables in the same area, I use the White/Huber estimator of the variance-covariance matrix to compute corrected standard errors that are robust to arbitrary heteroskedasticity and clustered standard errors.

²⁴Measurement error in voucher-school competition may also explain why my OLS estimates are smaller than my IV estimates.

equivalent to about half of the effect of increasing mother’s attainment from primary to secondary general education.

Estimates for other variables included in the regression have the expected signs. All socioeconomic controls are significant and have the expected sign: students with more educated mothers tend to perform significantly better, and students from households with higher incomes have higher test scores. The only two market-level variables with a statistically significant effect are mean per capita income (a positive effect) and the school-age population of the market (negative effect). The effect of the share of Catholics is negative, but it is not precisely estimated.

Next, column (7) in Table 7 presents estimates using *both* priests and the ratio of order-to-total priests as instruments. As expected, the estimated effect falls between the estimates in columns (4) and (6). More importantly, an over-identification test of this specification does not reject the null hypothesis that the instruments are valid. Formally, the result of the over-identification test implies that IV estimates using each of the two instruments separately are not statistically different among them.

These estimates of the effect of voucher school competition on test scores are in the range of the estimated results of previous studies for Chile. My estimates imply that a one-standard deviation increase in voucher school competition increases test scores by about 0.10 standard deviations. Auguste and Valenzuela (2003) find an effect of the same size at the student level, Contreras and Macias (2002) report an effect of a one-standard deviation increase in the Herfindahl index in the interval of 0.08 and 0.17 standard deviations of test scores, and Gallego (2002) presents estimates that imply an increase of between 0.03 and 0.18 standard deviations of the test scores when his measure of competition increases by one-standard deviation. In contrast, my estimates are slightly smaller than the effects of inter-school competition reported in papers for the US. Bayer and McMillan (2005) and Hoxby (2000) report that a one-standard deviation increase in their proxies for the degree of inter-school competition increases test scores by about 0.15 standard deviations.

The estimates on the effect of voucher-school competition on test scores also are consistent with my reduced-form estimates of the effects of priests on high school graduation rates reported in Section 6. My reduced-form estimates in the previous section imply that a one-standard deviation increase in the (log of the) number of priests (roughly equivalent to 43 log points) increases high school graduation by about 11 percentage points for people attending school after the reform (computed using results from Figure 1). In turn, a similar increase in the number of priests increases the ratio of voucher-

to-public schools by about 0.22 (Table 4), which increases test scores by between 0.031 and 0.037 standard deviations. To relate both results, I use the estimates of Hanushek and Kimko (2000), who find that a one-year increase in schooling is associated with an increase in about 0.042 standard deviations in test scores. In my sample, a person who graduated from high school has about six years more of education than the rest of the population. Putting everything together, I expect the impact of the increase in high school graduation to be consistent with an increase in test scores of 0.03 standard deviations ($0.11 \times 0.042 \times 6 \approx 0.028$). Therefore, reduced-form estimates of the impact of vouchers on high school graduation and cross-section estimates of the effects of voucher school competition on test scores are consistent.

Table 7 presents additional specifications in which I replace my measure of voucher-school competition by three alternative measures: the share of enrollment in voucher schools (Auguste and Valenzuela, 2003; Gallego, 2002; Hsieh and Urquiola, 2004), the Herfindahl index (Contreras and Macias, 2002), and the change in enrollment in public schools between the pre-reform (1975) and post-reform periods (2002). Results in the last three columns of Table 7 imply a positive effect of the three alternative measures of voucher school competition on test scores. The size of the effects of a one-standard deviation increase of competition on test scores varies across specifications: while the implicit estimates in columns (8) and (9) imply an increase of test scores of about 0.15 standard deviations, estimates in column (9) imply a probably unreasonable increase of test scores of 0.48 standard deviations.

I study several specifications checks in Table 8. First, I study one potential concern with the results in Table 7: some variables, such as income and mother's education, may be affected by my instruments if parents attended school after the reform. If mother's education and income do not involve measurement error, then my earlier estimates can be interpreted as the direct effects of voucher-competition on student outcomes. However, if mother's education and income are subject to measurement error, then the estimates of voucher-school competition may be biased upward.²⁵ To deal with this potential problem, Column (1) presents the results excluding students with parents who attended school after the reform (i.e. parents older than 39 years). The results are very similar to those shown in Table 7, suggesting that my previous estimates do capture the direct effect of voucher-school competition on test scores, controlling for mother's education and income.

Next, Column (2) presents the results of excluding schools located in rural areas.

²⁵More precisely, mother's education and income may not capture all the effects of mother's human capital on children's educational outcomes.

The implicit assumption in the model in Section 3 applies for students that have low physical transportation costs of moving from one school to another. I expect the effects of competition to be significantly smaller if students cannot move easily from one school to another, as expected in rural areas. Results in Column (2) confirm this idea: the point estimate of inter-school competition increases when excluding rural schools. The next two columns deal with the potential effect on the results of the Santiago Metropolitan Area. Santiago is at the same time the biggest market (includes about 28% of the students in my sample) and one of the markets with the highest ratio of voucher to public schools (2.41 voucher schools per public school). To deal with the size effect without losing information on a market that has a high degree of choice, I report in columns (2) and (3) the results of running 50 regressions excluding randomly 90% and 50% of the Santiago students. Point estimates are smaller but positive, statistically significant, and in the confidence interval of the estimates for the complete sample.

Next, Columns (5) to (7) present the results of an additional exercise: I include controls for systematic differences in pre-reform educational outcomes in equation (4). I use three proxies for pre-reform outcomes: (i) high school graduation rate in public schools for cohorts that attended school before 1980 from the Social Protection Survey (column 5), (ii) high school graduation rate at the municipality level for cohorts that attended school before 1980 from the CASEN survey (column 6), and (iii) average 1991 SIMCE test scores at the municipality level (column 7), (indeed, this test score was applied 10 years after the reform was implemented, but at the same time (i) 1991 corresponds to the first year for which I have complete information for all the schools after the decentralization of the management of public schools was completed and (ii) as previously discussed, it is hard to argue that a real voucher system was in operation until at least the mid 1990s). Even though my results in Section 6 suggest that my instruments are not correlated with pre-reform differences in academic outcomes, these results provide an additional check. The results show that my main estimates of the effect of the ratio of voucher-to-public schools change slightly in value, but remain statistically significant. The point estimates for the effect of voucher school competition decrease slightly in columns (6) and (7), and increase slightly in column (5).

