The Effectiveness and Efficiency of Private Schools in Chile's Voucher System

Patrick J. McEwan; Martin Carnoy

Educational Evaluation and Policy Analysis, Vol. 22, No. 3. (Autumn, 2000), pp. 213-239.

Stable URL:
http://links.jstor.org/sici?sici=0162-3737%28200023%2922%3A3%3C213%3ATEAEOP%3E2.0.CO%3B2-O

Educational Evaluation and Policy Analysis is currently published by American Educational Research Association.

Educational Evaluation and Policy Analysis
Fall 2000, Vol. 22, No. 3, pp. 213–239

The Effectiveness and Efficiency of Private Schools in Chile's Voucher System

Patrick J. McEwan
University of Illinois at Urbana-Champaign

Martin Carnoy
Stanford University

This paper assesses the relative effectiveness and efficiency of private and public schools in Chile, where the military government implemented a national voucher plan in 1980. Non-religious voucher schools (accounting for two-thirds of primary enrollments in all private voucher schools) are marginally less effective than public schools in producing academic achievement in the fourth grade; at best, they are similarly effective. Catholic voucher schools are somewhat more effective than public schools. Nevertheless, non-religious schools are more efficient, by virtue of producing academic achievement at a lower cost. The difference is probably attributable to lower teacher wages and constraints on public school resource allocation. The relative efficiency of public and Catholic schools is similar. We tentatively conclude that the case for shifting public resources to privately run schools is mixed (although a comprehensive evaluation would require evidence not provided by this research).

Private school vouchers are widely touted as a solution to low-quality public education, especially for disadvantaged children. A major justification is the oft-made claim that privately run schools will deliver education more effectively and at lower cost than public schools. However, we argue that most empirical evidence is unsuited to an evaluation of effectiveness and costs under a large-scale voucher plan. Most studies are conducted in locales where schools are not financed by vouchers, where private schools are mainly operated by the Catholic Church, or where the supply response of private schools to vouchers has been muted or nil (as in small-scale experiments like Milwaukee's). Presuming that the supply of non-profit Catholic schools is not limitless, a voucher plan would encourage a "healthy variety of schools" (Friedman, 1955, p. 130), many non-religious and profit maximizing. But current evidence tells us little about the effects these schools would have on student outcomes or whether they would produce outcomes at lower cost than public schools.[1]

Our premise in this paper is that we can gain insight into these issues by examining school systems where vouchers have been implemented on a large scale and where private school supply has increased. Influenced by Milton Friedman's proposal, Chile's military government decentralized public schools in 1980 and began financing public and most private schools with vouchers.[2] Each school's revenues were henceforth determined on a month-to-month basis by total enrollments and a government-determined voucher. Beginning in 1980, enrollments in private voucher schools increased rapidly, with most growth occurring through non-religious, profit maximizing schools (even though Chile is staunchly Catholic). These schools currently account for 21% of primary enrollments (Grades 1–8), with another 10% in Catholic voucher schools.

Chile's considerable database on private and public primary schools allows us to estimate whether private voucher schools are more effective and efficient than public schools. Greater ef-

fectiveness is defined as higher academic achievement once student background is held constant; greater efficiency is defined as producing the same achievement at lesser cost. This is not the first analysis to compare public and private school achievement in Chile (Aedo, 1998; Aedo & Larrañaga, 1994; Parry, 1997c; Winkler & Rounds, 1996), although it is distinguished by three characteristics. First, it uses a more complete set of student achievement and background data than other studies. Second, it divides voucher schools into three categories—Catholic, Protestant, and non-religious—instead of lumping them together (as it turns out, their effectiveness and costs are quite different). Third, it is the only comprehensive analysis of costs and efficiency.

The Usefulness of Existing Research

A vast literature compares the relative effectiveness of private and public schools in producing student outcomes such as achievement and attainment (for reviews, see Haertel, 1987; Jimenez & Lockheed, 1995; Neal, 1998; Riddell, 1993; Witte, 1992, 1996). The majority of research uses non-experimental data and multiple regression analysis to compare the outcomes of students who have chosen to attend Catholic and public schools. To avoid confusing the effects of schools and families on achievement, researchers make statistical controls for family variables like socioeconomic status.[3] More recently, small-scale experiments have compared outcomes of students who were awarded (or not awarded) private school vouchers in randomized lotteries.[4]

In contrast to the abundant evidence on effectiveness, there is no definitive cost analysis of public and private schools in the United States, a conclusion echoed by Rouse (1998b).[5] This lacuna is curious in light of persistent arguments over the "cost-effectiveness" and "efficiency" of private schools. In fact, strong opinions of any sort are not warranted by the available evidence.

The accumulated findings on effectiveness may be helpful in predicting the effects of small-scale programs that give students vouchers or scholarships to attend private (mainly Catholic) schools. But is research helpful in forecasting the relative effectiveness and costs of private schools under a large-scale voucher plan? We argue that such a forecast would require a substantial analytical leap.

Public and Private Effectiveness Under Vouchers

First, a large-scale voucher plan would lead to the creation of new private schools. It is improbable that every new school would be Catholic (or even that new secular schools would resemble existing ones). Many schools would be non-religious and profit maximizing. Would these duplicate the effects of existing Catholic schools? Chubb and Moe (1990) argue that they would, because Catholic school effectiveness stems from operating in the private sector. Bryk, Lee, and Holland's (1993) view predicts that non-religious, especially profit maximizing schools may not duplicate elements of effective Catholic schools such as their communal organization. While Bryk et al. (1993) note the potential benefits of decentralized governance, they are less sanguine about attributing the entirety of the Catholic school effect to the benefits of operating in the private sector. The disagreement is hard to resolve with current empirical evidence.

Second, a large-scale voucher plan might "permit competition to develop," thus leading to the "development and improvement of all schools" (Friedman, 1962, p. 93). If the argument holds, it suggests that vouchers will induce public schools to improve and perhaps diminish the gap in public/private effectiveness (presuming that one exists). The current evidence on this point is mixed. While a few authors find positive effects of private school competition on public school quality (Dee, 1998; Hoxby, 1994), recent evidence has yielded statistically insignificant effects (Jepsen, 1999; McMillan, 1998; Sander, 1999).

Public and Private Costs Under Vouchers

Similarly, a major expansion of private education may alter the relative costs of public and private schools. First, the expansion of private schooling might occur largely through the absorption of more students with attributes that are perceived as "undesirable," such as special educational needs or low socioeconomic status. If the labor market rewards teachers in such jobs with a compensating differential, as some evidence indicates, then the cost structure of private schools will be altered (Chambers, 1987; Chambers & Fowler, 1995).

Second, there are finite numbers of individuals willing to provide contributed services—as do many clergy—and work at below-market wages in private schools (Bartell, 1968; Kealey, 1996). New

or expanding private schools—particularly non-religious and profit maximizing, but perhaps even Catholic schools—may need to pay higher wages in order to attract the requisite numbers of personnel.

Third, vouchers modify the political economy of education through the creation of new interest groups. Large numbers of private school teachers, less likely to possess the altruistic preferences of clergy, would be more inclined towards unionization (Chambers, 1987). Increasing unionization may lead to increases in the teacher wage bill (Hoxby, 1996). Another plausible alternative is that increasing numbers of private school owners would form associations and lobby for increases in the size of the voucher (in fact, this occurred in Chile).

Fourth, increasing competition might be expected to reduce the costs of public schools by improving the incentives to minimize costs. Taken together, the prior discussion suggests important dividends to examining the relative effectiveness and costs of private schools in a school system where a voucher policy has encouraged a large-scale expansion of private schooling.

Education Reform in Chile

Decentralization and Privatization

In 1980, Chile's military government initiated a sweeping reform.[6] It transferred responsibility for public school management from the national Ministry of Education to local municipalities. Teachers lost their status as civil servants, reverting to municipal contracts, and school buildings and land were signed over to municipal control. Initial transfers proceeded rapidly, encouraged by financial incentives, and by 1982 most public schools were operated by municipalities. Once transferred, schools were placed under the control of one of two kinds of institutions, most under a *Departmento de Administración de la Educación Municipal* (henceforth referred to as a DAEM) and others under a quasi-autonomous "corporation."[7]

Concomitant to decentralization, the government altered how public and most private schools were financed. Prior to 1980, as in much of Latin America, school budgets were largely determined by the need to sustain an existing plant of teachers and facilities. If budgets adjusted in response to the level of student enrollments, they only did so at a sluggish pace. Under the reform, the Ministry of Education disbursed monthly payments to municipalities based on a fixed voucher multiplied by the number of students enrolled in their schools; private schools received equivalent per-student payments if they did not charge tuition.[8] Thus, payments to public or private schools began fluctuating in direct proportion to student enrollments. The law established a base voucher level, which varies according to school location and the level of schooling.[9] Although the real value of the voucher was initially indexed to keep pace with inflation, it was de-indexed following the economic crisis of the early 1980s. Over the course of the 1980s, the real value of the per-pupil voucher declined precipitously, reaching its lowest point in 1988 (see Figure 1). Despite the falling real value of the voucher, the reform sparked a rapid increase in the share of private voucher enrollments (see Figure 2). Throughout this period, between 5% and 9% of students were enrolled in non-voucher private schools charging high tuition.

Six Types of Public and Private Schools

Prior to the reforms, about half of private schools were managed by the Catholic church, and the rest by non-religious foundations or Protestant churches (Espinola, 1993). In contrast, private voucher schools that entered the market during the 1980s were mainly non-religious and profit maximizing (Aedo, 1996). Table 1 provides a brief description of the management and financing of six school types that we will employ as the analytical categories of this paper: public DAEM, public corporation, Catholic voucher, Protestant voucher, non-religious voucher, and non-voucher private schools. Table 2 shows how primary schools and enrollments are distributed across the six types. In urban areas, and even more so in rural areas, the majority of schools are still public. In 1996, 81 of Chile's 334 municipalities—mostly isolated and rural—did not have a single privately run school, although these municipalities account for a small percentage of overall enrollments.

Table 3 further describes each school type, using several student, teacher, and school variables. The students who enroll in private schools generally have higher levels of family income and parental schooling than public students. The difference is especially pronounced for non-voucher private schools, although Catholic and, to a lesser extent, non-religious voucher schools also enroll students of a higher socioeconomic status. Teachers in all types of private schools are younger, on aver-

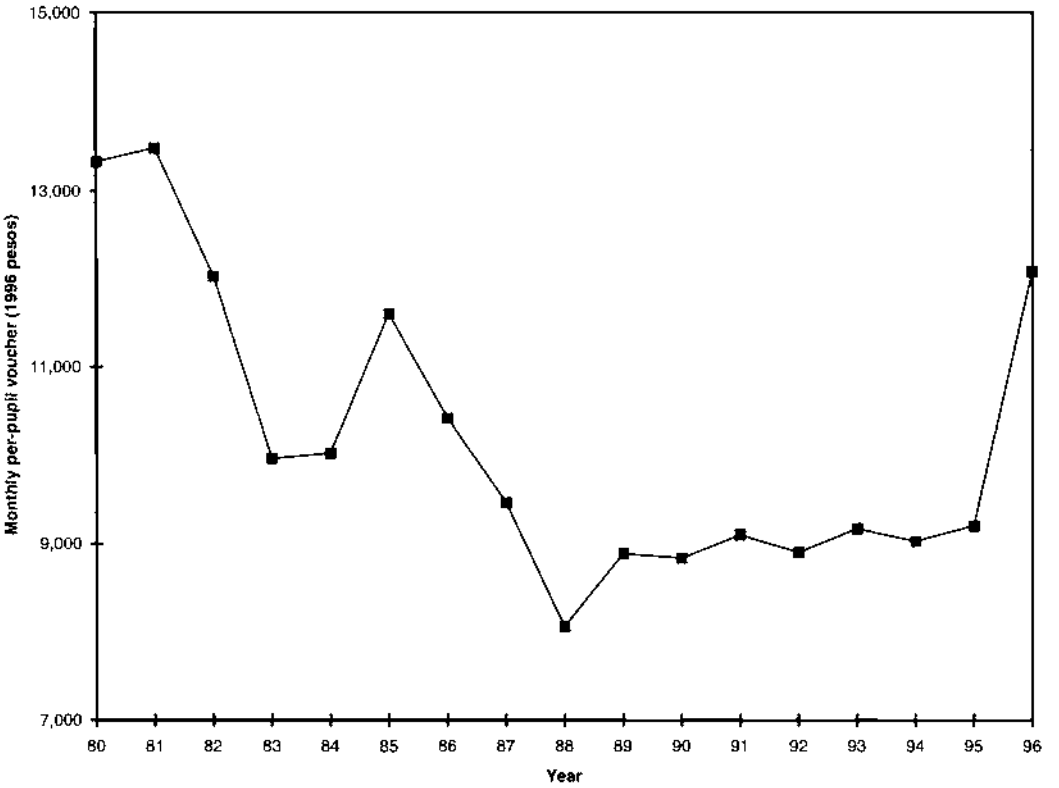

FIGURE 1. *Monthly per-pupil voucher in primary schools, 1981–1996 (1996 pesos). Note: The base voucher excludes bonuses and deductions, which vary by municipality and school. Data from Ministry of Education and authors' calculations.*

