FRANCISCO A. GALLEGO
ANDRÉS E. HERNANDO

On the Determinants and Implications of School Choice: Semi-Structural Simulations for Chile

School choice is one of the most widely debated policies aimed at increasing student welfare in different countries. Proponents argue that school choice may create incentives for schools to increase productivity, offer a product closer to student demands, and expand the choice set for poor students. Opponents, in contrast, argue that school choice may increase segregation, decrease school quality for poor students by moving good peers to other schools, and produce competition in irrelevant school attributes if parents do not care about education outcomes. Most researchers use reduced-form methods to study these claims. For instance, some papers analyze the effect of interschool competition on test scores and other measures, finding mixed evidence.[1] Other papers use a variety of methods to study the process of choice by parents. This paper uses semi-structural estimates of parents' preferences from an earlier work to study the effects of school choice on both student welfare and socioeconomic segregation.[2] To the best of our knowledge, this is the first time school choice has been evaluated using this kind of approach, in which preferences are explicitly taken into account.

Gallego is with the Pontificia Universidad Católica de Chile; Hernando is with Harvard University.

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1. Hoxby (2000) and Rothstein (2005, 2006) for the United States; Hsieh and Urquiola (2006), Gallego (2006), and Auguste and Valenzuela (2003) for Chile; Card, Dooley, and Payne (2008) for Canada.

2. Gallego and Hernando (2008).

We evaluate these effects in the context of the Chilean quasi-voucher system. The Chilean system, which has been in operation since 1981, has four key characteristics: private and public schools receive government subsidies proportional to school enrollment, based on a (mostly) flat per-student subsidy; students are free to apply to any school that receives government subsidies; voucher schools are free to choose students among the pool of applicants and may charge top-ups; and school entry is relatively easy. These conditions make the Chilean experience probably the most massive school choice program in the world.[3]

We use data on school choice for a sample of students living in the Metropolitan Area of Santiago, which has the broadest school choice in the country owing to the high entry of voucher schools and the existence of relatively low transportation costs.[4] We consider data for 2002 to capture a period in which the choice system was mostly consolidated: the bulk of school entry has taken place, and information on test scores is available from the mid-1990s onward. We use semi-structural estimates from our earlier work, which follows the literature on horizontal differentiation in the attribute space developed by Berry, Levinsohn, and Pakes, among others.[5] We model school choice as a discrete process in which parents choose schools based on attributes such as characteristics of peers (mean and standard deviation of income and mother's education at the school level), indicators of the development of cognitive abilities (test scores), indicators of the development of noncognitive skills (discipline and the teaching of religious values), proxies for transportation costs (distance from school to the center of the municipality in which the student lives and a dummy for whether the school is close to a subway station), the top-up charged by the school, a dummy indicating whether the school has an extended day, and a dummy for whether the school is single-sex or coeducational.[6] We further allow the choice to depend on an unobserved

3. We refer to the Chilean experience as a quasi-voucher system following Gallego (2006, 2008) because some basic preconditions for the operation of a voucher system are not met in Chile: public schools tend to face soft budget constraints (that is, they receive a nontrivial amount of nonvoucher transfers); the value of the voucher is low; and the families do not actually receive a voucher from the government and cannot use the voucher in private schools.

4. In the period for which we have data, 98 percent of households in Santiago had access to public transportation close to their homes (within eight blocks) (Balmaceda 2006).

5. Berry, Levinsohn, and Pakes (1995, 2004). Our earlier paper (Gallego and Hernando 2008) lays out the modeling, estimation details, and results (available on request).

6. We have considered other school characteristics such as participation in government programs, and we have found no significant effects.

(for us) school effect, which is common to all students, and interactions between the set of observed school attributes and student characteristics such as household income, mother's education and age, gender, preferences for the teaching of values, and a proxy for parents' expectations of student potential. We thus allow for considerable heterogeneity in preferences, which is supported by the data.

The paper also presents reduced-form estimates in which we relate the decision to attend school outside the home municipality as a function of differences in the average quality (both the mean and the standard deviation) of the destination and the home municipality and some socioeconomic controls. We see these results as a benchmark for semi-structural estimates. Interestingly, the estimated effects are quite similar to structural estimates, and we find that students react more strongly to differences in quality in urban markets with more competition than to differences among schools in less competitive markets, as expected.

The estimates of deep parameters allow us to implement a number of simulations related to the effects of different policies on consumers' welfare. Our first group of simulations is related to the value of school choice—that is, how much welfare parents would lose if the degree of choice were limited along different dimensions. We implement three counterfactuals. In the first, we keep the current supply of schools constant and compare consumer welfare in the current system with the benefits of a system in which students are randomly allocated to schools in the municipality in which they live and do not have to pay school fees. In the second simulation, we decrease the supply of schools so that only 15 percent of students in each municipality can attend voucher schools.[7] We assign these students randomly among voucher and public schools, keeping constant the relative size of schools in 2002 to accommodate the increase in the school-age population between 1981 and 2000. In the third simulation, related to allowing geographic mobility, we compare the current situation with a system in which there is free school choice but only within the municipality in which the student lives. Next we analyze the effects of the schools' option to charge top-ups to the voucher. In this case, we simply assume that all fees are equal to zero, or alternatively that each household receives a transfer from the government to exactly pay for the

7. This is the enrollment rate in fee private schools in the pre-1981 system. However, notice that net enrollment rates in primary and secondary schools were well below the levels of 2002. Gallego (2006) suggests that the enrollment rate in voucher schools was less than 10 percent of the school-age population.

fee. Finally, we evaluate the impacts on welfare of the introduction of a differentiated voucher, which pays a higher value for vulnerable students. We calibrate the policy change to a particular program that is currently being implemented in Chile.