Next, column (8) of Table 8 introduces controls for the composition of students at the school level: mean and standard deviation of mother's education and per-capita income. I follow Hoxby (2000) in including these variables without giving a formal interpretation to the estimates I find, and, therefore, I only focus on the effect of including these variables on the estimate of voucher-school competition on test scores. Results imply

that the point estimate of the effect of voucher school competition is basically unchanged with respect to most other estimates I present in Tables 7 and 8. Unfortunately, I do not have additional valid instruments to study the causal effects of peer-effects on test scores, but results in this column are at least suggestive that peer-effects are not driving my main results.

I take an alternative way of analyzing whether peer-effects are driving my results in the last two columns of Table 8, where I present estimates for sub-samples of students in public and voucher schools. These sub-samples allow me to analyze whether the estimated effect of voucher-school competition on student outcomes in public schools is different than for voucher schools. These exercises have interest from two perspectives: (i) I am able to study empirically the predictions of Corollary 2 and (ii) I am able to test the conjecture of some papers that voucher-school competition may increase average test scores but students attending public schools may be harmed if voucher schools are able to cream-skim. Indeed, I cannot disentangle the contributions of both perspectives without an additional source of exogenous variation.

Since I estimate (4) for sub-samples of students, I implement a Heckman selection model with endogenous variables (Wooldridge, 2002). This procedure allows me to control for potential selection bias if the students included in these regressions are not randomly selected from the population. To implement this procedure, I need to find a variable that affects the selection of students in different schools and has no direct effect on test scores. My instrument in the selection equation is a dummy that takes a value of one if the teaching of values was among the top three criteria used by parents for choosing schools. Since the mention of "teaching of values" (i.e., *la enseñanza de valores* in Spanish) has a religious connotation in Chile, this variable may capture relative preferences for voucher vis-a-vis public schools, or Catholic vis-a-vis non-Catholic voucher schools.²⁶ In terms of my model, the values variable is a proxy for the location of parents in the linear city.

In the initial stage of the estimation, I run a selection equation of the following form, using probit:

$$p_{im} = \mathbf{1} \left(\varphi S_{im} + \zeta Z_m + X'_{im} \xi + M'_m \varkappa + Y'_m \tau + \mu_{im} > 0 \right), \quad (5)$$

where p_{im} takes a value of 1 if an observation is included in the regression of interest, S_{im} is some variable that affects p_{im} and is not included in equation (4), Z_m is an instrument

²⁶Other papers have found that parents' preferences for the teaching of values affect the choice of private versus public schools in the US (Sander, 2001). In a related result, Howell (2004) finds that religious identity affect the participation in a voucher program in New York.

for R_m (i.e., priests per capita), and $\mu_{im} \sim N(0, 1)$. Notice that in this equation I include all the right-hand side variables included in the first stage of (4). Next, for the selected subsample (i.e., for observations with $p_{im} = 1$), I estimate the equation:

$$q_{im} = \pi R_m + X'_{im}\alpha + M'_m\beta + Y'_m\rho + \psi\hat{\lambda}_{im} + \varepsilon_{im}$$

by 2SLS, excluding S_{im} from the second stage regression. $\hat{\lambda}_{im}$ is the estimated inverse Mill's ratio for each observation.

Table 9 presents probit estimates of the marginal effects of the variables included in equation (5) on the choice between attending a public versus a voucher school and the choice between a non-Catholic versus a Catholic voucher school. The results indicate that the values variable is significantly correlated with the decision to send the student to a non-Catholic school. Marginal effects imply that if parents care about the teaching of values, they are 36% less likely to send their children to a public school versus a voucher school, and are 28% less likely to send their children to a non-Catholic voucher school vis-a-vis a Catholic voucher school.

Estimates for other variables included in equation (5) confirm previous results in the literature on the socioeconomic determinants of attending a public school (e.g. Sapelli and Vial, 2002 and 2003 for Chile; Checchi and Jappelli, 2004 for Italy): mother's education and family income have a negative and significant impact on the probability of attending a public school. Other estimates in column (1) suggest that market characteristics are also important: the probability of attending a public school drops in urban and more populated areas, in poorer areas, and in areas where Catholic affiliation increases. Results for the probability of attending a non-Catholic versus a Catholic voucher school indicate that education and income play a similar role to the choice between a public and a voucher school, although the estimated effects are smaller and less significant. Similarly, the probability of attending a non-Catholic voucher school decreases in areas with a larger Catholic population and increases in more populated markets. Interestingly, as previously discussed, priests do not have a significant effect on the probability of attending a non-Catholic vis-a-vis a Catholic school.

Using these probit models, I include the inverse of the Mills ratio in the second stage regression (columns (9) and (10) in Table 8). From these regressions, I obtain estimates that allow me to evaluate whether the effect of an additional voucher school is greater on public schools or existing voucher schools. The results show that the effect of an additional voucher school is quantitatively similar for public and voucher schools.

The results in the last two columns of Table 8 confirm the prediction of Corollary 2 in my model: public schools may react similarly to the entry of an additional voucher school

if most public schools face competition from at most one voucher school as the data for Chile confirm and the difference between the minimum quality offered by public schools and the minimum quality offered by voucher schools is sufficiently high. As previously discussed, an alternative interpretation of these results is that either voucher schools do not tend to cream-skim, peer-effects do not have a causal impact on test scores, *or* the incentive effects created by the voucher system on public school students dominate any cream-skimming effect.

Finally, I present quantile regression estimates of voucher-school competition for students in different positions of the distribution. Results suggest that the estimated effects do not vary a lot across quantiles, but are slight smaller for the students in the 1st and 10th quantile than for the other students. Therefore, these results also suggest that the effect of voucher-school competition on test scores do not vary significantly accordingly to the students characteristics.

Overall, the evidence presented in this section presents a consistent pattern of positive effects of voucher-school competition on test scores for the average student and for students attending public and voucher schools, as predicted by the model. In the next subsection, I study the effects of voucher-school competition on expenditures, productivity, and student composition at the school level.