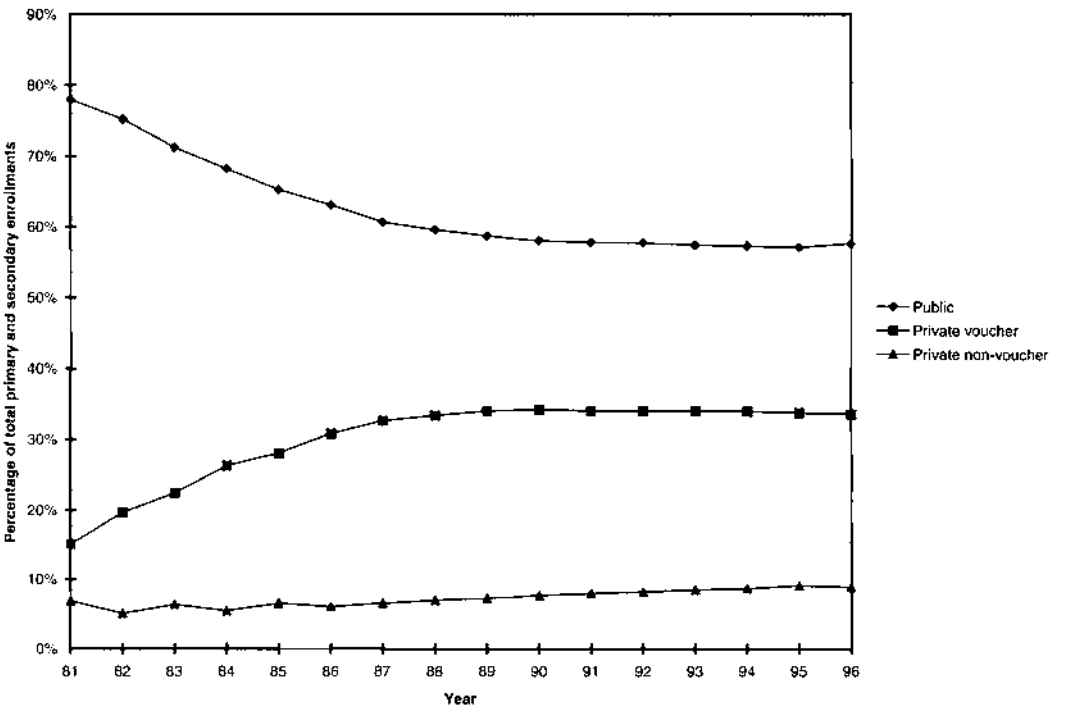

FIGURE 2. *Enrollment share in public and private schools, 1981–1996. Data from Vargas (1997).*

age, than those in public schools. This is not surprising, given the job guarantees available in the public sector. Rates of temporary contracting and moonlighting are highest in non-religious voucher schools (multiple job holders are so common in Chile that they are commonly referred to as "taxi" teachers). Among school characteristics, Table 3 indicates that public DAEM schools have somewhat lower class sizes than private voucher schools. However, this is influenced by the disproportionate location of DAEMs in sparsely populated rural areas with many small, one-room schools.[10] The number of teacher contract hours per class is a proxy of the length of the school day, although it might indicate whether multiple teachers are used in the same class. Non-religious voucher schools in urban areas average 33 teacher hours per class, less than either public or religious voucher schools. In contrast, private non-voucher schools have an average of 45, around 6 hours more than either public or religious voucher schools.

Method and Data

Private School Effectiveness

Method. To assess the relative effectiveness of public and private schools, we posit that academic achievement is produced by a combination of school and family inputs:

$$A_i = P_i\beta_1 + X_i\beta_2 + \varepsilon_i \quad (1)$$

The average achievement (A_i) of each school (indexed by the subscript i) is regressed on two vectors of variables. P_i includes five dummy variables indicating school type: public corporation, Catholic voucher, Protestant voucher, non-religious voucher, and non-voucher private schools (relative to the public DAEM category). X_i includes a series of controls for the socioeconomic status of students and school location. Unmeasured variables are captured in an error term, ε_i.

The principal goal of the analysis is to obtain unbiased estimates of β_1, the effect of private

TABLE 1
A Taxonomy of Private and Public Schools in Chile

School type	Management	Financing
Public DAEM	*Departmento de Administración de la Educación Municipal* (DAEM); part of municipal bureaucracy	National vouchers; municipal contributions; Regional Development Fund (infrastructure); private contributions[a]
Public corporation	Municipal corporation; quasi-autonomous from municipal bureaucracy	National vouchers; municipal contributions; Regional Development Fund (infrastructure); private contributions[a]
Catholic voucher	Branches of Catholic church, including religious orders, parishes, and the Archdiocese	National vouchers; private contributions[a]; church contributions[b]
Protestant voucher	Protestant churches, including Methodist, Baptist, Seventh-Day Adventist, Lutheran, and others not affiliated with specific denominations	National vouchers; private contributions[a]; church contributions[b]
Non-religious voucher	For-profit businesses; non-profit foundations; individuals	National vouchers; private contributions[a]
Private non-voucher	Catholic church; Protestant churches; for-profit businesses; non-profit foundations; individuals	Private contributions[a]; church contributions[b]

[a]Private contributions could include tuition payments (through "shared financing" or otherwise), Parent Center fees, private fundraising such as raffles, and donations from the private sector.
[b]Church contributions include contributed services of church personnel and monetary and in-kind church donations.

TABLE 2
Distribution of Primary Schools and Students Across School Types, 1996

	Percent of schools			Percent of enrollment		
	Total (%)	Urban (%)	Rural (%)	Total (%)	Urban (%)	Rural (%)
Public DAEM	55.2	31.5	74.6	40.0	34.7	70.5
Public corporation	12.3	15.5	9.6	18.5	19.4	13.4
Catholic voucher	4.6	9.3	0.8	10.3	11.6	2.8
Protestant voucher	1.2	1.9	0.6	1.5	1.4	1.9
Non-religious voucher	19.7	26.4	14.3	21.4	23.3	10.9
Private non-voucher	7.1	15.5	0.2	8.3	9.6	0.6
N (schools or students)	8,393	3,779	4,614	2,015,867	1,716,641	299,226

Note. Calculations exclude 163 schools (enrolling 49,537 students) for which data on rural or private status were incomplete. Data from Ministry of Education and authors' calculations.

schools relative to the public alternative, ceteris paribus. Whether the estimates are, in fact, unbiased will depend on the completeness of the control variables. For example, if student determinants of achievement are omitted—and correlated with the likelihood of attending a given school type—then we risk confounding the effects of student background and schools. We will explore this possibility in our presentation of the results.

The prior specification purposely omits school and teacher variables that may be correlated with achievement and school type. In doing so, it yields an overall effect that is essentially a "black box." To explore the roots of the effect, another specification will include teacher and school variables.

Data. The main data source is Chile's national assessment of mathematics and Spanish achievement, known as the *Sistema Nacional de Evaluación de Calidad de la Educación* (SIMCE). Between 1988 and 1996, the assessment was applied to roughly 90% of fourth-graders in even years, including public and private schools (excluded schools were located in isolated areas or enrolled only a few students). We analyze four rounds of the fourth-grade assessment: 1990, 1992, 1994, and 1996.[11] Unfortunately, the SIMCE data for these years are averaged to the school level. Estimates of regression coefficients that are derived from grouped rather than individual data continue to be unbiased, assuming the model is correctly specified, although the standard errors will be incorrect (Greene, 1997). Thus, we weight each observation by the square root of the number of students tested in each school, although unweighted estimates are similar.

Appendix A provides variable definitions and descriptive statistics for the dependent and independent variables. The dependent variables are drawn from the SIMCE assessment: mean fourth-grade achievement in Spanish (SPANISH) and mathematics (MATH) for each school. In each cross-section, we standardize these variables to a mean of zero and a standard deviation of one.

Five dummy variables indicate whether the school is a public corporation, Catholic voucher, Protestant voucher, non-religious voucher, or non-voucher private school (relative to the public DAEM category). These were created with official data of the Ministry of Education, as well as a directory published by the Catholic Church (Barahona & Cabre, 1996) to verify the coding of Catholic schools. Other control variables are derived from several sources. The SIMCE survey provides gross measures of the educational level of the school's parents (EDLEV) and the type of city where the school is located (CITY). These measures—reported by school principals—are unlikely to completely measure the background of students and families. To complement these, we use data collected by the agency that administers Chile's school meal program, the *Junta Nacional de Auxilio Escolar y Becas* (JUNAEB). JUNAEB administers annual surveys of first graders, in which teachers report their students' socioeconomic background. From these we calculate measures of the parental educational attainment in the school (BASINC and BASCOM) and a general index of socioeconomic status (SESINDEX).[12] Because these measures are not available for every school, regressions include dummy variables that indicate schools with missing data (BASMISS and SESMISS). Another independent variable indicates the school location (RURAL).

A final set of variables, only available in 1996,

describes selected characteristics of teachers and schools. Teacher variables include the percentage of female primary teachers (FEMALE), the percentage of teachers with a university degree (UNIV), the average age of teachers and its square (AVGAGE and AVGAGESQ), the percentage of teachers that hold another teaching job outside the school (MOONLT), and the percentage of teachers who are contractors (CONTRACT). Other school variables include the average class size in the primary grades (CLSSIZE) and the number of teacher contract hours per primary classroom (HRSCLS).

Private School Efficiency

Method. We compare the efficiency of public and private schools using a multi-product cost function (James, King, & Suryadi, 1996; Jimenez, 1986). Schools are hypothesized to minimize the costs of producing specified levels of outputs, constrained by several factors. These include local input prices such as teacher salaries as well as exogenous variables such as student background and school location. The notion is that variables that are beyond the control of school officials—such as high input prices, impoverished families, or rural location—

TABLE 3
Characteristics of Primary Students, Teachers, and Schools

Variables	Public DAEM	Public corporation	Catholic voucher	Protestant voucher	Non-religious voucher	Private non-voucher
Students						
Female (%)	48.7	48.2	57.2	49.4	46.2	50.5
Mother's schooling	7.49	8.97	10.70	9.95	9.28	14.20
(*M* years)[a]	(4.80)	(2.77)	(3.45)	(3.17)	(2.98)	(2.26)
Father's schooling	7.68	9.44	11.18	10.53	9.64	15.35
(*M* years)[a]	(5.01)	(2.92)	(3.56)	(2.93)	(3.06)	(2.36)
Monthly household	1.65	2.29	3.02	2.61	2.88	11.17
income (pesos)[b]	(2.34)	(2.23)	(3.19)	(1.96)	(3.11)	(31.01)
N	16,707	2,740	2,622	227	3,125	1,159
Teachers						
Female (%)	71.9	77.9	75.6	69.8	71.8	73.5
College graduate (%)	97.8	97.0	96.5	94.7	91.9	96.9
Age (*M* years)	46.1	46.1	40.7	38.5	39.7	39.1
	(8.4)	(8.6)	(10.0)	(9.1)	(9.8)	(9.8)
Contractors (%)	9.3	12.3	10.4	17.9	19.2	14.6
Moonlighting (%)	10.6	20.1	21.8	21.5	30.7	15.9
N	35,683	14,804	7,495	1,132	15,511	10,377
Schools						
Class size (*M*)[c]	22.8	28.6	38.7	32.3	28.0	21.8
	(8.9)	(10.3)	(5.9)	(8.7)	(9.6)	(8.8)
Teacher contract hours	38.1	37.9	40.7	38.3	34.0	45.1
per class (*M*)	(8.8)	(7.9)	(8.5)	(8.3)	(8.4)	(17.4)
Enrollment in Grades	215	414	576	334	286	292
1–8 (*M*)	(293)	(390)	(282)	(245)	(368)	(258)
N	3,823	972	337	87	1,455	499

Note. Standard deviations for continuous variables are in parentheses. Student observations are weighted in order to account for unequal probabilities of selection into the CASEN sample (thus, the distribution of observations across school types does not necessarily reflect the population distribution). Student data are from the 1994 CASEN household survey, Ministry of Planning. Teacher data are from the 1996 teacher census, Ministry of Education. School data are from Ministry of Education enrollment files, 1996.