The results of these simulations suggest that school choice, at least as it has been implemented in Chile, increases overall student welfare, but there is a lot of heterogeneity in the size and even the sign of the welfare changes. While some of the features of the system, such as geographic mobility, seem to be progressive policies (that is, they benefit the poor the most), others, such as allowing complete choice, seem to be regressive and still others, such as top-up charges, affect mostly middle-class students. As previously mentioned, the high socioeconomic segregation of the school system in Chile seems to be driven mainly by demand factors. The potential abolition of fees and the use of lotteries in the context of free application to all schools do not seem to decrease segregation significantly.

Our methodology of combining semi-structural estimates of preferences and policy simulations is new to the literature on the quantitative effects of school choice on student welfare.[8] This paper uses a multidimensional approach to assess the effects of several features of school choice on welfare and translates the effects into monetary equivalents. Our analysis has its limitations, however. First, we do not explicitly model potential direct effects of school choice on the supply of attributes (such as the effects of interschool competition on school quality), since doing so would require estimating the supply-side equations, which is not feasible at this time given the available data. Second, our simulations consider only a static situation in which no actor can enter or exit the system or change its relevant characteristics. That is, we assume that students do not drop out of the system either to nonenrollment or to enrollment in unsubsidized private schools, that schools cannot enter or exit the system, and that schools cannot change their sizes or prices (top-ups) in response to observed over- or underenrollment. Third, some of our policy simulations use lotteries to assign students to schools without examining whether these allocation mechanisms are actually implementable or considering their costs. Finally, we assume that our estimates correspond to stable deep parameters of consumers' preferences, when in fact parents

8. Simulations based on structural estimates of consumers' preferences are not new in the structural industrial organization literature. For instance, Berry, Levinsohn, and Pakes (2004) study the effects of closing one of the General Motors lines on automobile demand; Leslie (2004) compares price discrimination with uniform pricing of Broadway show tickets.

may not be maximizing their true utility function as a result of informational or other problems. We leave extensions of our work that will address these limitations for future research.

The paper is organized as follows. The next section presents a description of the Chilean school choice system. The paper then discusses the literature on structural estimates and presents our methodology and earlier results.[9] Next, we present the simulations implemented in this paper, while the final section briefly concludes.

The Chilean System

Before 1981, public schools in Chile were run by the central government and received funds independently of the number of students that attended the school.[10] Parents could choose to opt out of the public system, in which case they had two main alternatives: expensive unsubsidized private schools and free subsidized private schools. The subsidized private schools received some discretional funds from the government (equivalent to 50 percent of the operating costs of similar public schools), with the remainder of their funds coming from private donations and charitable organizations. In 1981, the government implemented a broad reform that changed the way schools were administered and expanded selection for both parents and schools. The reform transferred public schools from the central to the local governments (municipalities); gave parents total freedom to apply to any subsidized private or public school, which receive a per-student subsidy (voucher) based on enrollment; established free entry to the school market; and gave voucher schools complete freedom to select students from the pool of applicants. In addition, the value of the subsidy received per student increased significantly (30 percent for public schools and 160 percent for subsidized private schools).

In this context, subsidized private schools expanded dramatically. Before the reform, subsidized private schools enrolled about 7 percent of the school-age population (based on data from the 2002 Social Protection Survey). Enrollment in subsidized private (or voucher) schools increased to about 10 percent of the school-age population immediately following the implementation of

9. Gallego and Hernando (2008).

10. This section describes the features of the Chilean system that are most closely related to our paper. For a more general discussion, see Gallego (2006, 2008); Gallego and Sapelli (2007).

the reform, rising to about 42 percent of students in 2005. Public school enrollment dropped from about 73 percent in 1981 to 49 percent in 2005. The remaining enrollment corresponds to unsubsidized private schools, which we do not include in our sample.

Public and voucher schools present important differences in terms of their incentive structures and the amount of nonvoucher resources they receive. Voucher schools tend to behave like competitive firms, receiving revenues proportional to enrollment. While some voucher schools are operated by for-profit firms, others are run by not-for-profit organizations that raise additional funds in a relatively competitive market for donations.[11] Public schools, in turn, work under softer budget constraints: when necessary, public schools that are losing students receive transfers, over and above the per-student subsidy, to pay their expenses.[12] In the 1980s, vouchers were the only public intervention in the K–12 sector, but in the 1990s local governments channeled additional resources to vulnerable schools and increased their nonvoucher spending. Moreover, some programs operate more as supply subsidies to schools and thus limit the mobility of students across schools. For instance, free-lunch public programs tend to decrease mobility across schools because poor students lose their free lunches if they transfer to other schools.[13] Therefore, these programs may actually create segregation of poor students in some schools.