7.2 EXPENDITURES, PRODUCTIVITY, AND STUDENT COMPOSITION

This subsection studies the role that expenditures in education play in my previous results. I present results for the effects of voucher school competition on private, public, municipal (i.e. not related to the voucher or other central government programs), and total expenditure per capita in columns (1) to (4) of Table 10. The main motivation for these exercises is to study whether competition increases test scores by increasing expenditure in education. Results imply positive and significant effects on municipal, total public, and total expenditures per student. Only the implicit elasticity of the increase in municipal transfers is economically relevant (1.04), in all the other cases the implicit elasticities are smaller than 0.20. This result is interesting because suggests that local governments are able to increase expenditure in education, as competitive pressures increase. This has the positive effect that the increase in expenditure may reflect a higher effort to increase quality as a response to political pressures, but, at the same time, as suggested in my theoretical discussion, non-voucher transfers may dampen the incentive effect created by competition on test scores. I study the latter in the next section using a potentially valid source of exogenous variation of non-voucher transfers

to local governments.

Next, column (5) in Table 10 study how competition affects the copayment level in voucher schools. In the model I assume that there are no prices because copayments represent in average less than one third of public expenditure in education. In this sense, the model can be interpreted in terms of the effort that agents exert. However, in a more general model, voucher schools subject to competition may decrease prices. This is exactly what results in column (5) show: an increase in competition decreases copayment charged. Interestingly, the implicit elasticity is also economically significant: a one-percent increase in competition decreases copayments by 0.3%.

Overall, results in column (3) imply that an increase in competition increases total expenditure per-capita. However, the increase is relatively small: a one-standard deviation increase in competition increases total expenditure per-capita by about 9%. Given these results, in columns (6) and (7) I study the effects of competition on the *productivity* of education expenditure. I define two proxies for productivity: the (normalized) ratio of test scores to total expenditure per student and the log of total expenditure per student, respectively. These are rough measures of productivity—i.e. test scores per unit of expenditure—that can be interpreted as proxies for agents effort, their key choice variable in my theoretical model. Results suggest that the effects of voucher-school competition on both measures of productivity are positive and significant. An increase of one-standard deviation of voucher school competition increases normalized 0.20 and 0.23 standard deviations of the productivity indexes. These results imply that voucher-school competition increases the productivity of schools, as emphasized in the theoretical model of this paper.

The last three columns of Table 10 study how competition affects the composition of students within schools. Again, this is not present in my theoretical model, but extensions where parents and/or school agents value homogeneity in their schools may predict that increases in competition decrease the dispersion of student characteristics within schools.²⁷ I study this idea using an index of the distance of each student to the average student in her school. I use two measures of socioeconomic characteristics (mother's education and per-capita income) and test scores as measures of student characteristics. My results are not conclusive about the effect of competition on test scores, but imply a negative and significant effect of competition on the heterogeneity of mother's

²⁷Results in Gallego and Hernando (2006) support this presumption: in equilibrium students in Santiago tend to attend schools with similar peers in terms of mother's education, income, gender, and preferences for the teaching of values. Work in progress is trying to disentangle the effects of supply and demand factors to explain this equilibrium allocation of students.

education within schools, a negative but insignificant effect on heterogeneity of income within schools, and a positive and marginally significant effect on the heterogeneity of test scores within schools.

8 ESTIMATING INTERACTION EFFECTS

In this section, I expand the previous analysis by studying the implication of my model that there should be interaction effects: public school response to exogenous changes in voucher school competition depends on how binding the minimum enrollment is. Corollary 3 predicts that the effect of voucher school entry on test scores is smaller for schools that have low minimum enrollment levels (which in the model corresponds to receiving big non-voucher transfers). If this is the case, public schools can meet the minimum enrollment constraint more easily. This result illustrates the theoretical mechanism at work in the model, which is related to the implicit incentives that the minimum enrollment constraint presents for public school agents. In this section, I test this prediction against the data using proxies for (i) the size of the education deficit as a percentage of education revenues (a proxy for non-voucher transfers) and (ii) the average size of public schools in different municipalities. I interpret these characteristics as the degree of softness of the public school budget constraints.²⁸ Using these proxies, I study whether differences in these proxies affect the response of public schools to voucher-school competition. To do so, I split the sample of public schools into those located in municipalities that have education deficits above and below the median, and public schools located in municipalities that have average school sizes above and below the median of the distribution. I expect the effect of voucher-school competition to be larger in the samples in which education deficits are relatively low and average school size are relatively big.

I use a short-lived change in the Chilean electoral law that allows me to identify the short-run variation in deficits and average school size and, therefore, to control for potential selection bias in my estimates. The electoral law operating between 1999 and 2003 establishes that a mayor (who manages the public schools) is the elected member of the municipal council who receives the most votes (conditional on getting at least 20% of the votes). This source of variation is useful for my identification strategy because,

²⁸In general, non-voucher transfers are not allocated to local government in a transparent way. Serrano and Berner (2002) document the transfer process for the case of local government education debts related to teacher pensions. As the authors document, it is not easy to follow the actual decision process in part because central government authorities did not want to establish precedents to be used by other mayors.

as previously discussed, municipalities receive discretionary transfers from the central government and pro-government mayors are able to raise more of these funds.

I implement a difference-in-difference regression to study the effects of the 1999 electoral law on my two proxies for the degree of bindingness of the minimum enrollment level in the context of a selection model of the form:

$$P_m = \mathbf{1} \left(\varphi V_m K_m + \varpi V_m + \phi K_m + \zeta Z_m + M'_m \varkappa + Y'_m \tau + \mu_m > 0 \right), \quad (6)$$

where P_m is an indicator function that takes a value of one if the municipality has an education deficit above the median or an average public school size below the median; V_m is the share of votes that goes to the pro-government coalition; and K_m is a dummy that takes a value of one if the mayor belongs to the pro-government coalition. I exclude the interaction of V_m and K_m from (4) and include each variable separately, as well as the estimated inverse of the Mills-ratio in (4). Table 11 presents my marginal probit estimates of equation (6). The results indicate that the interaction variable has a positive and significant effect: the probability that a municipality has an education deficit above the median increases by 50% and average school size below the median increases by about 40% if the mayor belongs to the pro-government coalition and the probability of having, given the vote obtained by the pro-government coalition.

Table 12 presents estimated interaction effects. I present estimates including selection correction in the top panel and without including selection correction in the bottom panel. Results in both cases are qualitatively similar. The results for the subsample of students attending public schools that have high education deficits and low average school sizes tend to react by less than the other schools (and only in one case the reaction is positive and statistically significant). Overall, these results show that proxies for the bindingness of the minimum enrollment level affect the degree of response of public schools to voucher-school competition, as predicted by my model and support the existence of heterogeneous effects of voucher school competition on public schools. These results are hard to reconcile with alternative explanations for the positive effects of voucher school competition.