[a]Means of these variables exclude observations for children whose mothers or fathers are absent from the household.

[b]Variable divided by 100,000.

[c]Class size is calculated as total primary enrollments in each school divided by the number of primary classes.

may increase the costs of some schools relative to others (Downes & Pogue, 1994; Duncombe, Ruggiero, & Yinger, 1996). Costs may also differ according to the public or private management of the school.[13] A common hypothesis is that public schools are more costly than private schools, ceteris paribus, because they have different objectives, enjoy less autonomy in allocating resources, or face fewer market incentives to minimize costs (Chubb & Moe, 1990; James et al., 1996).[14]

Assuming a Cobb-Douglas functional form, the school cost function can be written as:[15]

$$\ln C_i = P_i\beta_1 + \ln Y_i\beta_2 + \ln R_i\beta_3 + X_i\beta_4 + \varepsilon_i \qquad (2)$$

The log of the annual per-student cost in a given school (C_i) is regressed on several variables. These include the school dummy variables already described (P_i), a vector of school outputs (Y_i), a vector of prices such as teacher salaries (R_i), and variables describing families and school location (X_i). The error term (ε_i) captures the effects of unmeasured variables. The relative efficiency of public and private schools is reflected in estimates of β_1. A positive coefficient indicates that a particular school type has relatively higher per-student costs, despite similar output levels, input prices, student characteristics, and location.

The specification purposely omits school inputs as independent variables. As suggested by economic theory, it presumes that schools have sufficient freedom to manipulate inputs so as to minimize costs (Jimenez, 1986). Thus, school inputs are properly treated as endogenous and excluded from regressions. In practice, however, many inputs are not easy to manipulate in public schools, at least in the short term, and might be viewed as exogenous.[16] For example, regulations place limits on teacher hiring and firing, perhaps limiting the opportunity to modify class sizes (we return to this issue in a later section). To assess whether observed differences in private and public efficiency are partially rooted in these constraints, additional specifications control for measures of school and teacher resources such as class size.

Data. We cannot systematically estimate school costs (C_i) using the "ingredients" method (Levin & McEwan, 2000). Instead, we use multiple data sources—including school revenues from the government and parents—to construct a proxy of the annual per-student cost of each school in 1996 (see Appendix C for details). As independent variables we utilize the measures of school type (P_i) and family background (X_i) described previously. Output variables (Y_i) include average test scores on the SIMCE assessment (TEST),[17] and the total number of students enrolled in the school (ENROLL). Because the sample is limited to schools that participate in the primary grade assessments, enrollments are naturally dominated by Grades 1 to 8. However, some schools also admit students in preprimary and secondary grades. Thus, we control for their respective enrollment shares in each school (PCTPRE and PCTOTH).

Properly specified cost functions should control for input prices faced by each school. Because price data for each school are unavailable, we pursue a different strategy. Chile is divided among 334 municipalities in which schools may face different prices for educational inputs, such as teacher salaries or school materials. One method of controlling for price variation across municipalities is to control for municipal fixed effects—essentially a series of dummy variables (Hsiao, 1986). Each municipal effect captures unobserved determinants of costs that are constant across the municipality, such as local market prices. While the strategy does not allow separate coefficients to be estimated for each input price, it helps ensure that omission of price variables does not bias other coefficients.

Results

Private School Effectiveness

Basic results. We estimated Equation 1 by weighted least squares for each year of data and for each dependent variable (the full regression results are in Appendix B, while Table 4 summarizes the coefficients of the dummy variables that indicate school type). Among student background variables, the signs and statistical significance of coefficients largely correspond to expectations. Dummy variables indicating higher levels of parental education (EDLEV) are positive and statistically significant across several rounds of data. BASINC and BASCOM are both negative and significant, indicating that a higher proportion of parents with incomplete or complete primary education tends to lower mean achievement, all else equal (these variables are interpreted relative to the proportion of parents with higher levels of education). Coefficients on SESINDEX are negative and significant, indicating that increasingly disadvantaged schools have lower mean achievement.

TABLE 4
Fourth-Grade Achievement Differences Between Public DAEM and Other School Types

	Dependent variable: SPANISH					Dependent variable: MATH				
	1990	1992	1994	1996	Mean effect (1990–1996)	1990	1992	1994	1996	Mean effect (1990–1996)
Unadjusted difference										
Public corporation	0.27	0.22	0.11	0.05	0.16	0.22	0.21	0.10	n.s.	0.13
Catholic voucher	1.11	1.09	1.07	0.99	1.07	1.02	0.98	0.91	0.87	0.94
Protestant voucher	0.40	0.31	0.47	0.39	0.39	0.37	0.22	0.36	0.33	0.32
Non-religious voucher	0.48	0.40	0.40	0.34	0.40	0.44	0.33	0.33	0.27	0.35
Private non-voucher	1.93	1.89	1.90	1.61	1.83	1.94	1.75	1.80	1.56	1.76
Adjusted for SES, location										
Public corporation	-0.04	-0.06	-0.08	-0.08	-0.06	-0.04	-0.03	-0.06	-0.09	-0.06
Catholic voucher	0.31	0.23	0.25	0.27	0.27	0.28	0.19	0.17	0.24	0.22
Protestant voucher	-0.17	-0.21	n.s.	-0.16	-0.14	-0.18	-0.27	-0.09	-0.15	-0.17
Non-religious voucher	-0.05	-0.10	-0.07	-0.07	-0.07	-0.04	-0.10	-0.08	-0.08	-0.07
Private non-voucher	0.63	0.61	0.66	0.38	0.57	0.67	0.58	0.65	0.40	0.57
Adjusted for SES, location, school characteristics										
Public corporation	—	—	—	-0.08	—	—	—	—	-0.08	—
Catholic voucher	—	—	—	0.26	—	—	—	—	0.22	—
Protestant voucher	—	—	—	-0.09	—	—	—	—	-0.08	—
Non-religious voucher	—	—	—	0.06	—	—	—	—	0.06	—
Private non-voucher	—	—	—	0.42	—	—	—	—	0.44	—

Note. Unadjusted differences are regression coefficients of school-type dummy variables, obtained from ordinary least squares regressions that included school type dummies as the sole independent variables. Adjusted differences are from regressions that control for additional independent variables (see Appendix B for the full regression results). "n.s." indicates that a coefficient is *not* statistically significant at the 5% level.

Table 4 summarizes the coefficients on school type (unless indicated by "n.s.," all coefficients are statistically significant at the 5% level). In addition to the "adjusted" differences in achievement between public DAEM and other school types, the table also reports "unadjusted" differences that are uncorrected for student background. The unadjusted differences, for both SPANISH and MATH, consistently favor private schools. Differences between public and non-voucher schools are especially pronounced, more than 1.5 standard deviations in every year. Catholic voucher schools also have substantially higher achievement, on the order of one standard deviation in most years. While less pronounced, the gaps between DAEMs and other private school types are still more than 0.3 standard deviations in most years.

Adjusting for parental background and location considerably alters the relative differences. The range of effects—relative to public DAEM schools—across several rounds of data declines to 0.38–0.67 for private non-voucher schools and 0.17–0.31 for Catholic voucher schools. In contrast, the coefficients of non-religious voucher schools—which account for 21% of primary enrollments—turn negative, ranging from –0.05 to –0.10. Despite their statistical significance, the magnitude of the latter effects is fairly small. In the United States, a positive effect for Catholic schools on the order of 0.1 standard deviation has been interpreted by some authors as too small to be of practical significance (e.g., Levin, 1998).

Although the prior analyses compared public DAEM schools with other school types, we can also use public corporation schools as the baseline for estimation of private school effects. To do so, we subtract the coefficient on corporation schools in a given year from those of other school types. When corporation schools are used as the baseline, the relative effectiveness of Catholic voucher and non-voucher private schools increases slightly. The difference between public corporation and non-religious voucher schools is close to zero in almost every cross-section of data (in six of eight regressions we cannot reject the null hypothesis that coefficients of public corporation and non-religious voucher schools are equal).[18]

Explaining the effectiveness of private schools. The observed effects could stem from different applications of teacher and school inputs in public and private schools. To explore this possibility, we estimated regressions for 1996 that also included measures of school and teacher characteristics (the complete regressions are in Appendix B). With the exception of CLSSIZE, the signs of these coefficients correspond to expectations. Teacher hours per class (HRSCLS) is positively related to achievement, though not strongly. A 10-hour increase leads to an increase in achievement of 5% of a standard deviation on the Spanish test. Of teacher variables, achievement increases in relation to the proportion of female teachers (FEMALE) and those possessing university degrees (UNIV). The average age of teachers (AVGAGE), a proxy for teacher experience, is positively related to achievement, but at a decreasing rate. Finally, achievement declines as the proportion of moonlighting (MOONLT) or contracting (CONTRACT) teachers increases in the school.

As these variables are added to the 1996 regressions, the coefficients of the dummy variables indicating school type are mostly stable, with an important exception. The coefficient on non-religious voucher schools reverses sign, from –0.07 to 0.06 in the SPANISH regression (with similar results for MATH). Not coincidentally, non-religious voucher schools are more likely than others to employ teachers without university degrees, to employ moonlighting or contracting teachers, and to pay fewer teacher contract hours per primary classroom. Once achievement comparisons are made that hold constant these inputs, the apparent disadvantage of non-religious voucher schools disappears. A possible conclusion is that resource allocation decisions that lower costs in non-religious schools are also responsible for their diminished effectiveness.

Alternate specifications. We varied the initial specification in two ways, in order to assess whether the previous findings are robust. First, we estimated a model for each year and dependent variable in which the school type dummies are fully interacted with other control variables:[19]

$$A_i = P_i\beta_1 + X_i\beta_2 + (P_i * X_i)\,\beta_3 + \varepsilon_i \qquad (3)$$

By doing so, we relax the assumption that coefficients on the control variables (X_i) are equal across school type. The parameter estimates from each regression—along with the average sample characteristics for the respective cross-section—were used to predict an achievement score for each school type. Private school effects were calculated by subtracting the public DAEM prediction from each of the other predictions. In most cases, the

relative effects of Catholic and non-religious voucher schools increase slightly over the estimates in Table 4. The range of Catholic effects across the four rounds of data and two dependent variables is from 0.25 to 0.37 (compared with 0.17 to 0.31 in Table 4).[20] The range of non-religious private school effects is from –0.09 to 0.01 (compared with –0.10 to –0.05 in Table 4).[21]

As a second specification check, we separately estimated Equation 1 for schools within and outside of the Metropolitan Region (dominated by Santiago). (Although the initial specification included regional dummy variables, it constrained private school effects to be equal across regions.) When each year's sample was limited to Santiago schools, the range of Catholic school effects increased slightly (0.25 to 0.42). For non-Santiago schools, the range of effects decreased slightly (0.15 to 0.30). A similar pattern existed for non-religious voucher schools. Effects in the Santiago samples ranged from –0.04 to 0.11 (with four of eight coefficients statistically insignificant). In the non-Santiago samples, the range of effects decreased (–0.15 to –0.07).

Evidence of selection bias. If omitted independent variables are correlated with achievement and the likelihood of attending a private school, then estimates of the effect of private schools are biased. Other research provides indirect evidence on the possible direction of bias. Parry's random survey (1996) shows that 15% of public and 63% of private voucher schools in Santiago use one of several methods to select students for admission, including entrance exams, interviews, and minimum grade requirements. Similarly, Gauri's (1998) random survey of Santiago households shows that 18% of public school students took an exam in order to enroll in their present school. For private voucher and private non-voucher schools, the figures were 37% and 82%, respectively. Thus, private schools are more likely to exercise selectivity in their admissions policies.

If private schools select their students based on characteristics that are unobserved to researchers but still correlated positively with achievement, as seems likely, then estimates of private school coefficients are probably biased upwards. Parry (1996) includes a variable measuring school selection—positively correlated with a private school dummy—in achievement regressions similar to ours. The selection variable's coefficient is strongly positive, while the coefficient on a private school dummy is statistically insignificant. Although the act of selection does not directly increase student performance, it may proxy unobserved characteristics of students who attend schools that select. The results are suggestive that the estimates in this paper—even the negative coefficients on non-religious voucher schools—are an upper bound to private school effects.

Private School Efficiency

Basic results. Mean per-student costs (in 1996 pesos) are presented in Figure 3, disaggregated by school type and location. The costs of public DAEMs and corporations are similar, but there is substantial heterogeneity among voucher schools. Those managed by the Catholic Church are somewhat more costly than DAEM schools, while non-religious voucher schools are less costly. Non-voucher private schools, which rely exclusively on private contributions, are the most costly alternative of the six. The differences between per-student costs in urban and rural schools are not particularly marked.

In Table 5, the per-student cost estimates are divided into their constituent elements (see Appendix C for a description of these categories). There is some variation in voucher revenues across schools, for two reasons. First, the base voucher is adjusted upward for some schools, especially those in isolated rural areas or poor municipalities. Second, the voucher payments of some schools are reduced in accordance with the amount of tuition charged to parents under the "shared financing" scheme instituted in 1993. Because public schools are more likely to be located in rural areas and less likely to participate in shared financing, their voucher payments are somewhat larger.

Private contributions are quite substantial, even in "free" public schools and private voucher schools (around 38% of the total in public DAEM and 59% in non-religious voucher schools). These contributions include tuition payments, Parent Center fees, uniforms, and textbooks. Unfortunately, the data do not allow us to apportion the overall figure among these categories. Though perhaps contrary to expectations, these results are consistent with research in other developing countries.[22]

Table 6 reports several specifications of Equation 2. The relative efficiency of each school type is gauged by examining the coefficients of the corresponding dummy variables. Negative coefficients imply that schools are more efficient because they

spend relatively less than public DAEM schools, ceteris paribus. In order to interpret the dummy coefficients as percentage changes in costs, we perform the transformation suggested by Halvorsen and Palmquist (1980) and summarize the results in Table 7.

Estimates taken from Model 1 imply that public corporation and Catholic schools are just as costly as public DAEM schools. Protestant and non-religious voucher schools are somewhat less costly (9% and 15%, respectively). Finally, non-voucher private schools are 14% more costly. Despite these results, the specification of Model 2 is preferable because it includes municipal dummies, thus accounting for unobserved cost determinants that are constant across each municipality. The coefficient on Protestant schools becomes statistically insignificant, and the new point estimate for non-religious voucher schools (–0.141) implies a slightly smaller difference in costs.

Explaining the efficiency of non-religious voucher schools. To explore the roots of efficiency differences, it is helpful to distinguish between technical and price efficiency (e.g., McMahon, 1982).[23] A technically efficient school produces the maximum amount of output for a given set of inputs, while a technically inefficient school squanders inputs, and produces less than the maximum. A price efficient school will further choose the combination of inputs that yields a given output at least cost, by favoring inputs with prices that are low relative to their marginal effects. In the context of our analysis, we might ask whether the inefficiency stems from resource wastage (technical inefficiency) or from poor resource allocation (price inefficiency).

Existing restrictions on public school resource allocation suggest that price inefficiency could be important. The government passed a national Teacher Statute in 1991—with subsequent modifications in 1995—which placed restrictions on the hiring and firing of teachers, especially in public schools. Restrictions include limits on the number of contracting teachers in public schools (in contrast to "tenured" teachers who enjoy greater job security), and severe limits on the ability of public school managers to fire or reassign teachers among public schools. Thus, public school inefficiency

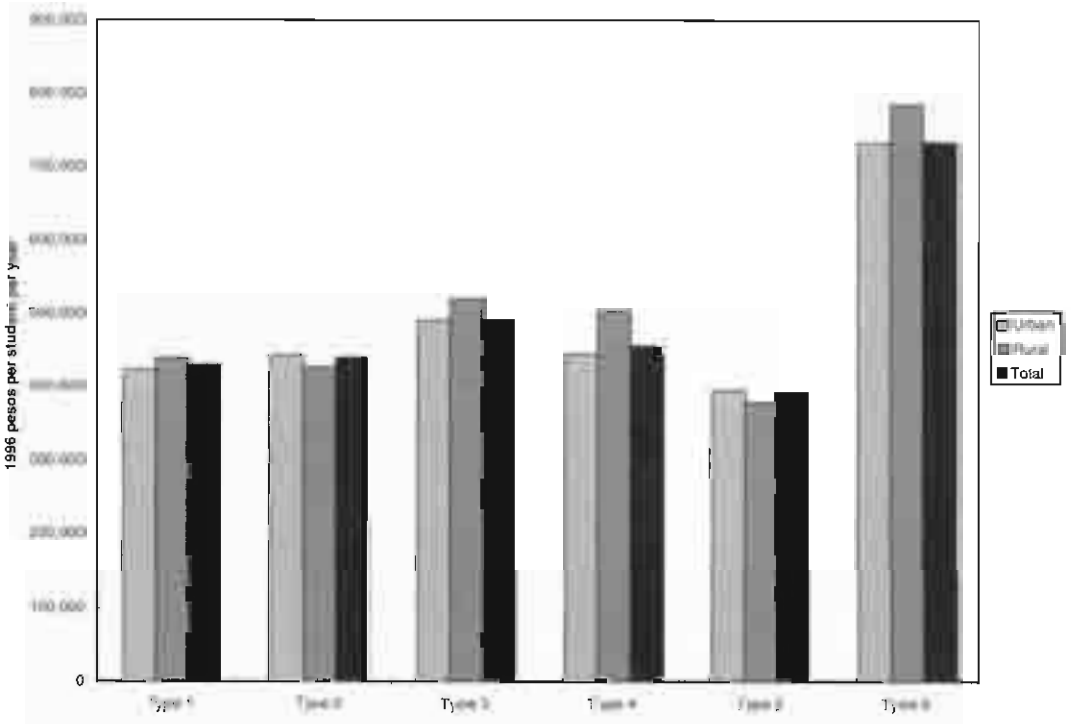

FIGURE 3. *Mean annual per-student costs (1996 pesos). Note: See Appendix C for details on cost estimates. Type 1: Public DAEM (N = 1,278); Type 2: Public corporation (N = 386); Type 3: Catholic voucher (N = 125); Type 4: Protestant voucher (N = 21); Type 5: Non-religious voucher (N = 766); Type 6: Private non-voucher (N = 369).*

TABLE 5
Mean Annual Per-Student Costs, Divided by Category (1996 pesos)

	Public DAEM	Public corporation	Catholic voucher	Protestant voucher	Non-religious voucher	Private non-voucher
National voucher payments	185,882	163,084	165,499	182,083	158,848	—
Municipal contributions	23,834	36,258	—	—	—	—
Parent contributions	164,224	193,794	252,312	211,965	232,363	731,125
Imputed rent on land and buildings	52,244	44,257	74,425	59,911	—	—
P-900 program	4,133	2,605	265	1,579	1,904	—
Total	430,316	439,998	492,501	455,538	393,115	731,125
	(120,913)	(99,291)	(97,937)	(115,373)	(96,596)	(120,318)
N	1,278	386	125	21	766	369

Note. Standard deviations are in parentheses. See Appendix C for details on methods and data.

may stem from exogenous constraints on their resource allocation. To partially assess this explanation, we re-estimated the cost function, holding constant several characteristics of schools and teachers, such as class size and the number of teacher contract hours. Including these variables only leads to a slight reduction in the cost difference between public DAEM and non-religious voucher schools (see the final column of Table 7).

There are other potential explanations for efficiency differences, though we cannot directly test their importance. First, a portion of the cost difference is almost certain to stem from teacher salary differences across public and private sectors,[24] given that the teacher wage bill accounts for 82% of municipal expenditures on education.[25] Chilean data on teacher salaries are poor, but a 1990 survey showed that primary teachers in private voucher schools earn about 25% less than DAEM teachers (Rojas, 1998). This gap may have declined since 1990 because the Teacher Statute established wage floors that also apply to private teachers, but it is likely that some difference still exists.

Second, public school costs may be higher because of constraints on their ability to allocate resources to school infrastructure. Non-religious private schools have the greatest autonomy in financing infrastructure, which they must accomplish with current revenues from voucher payments or tuition. Religious schools that receive donated resources from larger church institutions may have a lesser degree of autonomy. The least autonomy is enjoyed by many public schools and municipalities, for whom infrastructure is financed by grants from the Regional Development Fund. Public infrastructure projects may be implemented with little regard to expressed desires by local actors (Jofré, 1988). Unless costly investments lead to higher achievement, they could lower school efficiency.

Third, cost differences may be due to technical inefficiency of public schools, or wastage of existing resources. However, the strong constraints on wage levels and infrastructure investments in public schools make it unlikely that wastage accounts for a large portion of the observed efficiency gap.

Explaining the inefficiency of non-voucher schools. Chile's non-voucher private schools are somewhat more costly, holding constant student background and outcomes. Several explanations could be forwarded. First, the difference might be attributed to their lower class sizes and higher number of teacher contract hours per class. But controlling for both these variables in cost functions did little to alter the relative cost differences. Second, the facilities of non-voucher schools are often superior, and they tend to be concentrated in higher-income neighborhoods where buildings and land are more costly. If facilities have little impact on achievement, then non-voucher schools will appear relatively less efficient in our empirical framework. Third, some outcomes may be omitted from the cost function. It is probable that non-voucher schools excel in producing outcomes that other schools do not. In particular, their strong links with Chilean universities and the training they provide for college entrance exams might assist students in gaining college admissions. Though such outputs are not controlled for in cost functions, they may be positively correlated with costs. Thus, the apparent cost disadvantage of non-voucher schools could be a product of omitted variables bias.