9 CONCLUDING COMMENTS

The potential effects of school vouchers and inter-school competition on student outcomes has been a much debated topic in the US and elsewhere. My study of the Chilean voucher system, which has operated for more than 20 years in the complete K-12 system, can help us to understand the effects of vouchers on educational outcomes. Previous

research has been stymied by endogeneity problems. I argue that the interaction of the variation in the number of priests per person across Chilean areas in 1950, and the institution of the voucher system in 1981, allows me to identify the effects of voucher-school competition on test scores. I document that the number of Catholic priests *is not* correlated with educational outcomes in the pre-voucher period and *is* correlated with educational outcomes in the post-1981 period. This result allows me to use the number of priests per person in 1950 as an instrument for voucher-school entry during the voucher period.

I find that once I instrument for the ratio of voucher-to-public schools in an area, one additional voucher school per public school increases test scores by about 0.14 standard deviations. The magnitude of this effect on test scores is equivalent to about half of the effect of increasing a mother's attainment from primary to secondary education. These results are roughly similar for students attending public schools and students attending non-Catholic voucher schools.

My estimates of the effects of school competition on test scores are smaller for students attending public schools that face less binding minimum enrollment, measure using two alternative proxies. While agents operating voucher schools receive higher payoffs if they increase enrollment, agents operating public schools receive fixed wages and only have to meet a minimum enrollment constraint. Therefore, agents operating in areas where the minimum enrollment constraint is less binding react less to voucher-school competition, as predicted by the theoretical model presented in the paper. Overall, the evidence is consistent with a theoretical rationale that emphasizes the role of incentives provided by voucher-school competition.

My results do not imply that selection or segregation are not relevant issues in the Chilean case. Rather, controlling for characteristics of students and markets, there are sizeable direct effects of competition on test scores. More than 20% of educational markets in Chile have no voucher school in operation. Similarly, there are heterogeneous effects of voucher school competition for public school students, depending on how binding minimum enrollment constraints are. Thus, the introduction of the voucher system does increase educational inequality in Chile. The paradox, though, is that the Chilean system does not become more unequal because of the existence of voucher schools, but rather because of the absence of voucher schools in some areas, and the absence of strong incentives for some public school agents. The government could correct this inequality while preserving school choice by using the right incentives, such as letting per-student subsidies depend upon student characteristics, as proposed by Gonzalez et al. (2002)

Hoxby (2001), and Sapelli (2003), or by creating explicit incentives that relate the welfare of public school agents to student outcomes.

A APPENDIX: PROOFS

A.1 RESULT 1

First, notice that if $N = 0$, $n_P = \bar{L}$.

Second, I analyze the case when $N = 0$. Define \bar{x} as the location of parents that are indifferent toward both types of schools. These parents determine the share of the market going to each school. \bar{x} is given by:

$$\bar{x} = \frac{q_P - q_V + t}{2t} = \frac{q_P - q_V}{2t} + \frac{1}{2}.$$

This expression implies that the number of students attending public and voucher schools are $\bar{x}\bar{L}$ and $(1 - \bar{x})\bar{L}$, respectively. Therefore,

$$n_P = \bar{L} \frac{q_P - q_V}{2t} + \frac{\bar{L}}{2}, \text{ and}$$

$$n_V = \bar{L} \frac{q_V - q_P}{2t} + \frac{\bar{L}}{2}.$$

Regarding the distribution of students among voucher schools. If $N = 1$ obviously the enrollment of the only market school in the market is n_V . If $N \geq 1$, since parents randomize among all schools that offer the same quality, the probability that each of them is selected is $\frac{1}{N}$, which implies that:

$$n_{Vi} = \frac{n_V}{N} \quad \text{if } N \geq 1.$$

A.2 RESULT 2

Since quality is costly and that the only incentive to increase quality above the minimum level is to meet the minimum enrollment constraint, always one of the two constraints will bind in equilibrium. The simplest case is when $N = 0$, then optimal public school quality is q_P^M .

If $N > 0$ and the minimum quality constraint binds (i.e. Condition 1 does not hold), $q_P = q_P^M$. This will be the case if:

$$\left(\frac{\bar{n}}{\bar{L}} - \frac{1}{2}\right) < \frac{q_P^M - q_V}{2t}. \tag{7}$$

In this case, the number of students attending public schools is:

$$n_P = \bar{L} \frac{q_P^M - q_V}{2t} + \frac{\bar{L}}{2}.$$

If Condition 1 holds, then the minimum enrollment constraint binds and, therefore, $n_P = \bar{n}$. Given Result 1, optimal public school quality is:

$$q_P = 2t \left(\frac{\bar{n}}{\bar{L}} - \frac{1}{2} \right) + q_V.$$

A.3 RESULT 3

Voucher schools enter the market if:

$$\left[(v - c^V(q_V)) \frac{n_V}{N} - F \right] \geq 0.$$

$N^* = 0$ if

$$(v - c^V(q_V^M)) n_V < F.$$

because in this case, even producing the lowest possible level produces negative profits.

Using a similar argument, $N^* = 1$ when:

$$\begin{aligned} (v - c^V(q_V^M)) n_V &\geq F, \text{ and} \\ (v - c^V(q_V^M)) \frac{n_V}{2} &< F. \end{aligned}$$

Analogously, $N^* = 2$ when:

$$\begin{aligned} (v - c^V(q_V^M)) \frac{n_V}{2} &\geq F, \text{ and} \\ (v - c^V(q_V^M)) \frac{n_V}{3} &< F. \end{aligned}$$

Generalizing this argument, N^* has to satisfy:

$$\begin{aligned} (v - c^V(q_V^M)) \frac{n_V}{N} &\geq F, \text{ and} \\ (v - c^V(q_V^M)) \frac{n_V}{N+1} &< F. \end{aligned}$$