TABLE 6
Per-Student Cost Functions, 1996

	Dependent variable: ln (COST)		
	Model 1	Model 2	Model 3
Public corporation	0.005	0.014	0.017
	(0.012)	(0.016)	(0.016)
Catholic voucher	0.011	0.029	0.049*
	(0.018)	(0.019)	(0.022)
Protestant voucher	-0.098*	-0.060	-0.046
	(0.048)	(0.039)	(0.041)
Non-religious voucher	-0.161**	-0.141**	-0.119**
	(0.011)	(0.011)	(0.015)
Private non-voucher	0.129**	0.131**	0.115**
	(0.027)	(0.023)	(0.025)
ln(ENROLL)	-0.042**	-0.024**	0.015
	(0.007)	(0.007)	(0.010)
PCTPRE[a]	-0.200*	-0.117	-0.150
	(0.090)	(0.081)	(0.087)
PCTOTH[a]	0.290**	0.236**	0.152**
	(0.034)	(0.034)	(0.039)
ln(TEST)	0.221**	0.188**	0.180**
	(0.042)	(0.036)	(0.037)
EDLEV1	0.054	0.043	0.044
	(0.044)	(0.035)	(0.035)
EDLEV3	0.017	0.018	0.017
	(0.010)	(0.010)	(0.010)
EDLEV4	0.129**	0.134**	0.120**
	(0.018)	(0.018)	(0.018)
EDLEV5	0.250**	0.207**	0.165**
	(0.028)	(0.025)	(0.027)
BASINC[a]	-0.110**	-0.082**	-0.091**
	(0.031)	(0.027)	(0.028)
BASCOM[a]	-0.186**	-0.108**	-0.100*
	(0.045)	(0.039)	(0.039)
BASMISS	-0.062	-0.016	-0.032
	(0.058)	(0.039)	(0.039)
SESINDEX	0.002	-0.013	-0.017
	(0.041)	(0.035)	(0.035)
SESMISS	0.107	0.056	0.064
	(0.061)	(0.039)	(0.039)
CITY1	0.157**	0.056	0.050
	(0.032)	(0.033)	(0.033)
CITY2	0.064**	-0.011	-0.014
	(0.018)	(0.027)	(0.027)
CITY3	-0.004	-0.051*	-0.053*
	(0.010)	(0.024)	(0.025)
CITY4	-0.021*	-0.014	-0.014
	(0.011)	(0.026)	(0.026)
RURAL	-0.044*	0.002	0.008
	(0.018)	(0.019)	(0.019)
FEMALE[a]	—	—	-0.010
			(0.026)
UNIV[a]	—	—	-0.012
			(0.052)
AVGAGE[a]	—	—	-1.324
			(1.125)
AVGAGESQ[a]	—	—	0.012
			(0.013)
CONTRACT[a]	—	—	-0.027
			(0.027)
CLSSIZE[a]	—	—	-0.542**
			(0.098)
HRSCLS[a]	—	—	0.265**
			(0.052)
CONSTANT	12.374**	12.380**	12.590**
	(0.174)	(0.149)	(0.280)
N	2,945	2,945	2,813
R^2	0.59	0.70	0.70
Municipal dummies?	No	Yes	Yes

Note. Huber-White standard errors are in parentheses. Regional dummy variables were included in Model 1.
[a]Coefficients and standard errors for these variables are multiplied by 100.
*p < .05. **p < .01.

Alternate specifications. We attempted several alternate specifications to assess whether the previous findings are robust. First, we employed a translog rather than a Cobb-Douglas specification (e.g., Callan & Santerre, 1990; Jimenez, 1986). The translog allows for further non-linearities, by virtue of introducing a number of squared and interaction terms as regressors. Nonetheless, the magnitudes of the school type coefficients were similar in Cobb-Douglas and translog specifications (using the same independent variables as Model 2, Table 6).

Second, we re-estimated Model 2 with a full set of interactions between the school type dummies and the other independent variables. The parameter estimates and average sample characteristics were used to predict values of ln(COST) for each school type.[26] The adjusted cost differences were obtained by subtracting the public DAEM cost from those of other school types. Following this method, the Catholic school effect is unchanged and the non-religious voucher effect becomes slightly more

negative (from –0.141 to –0.184, a new cost difference of 17%).

Third, we estimated separate cost functions for schools within and outside of the Metropolitan Region that includes Santiago. Employing the same specification as Model 2 from Table 6, the coefficient for Catholic schools in the Santiago sample was not statistically significant (similar to the full sample result), while the Catholic coefficient in the non-Santiago sample became positive (0.061) and significant. The coefficient on non-religious schools in the Santiago sample became increasingly negative (to –0.192 instead of –0.141), suggesting that the efficiency gap is somewhat wider in Santiago. In contrast, the coefficient in the non-Santiago sample was similar to the full sample estimate.

Discussion

Chile's reforms encouraged a rapid growth in private school enrollment in the 1980s that was driven by an expansion of non-religious and profit maximizing voucher schools. On average, this type of privately run school is marginally less effective than public schools in producing Spanish and mathematics achievement in the fourth grade (or, at best, similarly effective). Further results suggest that non-religious private voucher schools are even less effective than public schools when they are located outside of the capital. Some evidence suggested that the gap is explained by different resources in private schools, such as a greater percentage of teachers with short-term contracts.

Although they produce somewhat lower test scores, non-religious private schools also cost about 13%–17% less than public schools once achievement and student background are held constant (the gap may be slightly larger in Santiago). Direct evidence suggests that a rather small portion of the difference is due to constraints on resource allocation such as the number of teacher contract hours and class size. Indirect evidence suggests that the difference is probably attributable to other constraints—externally imposed on public schools by the regulatory environment—such as higher public sector wages and less public sector flexibility in managing infrastructure investments. Our evidence cannot rule out the possibility that different regulations on public schools (such as less restrictive teacher legislation) could alter relative efficiency, quite independently of a voucher plan. In contrast to non-religious voucher schools, Catholic schools are more effective than public schools at producing achievement for similar students. Yet, because they consume more resources than public schools, Catholic voucher schools turn out to be similarly efficient in the production of achievement.

The results are probably not satisfying for either voucher advocates or opponents. They are inconsistent with advocates' claims that privately managed voucher schools produce significantly higher achievement than public schools for pupils with similar socioeconomic backgrounds. Even so, non-religious voucher schools are more cost-efficient than publicly run schools. Another category, Catholic voucher schools, is able to achieve higher test scores for similar students but only by spending more. The results deliver a mixed message, suggesting that more money may be needed to produce higher student achievement even in private schools, but that private schooling (or deregulation) could still produce savings. Although it would be difficult to argue for a strategy that reduces costs

TABLE 7
Cost Differences Between Public DAEM and Other School Types, 1996

	Difference adjusted for:		
	SES, location (%)	SES, location, municipal dummies (%)	SES, location, municipal dummies, school characteristics (%)
Public corporation	n.s.	n.s.	n.s.
Catholic voucher	n.s.	n.s.	5.0
Protestant voucher	-9.3	n.s.	n.s.
Non-religious voucher	-14.9	-13.2	-11.2
Private non-voucher	13.8	14.0	12.2

Note. Dummy variable coefficients in models 1–3 of Table 6 were converted to percentage differences according to $100*(e^{*}-1)$ (Halvorsen & Palmquist, 1980). "n.s." indicates that a difference is *not* statistically significant at the 5% level.

per student at the expense of student achievement, poor countries with limited resources may find vouchers to be attractive. At the very least, cost savings from voucher programs could be re-directed to more traditional efforts at compensatory education for low-achieving students.[27]

Implications for the U.S. Debate

Chile's plan is interesting because it is national in scope, unlike small experiments in Milwaukee, Cleveland, New York City, and other U.S. cities. It led to the creation of a broad range of schools with diverse objectives, resources, and constraints (and, despite large numbers of clergy and Catholic adherents, the Church was not the main engine of private school growth). Above all, our research suggests that a broad caricature of private schools—either positive or negative—is misleading; in fact, different categories vary widely in their effectiveness and efficiency.

The findings have several implications for the U.S. debate on school choice. First, they should temper our willingness to use existing comparisons of Catholic and public schools as direct evidence of the potential impact of a large-scale voucher plan. Second, they provide insights into how schools anywhere—including the United States—might respond to the introduction of educational markets. Our results suggest that the new players in education markets created by a large voucher plan are non-religious, for-profit schools. They successfully compete by cutting costs, rather than significantly raising academic achievement. Indeed, some of their cost-reduction strategies may contribute to lower achievement. The findings highlight the vital importance of assessing the relative costs of public and private schools, a topic that has been almost entirely ignored by researchers. Third, our results should encourage research on the effectiveness and costs of non-religious, privately managed schools in the United States. In particular, the potential for empirical research on the burgeoning charter school movement is barely tapped, despite similarities to private schools that may arise under vouchers. This is especially so in states like Arizona and Michigan, where for-profit management companies operate a large percentage of charter schools. The incipient evidence on this point is not inconsistent with our findings. For example, Bettinger (1999) finds that the test scores of charter students in Michigan did not improve, and may have declined relative to those of public school students.

Caveats and Further Research

While this paper's findings are suggestive, they do not resolve the debate on vouchers in Chile. We highlight three points which merit further analysis, briefly referring to other empirical research that may shed some light.

First, it is possible that selection bias is contaminating our estimates of private school effects. In a prior section, we discussed indirect evidence on the potential direction of bias. In 1997, the Ministry of Education conducted an eighth-grade assessment for which individual student data are available. In a separate paper, we used these individual data to compare public and private achievement, specifically focusing on corrections for selection bias (McEwan, in press-a). The initial estimates—uncorrected for selection bias—were comparable in sign and magnitude to those of this paper. Following Lee (1983), and using the same individual data, we estimated a multinomial logit model of choice among the six types of schools, results of which were used to construct a selection term.[28] When the term was included as a covariate in achievement regressions, the estimated private school effects declined in magnitude (or became increasingly negative, in the case of non-religious voucher schools). While the standard errors of the new estimates were large enough to prevent strong inferences, the analysis produced no evidence that selection bias favors public schools. In fact, it bolsters a conclusion of this paper: that non-religious voucher schools are, at best, similarly effective to public schools and, at worst, somewhat less effective.

Second, the small differences in effectiveness between public and non-religious private schools might result from market competition during the 1980s that led to improvements in public school quality. A private school advantage might have existed in the 1980s, but disappeared in the 1990s as public schools responded to declining revenues by improving effectiveness. In another paper, we estimate the effects of increasing private enrollments—a proxy for competition—on the academic achievement of fourth-grade students in public schools (McEwan & Carnoy, 1999).[29] The best estimates from these analyses suggest that 15 years of competition led to modest gains in achievement of around 0.16–0.20 standard deviations among public schools in Chile's capital of Santiago. In other regions, which are home to three-quarters of

the population, competition had slightly negative effects. At best, it appears that the public/private gap may have been affected slightly by competition, and then only in Santiago. In other regions, public school achievement was barely altered.

Third, vouchers encouraged a widespread sorting of students across public and private schools, reflected in the mass exodus from public schools. If student outcomes are influenced by peer-group characteristics, then sorting may have affected outcomes in public or private schools, independently of competition.[30] This paper did not assess the extent of sorting or the magnitude of peer effects, although estimates of both would be necessary to fully evaluate the impact of vouchers. Unfortunately, the available evidence on this point is only suggestive. It indicates that sorting probably resembled "cream-skimming," in which the ablest or most privileged students were the most likely to enter private schools. Surveys by Gauri (1998) and Parry (1996) indicate that private schools—including those accepting vouchers—frequently exercise selective admissions through parent interviews, testing, and other means. Thus, if private school receive more applicants than available spaces, they are likely to choose the "better" students. Other authors have used a single cross-section of data to show that Chilean schools are highly stratified, in that families of higher socioeconomic status are more likely to enroll their children in private schools (Aedo & Larrañaga, 1994; Gauri, 1998; McEwan, in press-a). Notwithstanding this evidence, it is problematic to use cross-sectional data to infer that the 1980 reform directly caused this stratification. Ultimately, we must assess whether the 1980 reforms increased stratification, relative to a pre-reform baseline (after all, stratification existed in Chile long before vouchers were implemented). Longitudinal data would be a more helpful means of exploring this issue.