Rearranging terms:

$$(v - c^V(q_V^M)) \frac{n_V}{N+1} < F \leq (v - c^V(q_V^M)) \frac{n_V}{N}.$$

A.4 RESULT 5

If Condition 1 holds, $N = 1$, and $N^P = 1$, voucher schools face no competition from other voucher schools and public schools will respond to their choices in order to meet the minimum enrollment constraint. Therefore, voucher schools face a constant demand $n_V = (\bar{L} - \bar{n})$, for any level of quality they offer. Then, profit maximization implies that voucher schools offer:

$$q_V = q_V^M.$$

If $N = 1$, but $N^P = 2$, and Condition 1 holds, the incumbent voucher has to offer a quality level such that the potential entrant is indifferent, i.e., profits have to be 0. Thus,

$$q_V = c^{V-1} \left(v - \frac{NF}{\bar{L} - \bar{n}} \right).$$

If Condition 1 does not hold, and $N = 1$, $N^P = 1$, the only difference with the previous case is that enrollment in the voucher school is not constant. Moreover, Result 1 implies that voucher school enrollment is increasing in voucher school quality (notice that the public school produces q_P^M). Therefore, the optimization of the voucher school is:

$$\text{Max}_{q_V} \left[(v - c^V(q_V)) \bar{L} \left(\frac{q_V - q_P^M}{2t} + \frac{1}{2} \right) - F \right],$$

the first order condition of this problem is (assuming an interior solution):

$$c^{V'}(q_V) n_V - \frac{c^V(q_V) \bar{L}}{2t} = 0 \Leftrightarrow \frac{c^V(q_V)}{c^{V'}(q_V)} = 2t \frac{n_V}{\bar{L}}.$$

Finally, If Condition 1 does not hold, and $N \geq 1$, and $N^P \geq 2$, competition between voucher schools imply that profits of incumbents go to 0, and, therefore:

$$q_V = c^{V-1} \left(v - \frac{NF}{n_V} \right).$$

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Table 1: Descriptive Statistics

Variable	Obs.	Mean	Median	Standard Deviation	5th percentile	95th percentile	Source
Student-level variables							
Test scores (standardized)	187610	-0.03	-0.03	0.97	-1.71	1.49	SIMCE
Mother's education							
Primary	187610	0.35	0.00	0.48	0.00	1.00	SIMCE
Secondary-General	187610	0.32	0.00	0.47	0.00	1.00	SIMCE
Secondary-Technical	187610	0.16	0.00	0.37	0.00	1.00	SIMCE
Higher-General	187610	0.08	0.00	0.27	0.00	1.00	SIMCE
Higher-Technical	187610	0.09	0.00	0.28	0.00	1.00	SIMCE
Average Years of Schooling	187610	9.84	11.00	3.31	5.00	15.00	SIMCE
Log(Per-Capita Income)	187610	10.27	10.31	0.90	8.87	11.83	SIMCE
Values among the three most important reasons for choosing a school	187610	0.28	0.00	0.45	0.00	1.00	SIMCE
Voucher school	187610	0.43	0.00	0.50	0.00	1.00	SIMCE
Catholic voucher school	187610	0.15	0.00	0.39	0.00	1.00	http://www.iglesia.cl/
Public expenditure per-capita	161563	27451	22128	12986	19219	52540	SIMCE, http://www.sinim.cl/ , MINEDUC
Private expenditure per-capita	180288	19309	12500	21548	2500	60000	SIMCE
Municipal transfers per-capita	96564	4115	1688	8332	0	12698	http://www.sinim.cl/
Total expenditure per-capita	155197	46643	40971	22261	23465	87582	Author's calculations
Copayments	183035	5730	2500	10288	0	25000	SIMCE
Productivity index 1 (test scores divided by total expenditure)	155197	-0.04	0.03	0.99	-1.79	1.47	Author's calculations
Productivity index 2 (test scores divided by log total expenditure)	155197	0.02	0.08	1.00	-1.71	1.58	Author's calculations
Individual-level variables							
High school graduation dummy	75805	0.40	0.00	0.49	0.00	1.00	CASEN
Immigration dummy	8857	0.17	0.00	0.37	0.00	1.00	Social Protection Survey
Market-level variables							
Ratio of Voucher to Public Schools	298	0.47	0.25	0.70	0.00	1.6	Ministry of Education
Mean years of schooling	298	8.82	8.66	1.29	7.21	10.96	SIMCE
Standard Deviation of Years of schooling	298	3.45	3.47	0.47	2.70	12	SIMCE
Mean Log Income	298	10.02	9.94	0.37	9.55	10.71	SIMCE
Standard Deviation of Log Income	298	0.85	0.85	0.14	0.66	1.08	SIMCE
Log School-Age Population	298	8.38	8.36	1.28	6.32	10.7	http://www.sinim.cl/
Urbanization Rate	298	0.34	0.25	0.28	0.00	0.93	Ministry of Education
High-School Graduation Rate							
37<age	304	0.28	0.26	0.14	0.08	0.56	CASEN
25<age<38	304	0.46	0.45	0.17	0.20	0.74	CASEN
age<26	304	0.52	0.53	0.16	0.24	0.79	CASEN
Pro-Government Mayor	331	0.51	0.00	0.50	0.00	1.00	Electoral Office
Pro-Government Vote	331	0.53	0.52	0.15	0.25	0.78	Electoral Office
Diocese-level variables							
Priests per 1000 people in 1950	26	0.32	0.31	0.13	0.15	0.54	Annuario Pontificio
Priests per 1000 people in 2000	26	0.15	0.14	0.04	0.08	0.21	Annuario Pontificio
Catholic Affiliation	26	0.78	0.79	0.08	0.68	0.90	Annuario Pontificio
Ratio of Religious to Total Priests	26	0.45	0.44	0.16	0.17	0.66	Annuario Pontificio
Region x Urban/Rural variables							
High-School Graduation Rate							
39<age	26	0.27	0.27	0.17	0.05	0.5	Social Protection Survey
27<age<40	26	0.47	0.59	0.22	0.17	0.71	Social Protection Survey
age<28	26	0.60	0.65	0.24	0.22	1	Social Protection Survey
High-School Graduation Rate in Public Schools							
39<age	26	0.26	0.27	0.16	0.08	0.5	Social Protection Survey
27<age<40	26	0.45	0.54	0.20	0.17	0.67	Social Protection Survey
age<28	26	0.55	0.62	0.26	0.00	1	Social Protection Survey
Voucher school attendance (% of total population)							
39<age	26	0.05	0.05	0.04	0.00	0.12	Social Protection Survey
27<age<40	26	0.08	0.07	0.06	0.00	0.23	Social Protection Survey
age<28	26	0.11	0.12	0.09	0.00	0.27	Social Protection Survey

Notes: Detailed definitions of each variable appear in the main text

Table 2
Determinants of Priests per Capita in 1950:
Religious Order Effects

Dependent Variable:	Log of Priests per 1,000 people in 1950			
	(1)	(2)	(3)	(4)
Log(income)	0.28 (0.27)		0.10 (0.26)	
Schooling		0.13 (0.09)		0.06 (0.09)
Ratio of order to total priests			1.25 (0.52)	1.19 (0.53)
R ²	0.0462	0.0783	0.2415	0.2494
Number of dioceses	26	26	26	26

Cross section regressions, each observation represents the value for a dioceses.

Robust standard errors in parentheses. Constants are not reported

Table 3
Municipal level regressions for
educational outcomes *before* and *after*
the reform

Dependent Variable:	High-School Graduation Rate		
Sample:	Age >37	37>=Age>=26	Age<26
	(1)	(2)	(3)
Log(Priests per 1000 people)	0.05 (0.13)	0.08 (0.14)	0.17 (0.10)
Catholic affiliation	0.02 (0.07)	0.10 (0.35)	0.01 (0.25)
Urbanization Rate	0.29 (0.03)	0.33 (0.04)	0.26 (0.03)
Log(population)	-0.02 0.05	0.01 (0.03)	0.04 (0.02)
R ²	0.49	0.55	0.46
Number of markets	300	300	300

Cross section regressions, each observation represents a value a for a market.
Standard errors clustered at the diocese level in parenthesis. Region dummies
and constants are not reported.

Table 4
Availability of Voucher Schools

Dependent Variable:	Ratio of voucher to public schools		Share of enrollment in voucher schools	Change in Public School Enrollment (Post-Pre Reform)	Ratio of Catholic to public schools	Ratio of Non-catholic to public schools	Share of Non-Catholic Schools (among Voucher Schools)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Mean of mother's schooling	0.22 (0.08)	0.21 (0.09)	0.04 (0.01)	-0.03 (0.01)	0.05 (0.02)	0.15 (0.07)	-0.03 (0.05)
Standard Deviation of mother's schooling	-0.16 (0.23)	-0.07 (0.33)	0.02 (0.04)	-0.09 (0.04)	-0.06 (0.04)	-0.17 (0.23)	0.09 (0.09)
Mean of Log Income	0.16 (0.13)	0.20 (0.11)	-0.02 (0.02)	0.00 (0.01)	0.00 (0.01)	0.17 (0.12)	0.02 (0.03)
Standard Deviation of Log Income	-1.20 (0.24)	-1.28 (0.55)	-0.11 (0.07)	0.07 (0.08)	-0.15 (0.09)	-1.27 (0.35)	-0.13 (0.14)
Log(Population)	0.22 (0.08)	0.21 (0.09)	0.05 (0.01)	-0.03 (0.01)	0.02 (0.02)	0.19 (0.07)	0.02 (0.02)
Urbanization Rate	0.38 (0.23)	0.30 (0.23)	0.17 (0.05)	-0.16 (0.06)	0.02 (0.01)	0.00 (0.03)	0.13 (0.12)
Log(Priests per 1,000 people in 1950)	0.50 (0.10)		0.06 (0.02)	-0.08 (0.02)	0.05 (0.02)	0.36 (0.08)	0.03 (0.02)
Ratio of order to total priests		1.69 (0.69)					
Share of Catholics in total population	1.69 (0.69)	2.99 (0.75)	0.87 (0.14)	-0.71 (0.14)	0.90 (0.27)	0.54 (0.27)	-0.55 (0.20)
R ²	0.72	0.76	0.71	0.69	0.47	0.61	0.25
Number of markets	298	298	298	298	298	298	203

Cross section regressions using the actual first stages. Clustered standard errors at the diocese level in parenthesis. Only estimates for variables at the market level are reported.

Table 5
Attendance to "Voucher" Schools, Pre and Post
Reform

Dependent Variable:	Dummy=1 if Person attended a subsidized private school	
Estimation Technique	(1)	(2)
	Probit	LPM
Log(Priests per 1,000 people in 1950)	-0.04 (0.12)	0.10 (0.04)
Log(Priests per 1,000 people in 1950)*Post Reform	0.26 (0.12)	0.29 (0.07)
Urban area	0.09 (0.02)	0.07 (0.01)
Urban area*post	-0.02 (0.03)	0.00 (0.01)
Pseudo-R ² /R ²	0.08	0.06
Number of observations	10566	10566

Cross section regressions weighted by expansion factors for individuals aged 19-50. Clustered standard errors at the diocese level in parenthesis. Estimates for age dummies, region dummies, and the interaction for region dummies and the post reform dummy are not reported.

Table 6
Priests and In-Migration Decisions

Dependent Variable:	In-migration Dummy		In-migration Rates	
	(1)	(2)	(3)	(4)
Log(Priests per 1000 people, destination/origin)	0.04 (0.10)		0.03 (0.13)	
Ratio order to total priests, destination-origin		0.20 (0.24)		0.09 (0.31)
Econometric Technique	Marginal Probit		OLS Estimates	
Number of observations	8857		13	

Standard errors clustered at the region level in parenthesis. Constants are not reported.