APPENDIX A

Descriptive statistics and variable definitions

	M (*SD*)					
	Effectiveness				Cost	
	1990	1992	1994	1996	1996	Description (source)
SPANISH	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	—	School average on fourth-grade Spanish test (SIMCE)
MATH	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	0.00 (1.00)	—	School average on fourth-grade mathematics test (SIMCE)
ln(COST)	—	—	—	—	13.00 (0.29)	Log of per-student cost (see Appendix C)
Public corporation	0.15	0.15	0.15	0.15	0.13	Dummy variables indicating school type; a dummy for Public DAEM schools is omitted in regressions (Ministry of Education; Barahona & Cabre, 1996)
Catholic voucher	0.07	0.07	0.08	0.07	0.04	
Protestant voucher	0.01	0.02	0.02	0.02	0.01	
Non-religious voucher	0.18	0.21	0.21	0.20	0.26	
Private non-voucher	0.07	0.08	0.10	0.09	0.13	
ln(ENROLL)	—	—	—	—	6.00 (0.80)	Log of school enrollment (Ministry of Education)
PCTPRE	—	—	—	—	8.71 (4.83)	% enrolled in pre-primary (Ministry of Education)
PCTOTH	—	—	—	—	7.17 (13.69)	% enrolled in secondary (Ministry of Education)
ln(TEST)	—	—	—	—	4.14 (0.15)	Log of average school test scores in fourth-grade Spanish, fourth-grade mathematics, eighth-grade Spanish, and eighth-grade mathematics (SIMCE)
EDLEV1	0.02	0.02	0.02	0.02	0.01	Dummy variables indicating the average schooling of parents in the school, ranging from 1 (*low*) to 5 (*high*); EDLEV2 is omitted in regressions (SIMCE)
EDLEV3	0.22	0.25	0.27	0.23	0.27	
EDLEV4	0.08	0.10	0.11	0.09	0.11	
EDLEV5	0.03	0.04	0.05	0.05	0.06	
BASINC	47.81 (32.91)	40.13 (31.86)	33.96 (29.26)	29.30 (28.05)	25.54 (24.92)	% of first-grade mothers with less than 8 years of schooling (JUNAEB)
BASCOM	9.11 (10.74)	13.41 (12.71)	14.77 (13.63)	13.03 (13.01)	13.83 (12.68)	% of first-grade mothers with 8 years of schooling (JUNAEB)
BASMISS	0.07	0.12	0.17	0.19	0.22	1 = BASINC and BASCOM are missing; 0 = not
SESINDEX	42.32 (30.82)	52.36 (33.80)	50.21 (35.25)	44.93 (34.20)	35.79 (29.97)	Index of socioeconomic status, ranging from 0 (*high*) to 100 (*low*) (JUNAEB)
SESMISS	0.14	0.12	0.18	0.18	0.22	1 = SESINDEX is missing; 0 = not
CITY1	0.23	0.10	0.06	0.12	0.05	Dummy variables indicating the type of city where the school is located, ranging from 1 (*small/rural*) to 5 (*completely urban*); CITY5 is omitted in regressions (SIMCE)
CITY2	0.16	0.20	0.20	0.25	0.21	
CITY3	0.13	0.12	0.13	0.11	0.13	
CITY4	0.09	0.10	0.12	0.11	0.12	
RURAL	0.39	0.31	0.26	0.37	0.23	1 = rural school; 0 = urban school (Ministry of Education)
FEMALE	—	—	—	70.18[a] (22.95)	71.24[b] (15.56)	% of female teachers, weighted by contract hours (Ministry of Education)

APPENDIX A
(continued)

	M (*SD*)					
	Effectiveness				Cost	
	1990	1992	1994	1996	1996	Description (source)
UNIV	—	—	—	96.36[a] (10.65)	96.88[b] (7.20)	% of teachers with university degree, weighted by contract hours (Ministry of Education)
AVGAGE	—	—	—	43.55[a] (5.47)	43.37[b] (4.87)	Average age of teachers, weighted by contract hours (Ministry of Education)
AVEAGESQ	—	—	—	1926.56[a] (477.54)	1904.68[b] (421.48)	Average age of teachers squared (Ministry of Education)
MOONLT	—	—	—	12.39[a] (16.20)	—	% of teachers employed by another school, weighted by contract hours (Ministry of Education)
CONTRACT	—	—	—	11.02[a] (17.43)	11.08[b] (14.14)	% of teachers in school that are contractors, weighted by contract hours (Ministry of Education)
CLSSIZE	—	—	—	28.86[a] (8.82)	27.38[b] (7.67)	Average number of students per classroom (Ministry of Education)
HRSCLS	—	—	—	37.46[a] (9.47)	40.94[b] (9.10)	Average number of teacher contract hours per classroom (Ministry of Education)
N	5,088	4,727	4,485	5,429	2,945	

Note. SIMCE is the *Sistema Nacional de Medición de Calidad de la Educación.* JUNAEB is the *Junta Nacional de Auxilio Escolar y Becas.*

[a]These variables are averages of primary teacher characteristics ($N = 4,911$).

[b]These variables are averages of every teacher's characteristics ($N = 2,813$).

APPENDIX B

Effectiveness regressions, 1990–1996

	Dependent variable: SPANISH					Dependent variable: MATH				
	1990	1992	1994	1996		1990	1992	1994	1996	
				Model 1	Model 2				Model 1	Model 2
Public corporation	-0.043**	-0.058**	-0.079**	-0.077**	-0.079**	-0.040**	-0.034**	-0.062**	-0.090**	-0.084**
	(0.011)	(0.011)	(0.011)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Catholic voucher	0.307**	0.231**	0.254**	0.274**	0.263**	0.276**	0.194**	0.169**	0.237**	0.224**
	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)	(0.015)	(0.015)	(0.015)	(0.015)	(0.017)
Protestant voucher	-0.170**	-0.209**	-0.006	-0.158**	-0.088**	-0.175**	-0.266**	-0.085**	-0.145**	-0.081*
	(0.031)	(0.028)	(0.028)	(0.029)	(0.031)	(0.033)	(0.031)	(0.031)	(0.031)	(0.033)
Non-religious voucher	-0.053**	-0.101**	-0.070**	-0.069**	0.059**	-0.039**	-0.100**	-0.078**	-0.075**	0.059**
	(0.011)	(0.010)	(0.011)	(0.011)	(0.014)	(0.012)	(0.011)	(0.012)	(0.012)	(0.014)
Private non-voucher	0.627**	0.612**	0.663**	0.376**	0.419**	0.667**	0.577**	0.645**	0.403**	0.435**
	(0.023)	(0.022)	(0.022)	(0.023)	(0.026)	(0.024)	(0.024)	(0.025)	(0.025)	(0.028)
EDLEV1	-0.012	-0.293**	-0.124**	-0.384**	-0.334**	-0.034	-0.184**	-0.145**	-0.360**	-0.287**
	(0.031)	(0.031)	(0.033)	(0.034)	(0.034)	(0.033)	(0.033)	(0.037)	(0.036)	(0.036)
EDLEV3	0.312**	0.282**	0.235**	0.301**	0.281**	0.313**	0.263**	0.226**	0.291**	0.276**
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.011)	(0.011)	(0.011)
EDLEV4	0.603**	0.591**	0.589**	0.691**	0.657**	0.631**	0.578**	0.567**	0.658**	0.623**
	(0.017)	(0.017)	(0.016)	(0.017)	(0.018)	(0.018)	(0.018)	(0.018)	(0.019)	(0.019)
EDLEV5	0.918**	0.890**	0.836**	0.879**	0.800**	0.966**	0.887**	0.834**	0.918**	0.842**
	(0.029)	(0.026)	(0.026)	(0.027)	(0.029)	(0.031)	(0.029)	(0.028)	(0.029)	(0.031)
BASINC[a]	-0.618**	-1.301**	-1.707**	-0.656**	-0.664**	-0.640**	-1.282**	-1.435**	-0.591**	-0.586**
	(0.029)	(0.038)	(0.036)	(0.024)	(0.025)	(0.031)	(0.041)	(0.040)	(0.026)	(0.027)
BASCOM[a]	-0.132**	-0.890**	-1.423**	-0.391**	-0.398**	-0.183**	-0.836**	-1.193**	-0.287**	-0.249**
	(0.042)	(0.045)	(0.043)	(0.038)	(0.039)	(0.045)	(0.049)	(0.048)	(0.041)	(0.042)
BASMISS	-0.183**	-0.228**	-0.243**	-0.177**	-0.148**	-0.154**	-0.299**	-0.263**	-0.050	-0.004
	(0.019)	(0.049)	(0.031)	(0.037)	(0.036)	(0.020)	(0.053)	(0.034)	(0.039)	(0.039)
SESINDEX[a]	-0.973**	-0.232**	-0.043	-1.047**	-0.907**	-0.789**	-0.123*	-0.216**	-0.923**	-0.852**
	(0.045)	(0.051)	(0.047)	(0.032)	(0.034)	(0.048)	(0.055)	(0.053)	(0.034)	(0.036)
SESMISS	-0.104**	-0.180**	-0.116**	0.045	0.058	-0.089**	-0.107	-0.087*	-0.069	-0.078
	(0.016)	(0.051)	(0.033)	(0.038)	(0.038)	(0.017)	(0.055)	(0.036)	(0.040)	(0.040)
CITY1	-0.226**	-0.207**	-0.294**	-0.180**	-0.114**	-0.116**	-0.197**	-0.228**	-0.086**	-0.062*
	(0.022)	(0.021)	(0.025)	(0.025)	(0.026)	(0.024)	(0.023)	(0.028)	(0.026)	(0.028)

CITY2	-0.089**	0.074**	0.132**	0.138**	0.175**	-0.074**	0.081**	0.122**	0.155**	0.178**
	(0.020)	(0.016)	(0.017)	(0.018)	(0.019)	(0.021)	(0.017)	(0.018)	(0.019)	(0.020)
CITY3	0.032**	0.090**	0.112**	0.075**	0.093**	0.005	0.064**	0.087**	0.079**	0.092**
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
CITY4	0.027*	0.067**	0.087**	0.050**	0.066**	0.015	0.058**	0.057**	0.031*	0.056**
	(0.013)	(0.012)	(0.012)	(0.012)	(0.012)	(0.014)	(0.013)	(0.013)	(0.013)	(0.013)
RURAL	0.175**	-0.057**	-0.016	0.173**	0.178**	0.084**	-0.080**	0.027	0.153**	0.164**
	(0.021)	(0.018)	(0.022)	(0.018)	(0.018)	(0.023)	(0.020)	(0.025)	(0.019)	(0.019)
FEMALE[a]	—	—	—	—	0.397**	—	—	—	—	0.249**
					(0.021)					(0.022)
UNIV[a]	—	—	—	—	0.567**	—	—	—	—	0.522**
					(0.042)					(0.044)
AVGAGE[a]	—	—	—	—	7.415**	—	—	—	—	9.297**
					(0.893)					(0.946)
AVGAGESQ[a]	—	—	—	—	-0.089**	—	—	—	—	-0.110**
					(0.010)					(0.011)
MOONLT[a]	—	—	—	—	-0.394**	—	—	—	—	-0.404**
					(0.028)					(0.030)
CONTRACT[a]	—	—	—	—	-0.252**	—	—	—	—	-0.293**
					(0.024)					(0.026)
CLSSIZE[a]	—	—	—	—	0.333**	—	—	—	—	0.246**
					(0.065)					(0.069)
HRSCLS[a]	—	—	—	—	0.510**	—	—	—	—	0.599**
					(0.044)					(0.046)
CONSTANT	0.552**	0.653**	0.592**	0.372**	-2.250**	0.451**	0.559**	0.526**	0.287**	-2.583**
	(0.015)	(0.018)	(0.018)	(0.017)	(0.195)	(0.016)	(0.019)	(0.020)	(0.018)	(0.206)
N	5,088	4,727	4,485	5,429	4,911	5,088	4,727	4,485	5,429	4,911
R^2	0.60	0.63	0.64	0.54	0.55	0.55	0.55	0.56	0.47	0.48

Note. Standard errors are in parentheses. Regional dummy variables were included in all regressions. Each observation is weighted by the square root of the number of students tested.
[a]Coefficients and standard errors for these variables are multiplied by 100.
*$p < .05$. **$p < .01$.

APPENDIX C

Estimation of Per-Student Costs

We used several data sources to arrive at a proxy of annual per-student costs in 1996. Data were derived from five sources that mainly describe school revenues from the national government, municipal governments, and families. For several categories of schools, we also impute the cost of buildings and land, when these are not covered by other sources of revenue.

First, the Ministry of Education maintains a database of annual voucher payments to schools. In practice, a single monthly payment is made to the *sostenedor* (an individual or organization) that manages each school. In the case of public schools, the *sostenedor* is the municipal DAEM or corporation, while in the case of private schools, it may be a single individual or institution (e.g., a diocese or private corporation) that manages several schools. Nonetheless, the 1996 database records the separate portion of each payment that is due to each school during the year. The payment includes the base voucher, net of deductions for *financiamiento compartido* (shared financing), under which some private schools charge tuition to students but receive reduced voucher payments. It also includes additional payments to schools, such as bonuses for location in high-poverty municipalities or rural areas. We divide the total annual payment to each school by its total enrollments.