Table 7
Test Scores: OLS and IV Results

Dependent Variable:	Test scores										
Estimation Technique	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	
Measure of Competition	OLS	OLS	IV	IV	IV	IV	IV	IV	IV	IV	
	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Ratio of Voucher to Public Schools	Enrollment in Voucher Schools	Herfindahl index	Change in Public School Enrollment (Post- Pre Reform)
Voucher school competition	0.04 (0.01)	-0.02 (0.02)	0.17 (0.06)	0.15 (0.05)	0.16 (0.04)	0.13 (0.04)	0.14 (0.03)	0.98 (0.37)	12.17 (4.44)	-0.93 (0.36)	
Mother Education:											
Secondary-General		0.27 (0.01)		0.28 (0.01)		0.28 (0.01)	0.28 (0.01)	0.27 (0.01)	0.27 (0.01)	0.28 (0.01)	
Secondary-Technical		0.40 (0.02)		0.40 (0.02)		0.40 (0.02)	0.40 (0.02)	0.40 (0.02)	0.40 (0.02)	0.40 (0.02)	
Higher-General		0.64 (0.02)		0.64 (0.02)		0.64 (0.02)	0.64 (0.02)	0.64 (0.02)	0.61 (0.03)	0.64 (0.02)	
Higher-Technical		0.49 (0.02)		0.50 (0.02)		0.50 (0.02)	0.50 (0.02)	0.50 (0.02)	0.47 (0.02)	0.50 (0.02)	
Log(Per-Capita Income)		0.23 (0.00)		0.23 (0.00)		0.23 (0.00)	0.23 (0.00)	0.24 (0.01)	0.24 (0.00)	0.23 (0.00)	
Market Level Variables:											
Mean Education		0.02 (0.02)		-0.01 (0.02)		-0.01 (0.03)	-0.01 (0.02)	-0.03 (0.03)	0.09 (0.03)	-0.01 (0.02)	
Standard Deviation of Education		0.03 (0.04)		0.05 (0.07)		0.05 (0.07)	0.05 (0.07)	-0.03 (0.06)	-0.16 (0.12)	-0.06 (0.06)	
Mean Log(Per-Capita Income)		0.18 (0.03)		0.12 (0.07)		0.13 (0.05)	0.13 (0.06)	0.14 (0.05)	0.17 (0.08)	0.14 (0.05)	
Standard Deviation of Log(Per-Capita Income)		-0.27 (0.05)		-0.02 (0.11)		-0.05 (0.08)	-0.04 (0.08)	-0.12 (0.07)	-0.25 (0.23)	-0.14 (0.06)	
Log(Population)		-0.03 (0.02)		-0.06 (0.02)		-0.06 (0.02)	-0.06 (0.02)	-0.06 (0.01)	-0.38 (0.09)	-0.06 (0.01)	
Urbanization Rate		0.00 (0.09)		-0.08 (0.14)		-0.07 (0.12)	-0.07 (0.13)	-0.20 (0.17)	0.09 (0.18)	-0.18 (0.17)	
Share of Catholic Population		-0.20 (0.17)		-0.48 (0.26)		-0.44 (0.21)	-0.46 (0.22)	-1.00 (0.41)	-1.32 (0.56)	-0.89 (0.35)	
Instrumental Variable:	-	-	Priests	Priests	Order	Order	Priests, Order	Priests	Priests	Priests	
Over-identification test (p-value)	-	-	-	-	-	-	0.83	-	-	-	
Number of students	187610	187610	187610	187610	187610	187610	187610	187610	187610	187610	
Number of schools	5433	5433	5433	5433	5433	5433	5433	5433	5433	5433	
Number of markets	298	298	298	298	298	298	298	298	298	298	

Cross section regressions. Standard errors clustered at the diocese level in parenthesis. Region dummies and constants are not reported.

Table 8
Test Scores: Additional IV Results

Dependent Variable:	Test scores									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Voucher school competition	0.17 (0.05)	0.21 (0.05)	0.08 (0.02)	0.14 (0.04)	0.17 (0.06)	0.12 (0.04)	0.13 (0.04)	0.13 (0.05)	0.15 (0.04)	0.13 (0.05)
Mother Education:										
Secondary-General	0.27 (0.02)	0.27 (0.01)	0.27 (0.01)	0.27 (0.01)	0.26 (0.01)	0.26 (0.01)	0.26 (0.01)	0.18 (0.01)	0.23 (0.01)	0.24 (0.02)
Secondary-Technical	0.40 (0.02)	0.40 (0.02)	0.41 (0.02)	0.40 (0.01)	0.39 (0.02)	0.40 (0.02)	0.40 (0.02)	0.28 (0.02)	0.34 (0.02)	0.36 (0.03)
Higher-General	0.62 (0.02)	0.63 (0.02)	0.64 (0.02)	0.65 (0.01)	0.63 (0.02)	0.64 (0.02)	0.64 (0.02)	0.40 (0.02)	0.53 (0.02)	0.57 (0.02)
Higher-Technical	0.48 (0.02)	0.49 (0.02)	0.51 (0.02)	0.50 (0.02)	0.48 (0.02)	0.49 (0.02)	0.49 (0.02)	0.30 (0.02)	0.40 (0.02)	0.43 (0.03)
Log(Per-Capita Income)	0.24 (0.00)	0.24 (0.00)	0.24 (0.01)	0.24 (0.00)	0.23 (0.00)	0.23 (0.00)	0.23 (0.00)	0.13 (0.00)	0.16 (0.01)	0.20 (0.01)
School Level Variables:										
Mean Education								0.10 (0.01)		
Standard Deviation of Education								-0.01 (0.01)		
Mean Log(Per-Capita Income)								0.19 (0.02)		
Standard Deviation of Log(Per-Capita Income)								-0.14 (0.04)		
Market Level Variables:										
Mean Education	0.07 (0.03)	-0.06 (0.03)	0.00 (0.03)	-0.03 (0.02)	-0.03 (0.03)	-0.01 (0.02)	-0.03 (0.01)	-0.06 (0.02)	-0.04 (0.03)	0.00 (0.05)
Standard Deviation of Education	-0.01 (0.02)	0.09 (0.09)	0.06 (0.06)	0.07 (0.05)	0.03 (0.06)	0.05 (0.07)	0.01 (0.07)	0.08 (0.07)	0.04 (0.05)	0.10 (0.13)
Mean Log(Per-Capita Income)	-0.13 (0.10)	0.12 (0.07)	-0.04 (0.12)	0.08 (0.04)	0.13 (0.06)	0.06 (0.07)	0.12 (0.06)	-0.08 (0.04)	0.23 (0.06)	0.11 (0.09)
Standard Deviation of Log(Per-Capita Income)	0.12 (0.12)	0.06 (0.13)	0.11 (0.15)	0.13 (0.13)	0.03 (0.11)	-0.06 (0.10)	-0.03 (0.11)	0.18 (0.11)	-0.08 (0.05)	-0.22 (0.22)
Log(Population)	-0.07 (0.02)	-0.06 (0.02)	-0.02 (0.02)	-0.04 (0.02)	-0.05 (0.02)	-0.06 (0.02)	-0.07 (0.02)	-0.06 (0.02)	-0.05 (0.01)	-0.08 (0.01)
Urbanization Rate	-0.15 (0.13)	-0.13 (0.15)	-0.13 (0.11)	-0.12 (0.06)	-0.18 (0.14)	-0.09 (0.13)	-0.04 (0.13)	-0.05 (0.13)	-0.22 (0.12)	0.20 (0.18)
Share of Catholic Population	-0.49 (0.29)	-0.62 (0.27)	-0.38 (0.21)	-0.53 (0.19)	-0.54 (0.27)	-0.40 (0.26)	-0.39 (0.22)	-0.49 (0.23)	-0.58 (0.23)	-1.68 (0.46)
High-School Graduation Rate before the Reform					0.39 (0.06)	0.24 (0.17)				
SIMCE Tests in 1991							1.67 (0.05)			
Instrumental Variable:	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests
Sample	Exclude if parents attended school after reform	Exclude if schools located in rural areas	Exclude 90% of Santiago MA sample, bootstrapping	Exclude 50% of Santiago MA sample, bootstrapping	All students	All students	All students	All students	Include only public school students, selection model	Include only non-public school voucher school students, selection model
Number of students	85819	148860	105045	124517	187610	184784	187545	187610	106094	53319
Number of schools	5267	3013	2963	3013	5433	5272	5426	5433	3355	1552
Number of markets	298	278	278	298	298	264	292	298	298	176