Second, the Ministry of the Interior maintains budgets for each municipality. Municipalities have the option of making additional contributions to public schools out of their own revenues. Thus, we extracted each municipality's own contribution to education in 1996 and divided it by the total number of students enrolled in the public system at any level.

Third, the Ministry of Education, via a questionnaire item on the 1997 SIMCE assessment, surveys eighth-grade parents on their monthly educational expenditures. A single question was put to approximately 90% of parents in most public and private schools: "How much money do you spend each month on the education of the boy or girl? Include the Parent Center fee, tuition payments, school textbooks, uniforms, transportation, and lunch" (our translation). Some categories may not merit inclusion because they are not strictly costs of education. Lunch costs, for example, may be incurred even if the student does not attend school. Nevertheless, it seems unlikely that relative costs of public and private schools will be biased since the same measure is used for all children. The survey makes no further divisions among categories of family expenditures (e.g., tuition and uniforms). Each family's response was deflated to 1996 pesos with the Consumer Price Index and multiplied by nine to arrive at annual expenditures. The per-student expenditure was derived by averaging the response of every parent in a given school.

Fourth, the Ministry of Education collected an extensive survey of school infrastructure in 1996. We used the survey, in concert with price data, to impute the annual cost of buildings and land for public and religious voucher schools. This is necessary for the following reason: Most public schools inherited their land and facilities from the national government after the 1980 reform, or municipalities constructed it with financial assistance from the nationally financed Regional Development Fund. Similarly, religious schools receive monetary or in-kind donations for land and facilities. (In contrast, most other schools finance their infrastructure out of voucher revenues that are already accounted for in the cost estimates; thus, we impute no land and building cost for these schools.)

We used the following procedure to impute the annual cost of land and buildings in public and religious private schools. We first calculated the replacement value of buildings (including classrooms and on-site teacher housing), multiplying square meters of construction by the estimated price per square meter. Prices are adjusted according to the type of construction materials, following Quiroz and Chumacero (1996). We estimated the current value of buildings by deducting an amount for depreciation, based on the current age of the buildings and an assumed useful life of 50 years. Finally, we applied an annualization factor to the remaining amount—utilizing a discount rate of 10%—arriving at an annual cost which reflects depreciation and the opportunity cost of funds (Levin & McEwan, 2000). To compute the annual cost of land, we estimated the market value of land by multiplying square meters by estimated land prices. Land prices, assumed to vary by municipality, are taken from Opazo and Chumacero (1997). To arrive at the annual cost, we multiplied the total value by the discount rate. The total annual cost of buildings and land was divided by total student enrollments.

Fifth, the Ministry of Education has initiated a variety of school programs since 1990, the costs of which are assumed by the national government. The longest-running program, P-900, is targeted at the poor and low-achieving schools—either public or private voucher. We use an annual cost estimate of US$26 per student (Peirano & McMeekin, 1995), converted to pesos at 425 per dollar.

There are four possible biases in the estimates. First, it was not possible to estimate costs of the nationally financed MECE program, which has endowed primary schools with textbooks, training, and other programs since 1992. But unlike P-900, MECE has been universally applied to all public and private voucher schools (one category of schools, private non-voucher, did not receive assistance). Thus, it is likely that our estimates are a still a good measure of relative costs between public and private voucher schools. Second, it was not possible to fully account for donated resources,

monetary or in-kind, that religious schools may receive. Although we imputed annual land and building costs for religious schools, it is possible that schools receive other donations. For example, clergy may work at below-market wages, and a full accounting of social costs should estimate the value of their contributed services (e.g., Bartell, 1968). Third, it is possible that some non-religious voucher schools receive donated resources from private foundations or other sources. However, there was no means of identifying these schools. Fourth, there is no cost estimate of the nationally administered school meals program of the *Junta Nacional de Auxilio Escolar y Becas* (JUNAEB). The program is theoretically available to any school in Chile, but is mostly available in low- and middle-class schools.

Notes

Carnoy and McEwan were supported by a grant from the Ford Foundation. McEwan was also supported by a Spencer Fellowship for Research Related to Education. Most of this research was carried out while McEwan was at Stanford University and the National Center for the Study of Privatization in Education at Teachers College. We are grateful to Patrick Bayer, Cristián Cox, Henry Levin, Susanna Loeb, Robert McMillan, Thomas Nechyba, and the anonymous referees for their helpful comments on this research, without implicating them for its conclusions or errors. We extend our thanks to many personnel of Chile's Ministry of Education for their cooperation in providing the data.

[1]Derek Neal concludes in his review of Catholic school effectiveness that

> we cannot confidently expect positive outcomes for [voucher] program participants if the program is large in scale. . . .Large school voucher programs would likely mean the expansion of many existing private schools and the entry of many new private schools. How would this expansion and entry affect the quality of private schools or the quality of remaining public schools? We do not know, and available data shed little light on this question. (1998, p. 84)

[2]Most Chilean economic and social policy during the military government was deeply influenced by the Chicago School of economics (Valdes, 1995).

[3]While most studies focus on Catholic schools, some analyze public magnet schools and secular private schools (e.g., Gamoran, 1996).

[4]The Milwaukee voucher plan resembled an experimental design, in that applicants were selected by lottery at individual school sites (although attrition from control and treatment groups may have complicated the interpretation of results). Greene, Peterson, and Du (1998) and Rouse (1998a) exploited this feature of program design in their evaluations. In contrast, Witte (1998) used a sample of public school students as the comparison group. More recently, there have been randomized experiments conducted in New York City (Peterson, Myers, Howell, & Mayer, 1999); Dayton, Ohio (Howell & Peterson, 2000); and Washington, DC (Wolf, Howell, & Peterson, 2000).

[5]Although Hoxby (1998) asserts that private schools cost around 50% to 60% less than public schools, she presents no data. Using principal-reported data from High School and Beyond, Coleman and Hoffer (1987) also conclude that per-pupil expenditures in Catholic schools are roughly 50% less than public schools, but the same data show that "other private" and "high-performance private" schools are 38% and 131% more costly than public schools. Although Milwaukee choice schools may have had considerably lower costs when vouchers were first introduced, 5 years into the voucher plan choice schools appear to have only a slight cost advantage, according to Levin's (1998) calculations. Private-public cost comparisons for other countries suggest that private schools are often less costly than public (Jimenez & Lockheed, 1995).

[6]The following section draws on the work of other authors who have described the Chilean reforms. See especially Gauri (1998), Jofré (1988), and Parry (1997a, 1997b).

[7]DAEMs are governed by the larger municipal bureaucracy and, as such, are governed by municipal rules. For instance, the head of the DAEM is required to be a teacher and he or she reports directly to the mayor. Employee contracts must conform to municipal regulations on hiring and salary scales. In contrast, corporations are non-profit organizations that are not subject to direct mayoral control, although the mayor presides over a governing board. Their operations are generally subject to fewer regulations. For example, the corporation head is not required to be a teacher and corporation employees are not subjected to municipal rules regarding the hiring and remuneration of municipal employees.

[8]Since 1993, a policy called *financimiento compartido* (shared financing) has allowed all private and a few public secondary schools to charge limited tuition in exchange for reduced voucher payments.

[9]Chilean law specifies a factor by which the base voucher is adjusted for students at every grade level. Furthermore, selected municipalities receive "zone assignments" to compensate for high poverty or isolation. It should be noted, however, that adjustments are largely ad hoc and may not reflect true variation in educational costs. Since 1987, rural schools within municipalities have received upward adjustments. See Parry (1997a) for details.

[10]Restricting the sample to urban areas, public DAEM schools have an average class size of 32.1, compared with 32.2 in non-religious voucher schools.

[11]We do not analyze the 1988 survey because comparable control variables—specifically the JUNAEB survey—were not available in that year. Similar achievement data were collected between 1982 and 1984, un-

der the auspices of the *Programa de Evaluación del Rendimiento Escolar* (PER). However, there are not good control variables for student background available for earlier years.

[12]The variable SESINDEX is equivalent to JUNAEB's *índice de vulnerabilidad*.

[13]Only a few studies, all in developing countries, compare private and public school costs in the framework of a cost function (James et al., 1996; Jimenez, 1986; Tsang & Taoklam, 1992).

[14]These arguments are usually applied to private/public cost differences in non-voucher systems. It is conceivable that competition for students in a voucher system would lead to reductions in cost differences, as we noted previously. This complicates the interpretation of our results, which we note in the last section.

[15]This functional form is more restrictive than others that could be used, such as the translog. For example, the Cobb-Douglas restricts the elasticity of substitution between factor inputs to be one and assumes homotheticity between costs and inputs. Later analyses assess whether empirical findings are robust to the use of alternative functional forms. Among recent studies, Downes and Pogue (1994), Duncombe et al. (1996), and James et al. (1996) employ the Cobb-Douglas functional form. Callan and Santerre (1990) and Jimenez (1986) employ the translog.

[16]For example, Bee and Dolton (1985) treat the pupil-teacher ratio, among other inputs, as exogenous in some specifications. Callan and Santerre (1990) treat the capital stock as exogenous.

[17]In fact, TEST is the mean of each school's Spanish and mathematics assessments in fourth grade and eighth grade. The four outcome measures are highly collinear, which cautions against their inclusion as separate independent variables (Duncombe et al., 1996). Nonetheless, we carried out all analyses with the disaggregated outcome measures, which did not alter the coefficients on the school type dummy variables.

[18]We use a Wald test and a significance level of 0.05.

[19]We could accomplish the same by dividing each year's sample by the six school types and estimating Equation 1—excluding the school type dummies—in each sub-sample.

[20]We further estimated the 1996 model with school and teacher variables and a full set of interactions. Private school effects derived from the estimates were similar to those in the simpler model without interaction effects.

[21]Using the same parameter estimates, we re-calculated the predictions with the average characteristics of public DAEM schools—which enroll lower SES students—rather than sample-wide averages. Doing so yields smaller effects for Catholic schools (from 0.06 to 0.25), and increasingly negative effects for non-religious schools (–0.23 to –0.13). When students are of relatively lower SES, both school types exhibit decreased relative effectiveness. The existence of interactions between private school effectiveness and student SES is consistent with other research on Chile (Parry, 1997c).

[22]See Tsang (1988) for a general discussion. Bray (1996) surveys educational cost studies in nine East Asian countries, finding that direct private costs as a percentage of total costs in public primary schools range from less than 10% in Lao PDR to over 70% in Cambodia. McEwan (1999) finds that family contributions account for 44% of per-student costs in Honduras.

[23]In economic language, a technically inefficient school operates off the isoquant, using more than the necessary amounts of inputs (given prevailing technology) to produce a given amount of output. A price inefficient school may operate on the isoquant, but not at the point of tangency between the isoquant and the budget line (and thus, more output could be obtained by reallocating inputs towards those with higher marginal effects relative to their marginal costs).

[24]Prior regressions included municipal dummy variables to account for differences in teacher salaries and other input prices across municipalities. However, there are still likely to be differences in the wages of private and public teachers within each municipality.

[25]Authors' calculations with 1996 municipal budgets.

[26]We also used the average characteristics of DAEM schools (as opposed to the entire sample), which did not appreciably alter the results.

[27]Chile's P-900 program, implemented after the return to democracy in 1990, was just such an attempt.

[28]The multinomial logit included a measure of local supply of each school type as an independent variable, which was excluded from subsequent achievement regressions.

[29]Several other papers, all in the U.S., use comparable proxies of competition (Dee, 1998; Hoxby, 1994; Jepsen, 1999; McMillan, 1998; Sander, 1999). These papers, like ours, face a common empirical challenge. Partial correlations between private enrollments and achievement, even controlling for a wide range of background variables, are likely to yield biased estimates of the effects of competition. For example, private enrollments may be correlated with unmeasured determinants of achievement. In Chile, private enrollments tend to be higher in more privileged municipalities. If we do not perfectly control for municipal wealth or socioeconomic status—both likely determinants of achievement—then we confound the effects of competition and unmeasured municipal characteristics. We address these biases by using panel data that track fourth-grade achievement in the majority of public schools between 1982 and 1996. By first-differencing the data, we are able to control for unobserved determinants of achievement that are constant across time for individual schools. By differencing the data once more—a "difference-in-difference" approach—we also control for constant time-trends in each school's achievement.