Cross section regressions. Standard errors clustered at the diocese level in parenthesis. Region dummies and constants are not reported.

Table 9
Choice of Schools: Marginal Probit
Estimates

Dependent Variable: Dummy takes a value of 1 if:	Student attends a public school versus a voucher school	Student attends a non-Catholic versus a Catholic voucher school
	(1)	(3)
Values among top priorities when choosing among schools	-0.36 (0.01)	-0.28 (0.01)
Mother Education:		
Secondary-General	-0.07 (0.01)	-0.03 (0.01)
Secondary-Technical	-0.10 (0.01)	-0.05 (0.02)
Higher-General	-0.21 (0.02)	-0.07 (0.02)
Higher-Technical	-0.19 (0.02)	-0.06 (0.02)
Log(Per-Capita Income)	-0.11 (0.01)	-0.03 (0.01)
Market Level Variables:		
Mean of Mother Education	-0.02 (0.02)	-0.01 (0.07)
Standard Deviation of Mother Education	-0.09 (0.06)	0.15 (0.07)
Mean of Log(Per-Capita Income)	-0.11 (0.01)	-0.14 (0.07)
Standard Deviation of Log(Per- Capita Income)	0.00 (0.10)	-0.17 (0.25)
Log(Population)	-0.06 (0.01)	0.09 (0.03)
Urbanization Rate	-0.14 (0.10)	0.08 (0.15)
Log of (Priests per 1,000 people)	-0.07 (0.02)	0.04 (0.03)
Ratio of order to total priests		
Share of Catholic Population	-1.07 (0.15)	-0.63 (0.22)
Pseudo R ²	0.22	0.15
Number of students	172309	69937
Number of schools	5433	1701
Number of markets	285	203

Cross section regressions, each observation represents a value a for a student. Standard errors clustered at the diocese level in parenthesis. Region dummies and constants are not reported.

Table 10

Expenditures in Education, Productivity, and Student Composition: IV Results

Dependent Variable:	Public	Private	Total	Municipal	Copayment	Normalized	Normalized	Distance of	Distance of per-	Distance of test
	Expenditures	Expenditures	expenditures per	Expenditures		Productivity	Productivity	mother's	capita income to	score to school
	per student	per student	student	per student		Index 1	Index 2	education to	school mean	mean
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Voucher school competition	3761.94	867.71	4464.08	3572.42	-2513.69	0.23	0.20	-0.09	-0.01	0.007
	(1463.37)	(635.96)	(1701.04)	(493.12)	(1067.13)	(0.07)	(0.07)	(0.04)	(0.01)	(0.003)
Instrumental Variable:	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests	Priests
Sample					Voucher school					
	All students	All students	All students	All students	students w/ selection correction	All students	All students	All students	All students	All students
Number of students	165163	180288	155197	96564	80148	155197	155197	187538	187610	187610
Number of schools	4488	5427	4452	2845	2076	4452	4452	5404	5433	5433
Number of markets	261	298	261	222	203	261	261	298	298	176

Cross section regressions. Standard errors clustered at the diocese level in parenthesis. Estimates for other covariates are not reported.

Table 11
Proxies for Soft Budget Constraints in
Public Schools: Marginal Probit Estimates

Dependent Variable: Dummy takes a value of 1 if municipality	has Education Deficit above the Median	has Average School Size below the Median
	(1)	(2)
Pro-Government Mayor*Pro- Government Vote	0.50 (0.26)	0.41 (0.10)
Pro-Government Mayor	-0.07 (0.14)	-0.16 (0.06)
Pro-Government Vote	-0.51 (0.17)	-0.30 (0.07)
Mean of Mother Education	-0.14 (0.03)	-0.01 (0.01)
Standard Deviation of Mother Education	-0.30 (0.08)	0.04 (0.02)
Mean of Log(Per-Capita Income)	0.25 (0.07)	-0.02 (0.02)
Standard Deviation of Log(Per- Capita Income)	-0.37 (0.21)	-0.08 (0.06)
Log(Population)	0.06 (0.02)	-0.06 (0.01)
Urbanization Rate	0.30 (0.10)	0.13 (0.03)
Log of (Priests per 1,000 people)	-0.13 (0.05)	-0.05 (0.02)
Share of Catholic Population	-0.05 (0.27)	-0.22 (0.09)
Pseudo R ²	0.17	0.38
Number of municipalities	299	249

Cross section regressions, each observation represents a value a for a municipality, estimates from the selection equation actually used in the paper.

Table 12
Test Scores: IV Estimates, Interaction Effects

	(1)	(2)	(3)	(4)
	Second stage estimates with selection correction			
Ratio of voucher to public schools	0.09 (0.07)	0.52 (0.31)	0.03 (0.20)	0.18 (0.06)
	Second stage estimates without selection correction			
Ratio of voucher to public schools	0.08 (0.04)	0.52 (0.21)	0.06 (0.20)	0.17 (0.03)
Sample: Municipalities with	Big education deficits	Small education deficits	Low school size	High school size
Number of students	46819	59275	18234	87860
Number of schools	1309	2046	885	2470
Number of municipalities	108	191	104	194

Cross section regressions, each observation represents a value a for a student. Standard errors clustered at the diocese level in parenthesis. Coefficients of all other control variables included in the second and first stage equations are not reported.