[30]See Levin (1998) or McEwan (in press-b) for a review of the literature on sorting and peer effects.

References

Aedo, C. (1996). Calidad de la educación y elementos de mercado, *Educación en Chile: Un desafío de calidad* (pp. 57–130). Santiago: ENERSIS.

Aedo, C. (1998). Differences in schools and student performance in Chile. In W. D. Savedoff (Ed.), *Organization matters: Agency problems in health and education in Latin America* (pp. 39–73). Washington, DC: Johns Hopkins University Press.

Aedo, C., & Larrañaga, O. (1994). Sistemas de entrega de los servicios sociales: La experiencia chilena. In C. Aedo & O. Larrañaga (Eds.), *Sistema de entrega de los servicios sociales: Una agenda para la reforma* (pp. 33–74). Washington, DC: Banco Interamericano de Desarrollo.

Barahona, A., & Cabre, A. (Eds.). (1996). *Guia de la iglesia en Chile, 1996–1998*. Santiago: Ediciones Mundo.

Bartell, E. (1968). *Costs and benefits of Catholic elementary and secondary schools*. Notre Dame: Notre Dame Press.

Bee, M., & Dolton, P. J. (1985). Costs and economies of scale in UK private schools. *Applied Economics, 17*, 281–290.

Bettinger, E. P. (1999). *The effect of charter schools on charter students and public schools*. Unpublished manuscript, MIT.

Bray, M. (1996). *Counting the full cost: Parental and community financing of education in East Asia*. Washington, DC: The World Bank.

Bryk, A. S., Lee, V. E., & Holland, P. B. (1993). *Catholic schools and the common good*. Cambridge, MA: Harvard University Press.

Callan, S. J., & Santerre, R. E. (1990). The production characteristics of local public education: A multiple product and input analysis. *Southern Economic Journal, 57*(2), 468–480.

Chambers, J., & Fowler, W. J. (1995). *Public school teacher cost differences across the United States*. Washington, DC: National Center for Education Statistics.

Chambers, J. G. (1987). Patterns of compensation of public and private school teachers. In T. James & H. M. Levin (Eds.), *Comparing public and private schools* (Vol. 1, pp. 190–217). New York: The Falmer Press.

Chubb, J. E., & Moe, T. M. (1990). *Politics, markets, and America's schools*. Washington, DC: The Brookings Institution.

Coleman, J. S., & Hoffer, T. (1987). *Public and private high schools: The impact of communities*. New York: Basic Books.

Dee, T. S. (1998). Competition and the quality of public schools. *Economics of Education Review, 17*(4), 419–427.

Downes, T. A., & Pogue, T. F. (1994). Adjusting school aid formulas for the higher cost of educating disadvantaged students. *National Tax Journal, 47*(1), 89–110.

Duncombe, W., Ruggiero, J., & Yinger, J. (1996). Alternative approaches to measuring the cost of education. In H. F. Ladd (Ed.), *Holding schools accountable: Performance-based reform in education* (pp. 327–356). Washington, DC: The Brookings Institution.

Espinola, V. (1993). *The educational reform of the military regime in Chile: The system's response to competition, choice, and market relations*. Unpublished Ph.D. dissertation, University of Wales, United Kingdom.

Friedman, M. (1955). The role of government in education. In R. A. Solo (Ed.), *Economics and the public interest* (pp. 123–144). New Brunswick, NJ: Rutgers University Press.

Friedman, M. (1962). *Capitalism and freedom*. Chicago: University of Chicago Press.

Gamoran, A. (1996). Student achievement in public magnet, public comprehensive, and private city high schools. *Educational Evaluation and Policy Analysis, 18*(1), 1–18.

Gauri, V. (1998). *School choice in Chile: Two decades of educational reform*. Pittsburgh: University of Pittsburgh Press.

Greene, J. P., Peterson, P. E., & Du, J. (1998). School choice in Milwaukee: A randomized experiment. In P. E. Peterson & B. C. Hassel (Eds.), *Learning from school choice* (pp. 335–356). Washington, DC: Brookings Institution Press.

Greene, W. H. (1997). *Econometric analysis* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.

Haertel, E. H. (1987). Comparing public and private schools using longitudinal data from the HSB study. In E. H. Haertel, T. James, & H. M. Levin (Eds.), *Comparing public and private schools* (Vol. 2, pp. 9–32). New York: The Falmer Press.

Halvorsen, R., & Palmquist, R. (1980). The interpretation of dummy variables in semilogarithmic equations. *American Economic Review, 70*(3), 474–475.

Howell, W. G., & Peterson, P. E. (2000). *School choice in Dayton, Ohio: An evaluation after one year*. Cambridge, MA: Program on Education Policy and Governance, Harvard University.

Hoxby, C. M. (1994). *Do private schools provide competition for public schools?* (Working Paper No. 4978). Cambridge, MA: National Bureau of Economic Research.

Hoxby, C. M. (1996). How teachers' unions affect education production. *Quarterly Journal of Economics, 111*(3), 671–718.

Hoxby, C. M. (1998). What do America's 'traditional'

forms of school choice teach us about school choice reforms? *Federal Reserve Bank of New York Economic Policy Review, 4*(1), 47–59.

Hsiao, C. (1986). *Analysis of panel data*. Cambridge: Cambridge University Press.

James, E., King, E. M., & Suryadi, A. (1996). Finance, management, and costs of public and private schools in Indonesia. *Economics of Education Review, 15*(4), 387–398.

Jepsen, C. (1999). *The effects of private school competition on student achievement*. Unpublished manuscript, Northwestern University.

Jimenez, E. (1986). The structure of educational costs: Multiproduct cost functions for primary and secondary schools in Latin America. *Economics of Education Review, 5*(1), 25–39.

Jimenez, E., & Lockheed, M. E. (1995). *Public and private secondary education in developing countries: A comparative study*. (World Bank Discussion Paper 309). Washington, DC: World Bank.

Jofré, G. (1988). El sistema de subvenciones en educación: La experiencia chilena. *Estudios Públicos*, No. 32, 193–237.

Kealey, R. J. (1996). *Balance sheet for Catholic elementary schools: 1995 income and expenses*. Washington, DC: National Catholic Educational Association.

Lee, L.-F. (1983). Generalized econometric models with selectivity. *Econometrica, 51*(2), 507–512.

Levin, H. M. (1998). Educational vouchers: Effectiveness, choice, and costs. *Journal of Policy Analysis and Management, 17*(3), 373–391.

Levin, H. M., & McEwan, P. J. (2000). *Cost-effectiveness analysis: Methods and applications* (2nd ed.). Thousand Oaks, CA: Sage Publications.

McEwan, P. J. (1999). Private costs and the rate of return to primary education. *Applied Economics Letters, 6*(11), 759–760.

McEwan, P. J. (in press-a). The effectiveness of public, Catholic, and non-religious private schools in Chile's voucher system. *Education Economics*.

McEwan, P. J. (in press-b). The potential impact of large-scale voucher programs. *Review of Educational Research*.

McEwan, P. J., & Carnoy, M. (1999). *The impact of competition on public school quality: Longitudinal evidence from Chile's voucher system*. Unpublished manuscript, Stanford University.

McMahon, W. W. (1982). Efficiency and equity criteria for educational budgeting and finance. In W. W. McMahon & T. G. Geske (Eds.), *Financing education: Overcoming inefficiency and inequity* (pp. 1–30). Urbana: University of Illinois Press.

McMillan, R. (1998). *Parental pressure and competition: An empirical analysis of the determinants of public school quality*. Unpublished manuscript, Stanford University.

Neal, D. (1998). What have we learned about the benefits of private schooling? *Federal Reserve Bank of New York Policy Review, 4*(1), 79–86.

Opazo, L. A., & Quiroz, J. A. (1997). Reforma educacional: Modalidades alternativas de financiamento de infraestructura. *Persona y Sociedad, 11*(2), 169–182.

Parry, T. R. (1996). Will pursuit of higher quality sacrifice equal opportunity in education? An analysis of the education voucher system in Santiago. *Social Science Quarterly, 77*(4), 821–841.

Parry, T. R. (1997a). Achieving balance in decentralization: A case study of education decentralization in Chile. *World Development, 25*(2), 211–225.

Parry, T. R. (1997b). Decentralization and privatization: Education policy in Chile. *Journal of Public Policy, 17*(1), 107–133.

Parry, T. R. (1997c). Theory meets reality in the education voucher debate: Some evidence from Chile. *Education Economics, 5*(3), 307–331.

Peirano, C., & McMeekin, R. (1995). Gastos y costos del Programa de las 900 Escuelas en el período enero 1990–junio 1993. In M. Gajardo (Ed.), *Cooperación internacional y desarollo de la educación*. Santiago: Agencia de Cooperacion Internacional de Chile (AGCI), in cooperation with Swedish SIDA and CIDE.

Peterson, P. E., Myers, D. E., Howell, W. G., & Mayer, D. P. (1999). The effects of school choice in New York City. In S. E. Mayer & P. E. Peterson (Eds.), *Earning and learning: How schools matter* (pp. 317–339). Washington, DC and New York: Brookings Institution Press and Russell Sage Foundation.

Quiroz, J. A., & Chumacero, R. A. (1996). *El costo de la educación particular subvencionada en Chile*. Santiago: GERENS.

Riddell, A. R. (1993). The evidence on public/private educational trade-offs in developing countries. *International Journal of Educational Development, 13*(4), 373–386.

Rojas, P. (1998). Remuneraciones de los profesores en Chile. *Estudios Públicos* (71), 121–175.

Rouse, C. E. (1998a). Private school vouchers and student achievement: An evaluation of the Milwaukee parental choice program. *Quarterly Journal of Economics, 113*(2), 553–602.

Rouse, C. E. (1998b). Schools and student achievement: More evidence from the Milwaukee Parental Choice Program. *Federal Reserve Bank of New York Economic Policy Review, 4*(1), 61–76.

Sander, W. (1999). Private schools and public school achievement. *Journal of Human Resources, 34*(4), 697–709.

Tsang, M. C. (1988). Cost analysis for educational policymaking: A review of cost studies in education in developing countries. *Review of Educational Research, 58*(2), 181–230.

Tsang, M. C., & Taoklam, W. (1992). Comparing the costs of government and private primary education in Thailand. *International Journal of Educational Development, 12*(3), 177–190.

Valdes, J. G. (1995). *Pinochet's economists: The Chicago School in Chile.* Cambridge: Cambridge University Press.

Vargas, J. (1997). Mercado, competencia y equidad en la educación subvencionada. *Persona y Sociedad, 11*(2), 59–69.

Winkler, D. R., & Rounds, T. (1996). Municipal and private sector response to decentralization and school choice. *Economics of Education Review, 15*(4), 365–376.

Witte, J. F. (1992). Private school versus public school achievement: Are there findings that should affect the educational choice debate? *Economics of Education Review, 11*(4), 371–394.

Witte, J. F. (1996). School choice and student performance. In H. F. Ladd (Ed.), *Holding schools accountable: Performance-based reform in education* (pp. 149–176). Washington, DC: The Brookings Institution.

Witte, J. F. (1998). The Milwaukee voucher experiment. *Educational Evaluation and Policy Analysis, 20*(4), 229–251.

Wolf, P. J., Howell, W. G., & Peterson, P. E. (2000). *School choice in Washington, DC: An evaluation after one year.* Cambridge, MA: Program on Education Policy and Governance, Harvard University.

Author

PATRICK J. McEWAN is a visiting assistant professor at the University of Illinois at Urbana-Champaign, College of Education, 360 Education Building, 1310 S. Sixth Street, Champaign, IL 61820. He specializes in economics of education.

MARTIN CARNOY is a professor at Stanford University, School of Education, Stanford, CA 94305-3096. His area of specialization is economics of education.

Manuscript received June 7, 1999
Revisions received December 6, 1999; April 24, 2000
Accepted May 3, 2000