In terms of other differences among schools, voucher schools tend to have more freedom in their choice of inputs, their selection policies, and their price determination. Public schools are restricted in the copayments they can charge, especially at the primary level, and they must be open to receive any student as long as they have spare capacity. The latter restriction is key to understanding selection in the Chilean school system. Both voucher and public schools with excess demand tend to select the "better" students because they receive the same voucher irrespective of the characteristics of their students.[14] Contreras, Bustos, and Sepúlveda report that 5 percent of students attending public schools were given some sort of entry exam, versus 48 per-

11. Aedo (1998). In addition, Gregory Elacqua (personal communication) estimates that about 58 and 63 percent of voucher school students were enrolled in for-profit schools in 1992 and 1998, respectively.

12. Gallego (2006); Sapelli (2003).

13. Sapelli and Torche (2002).

14. Currently, there is a law that creates a voucher that is different for students from different socioeconomic backgrounds. There is also a law proposal that considers an amendment to current legislation that will make the application of any selection process, other than a lottery, illegal for any school that receives voucher payments.

cent in voucher schools.[15] In terms of socioeconomic information, almost no school asked the parents for proof of income, but 23 percent of parents of students in voucher schools had an application interview in the school (versus 1 percent for public schools). This evidence shows that while voucher schools have more freedom to choose students than public schools, less than 50 percent carry out selection for academic purposes (and at the same time, public schools do undertake selection processes).

Two recent surveys applied to representative samples find interesting results in terms of the selection process. First, a 2006 survey by the Centro de Estudios Públicos (CEP) reports that 93 percent of parents say that their children attend the school they want them to attend. Second, the mean number of applications that parents make is about 1.1 (which increases to about 1.25 in Santiago), and about 4 percent of parents say their children were not accepted at a school to which they applied.[16] While survey data certainly have important problems, the order of magnitude of these results suggests that the observed stratification in the Chilean voucher system may be a consequence of self-selection or selection from the demand side, rather than from the supply side.[17] Finally, with regard to price policies, our dataset indicates that 78 percent of public school students attend free schools (that is, schools that do not require a copayment on top of the voucher), while only 24 percent of voucher school students attend free voucher schools.

Overall, this description of the Chilean system suggests a lot of heterogeneity in schools in terms of characteristics, price, participation in public programs, selection policies, incentives, and choice of inputs.

Literature and Results

In this review, we focus on studies that use structural estimation methods and papers that focus on the Chilean school system.[18] For the United States, Hastings, Kane, and Staiger use the information provided by a school choice program in North Carolina.[19] They apply a mixed logit model because they know not only the school to which students are allocated, but also their second and third choices. Their results imply that parents value proximity highly and that

15. Contreras, Bustos, and Sepúlveda (2007).
16. Gallego and others (2008).
17. Hsieh and Urquiola (2006) document the stratification in the Chilean system.
18. This section is based on Gallego and Hernando (2008).
19. Hastings, Kane, and Staiger (2007).

they have heterogeneous preferences for mean test scores: richer parents and more able students tend to place a higher value on test scores than do poorer families and students with difficulties. The authors also find a lot of heterogeneity in preferences after controlling for observables.

Bayer, Ferreira, and McMillan exploit residential choices by parents in the San Francisco Bay Area to estimate the determinants of the demand for school quality using a household location model in the spirit of Berry, Levinsohn, and Pakes.[20] The household location decision depends on a vector of neighborhood characteristics, and the authors allow preferences to be heterogeneous depending on the household's own characteristics. Their main results imply a relatively small willingness to pay for school quality of about U.S.$26.00 in monthly rent, for a one-standard-deviation increase in school quality and a lot of heterogeneity in preferences.

A number of papers explore school choice in Chile, although they do not use structural econometric methods. Sapelli and Torche study the choice between public and private schools.[21] They use a binary choice model in which the dependent variable identifies students attending private schools, and the independent variables are student and school characteristics. They find that the presence of high-quality public schools decreases the likelihood of attending private schools.

Elacqua, Schneider, and Buckley focus on the search behavior of parents in the Metropolitan Area of Santiago.[22] Using survey data, they study how parents construct choice sets and compare this to what they declare they are looking for when searching for schools. They conclude that parental decisions are influenced more by demographics, such as the socioeconomic composition of the school, than by school results. This evidence is interesting, but their identification strategy of using the relative variance of an attribute to determine preferences is subject to some limitations. Also, stated choice sets may be endogenous to the parents' perceived likelihood of actually getting into a school, and thus they do not provide good estimates of deep preference parameters.

Our own earlier work uses an estimation procedure closely related to that of Berry, Levinsohn, and Pakes to make two important contributions to the previous literature.[23] First, we estimate a structural model of school choice in a context in which parents can choose among public and private schools. Sec-

20. Bayer, Ferreira, and McMillan (2004); see Berry, Levinsohn, and Pakes (2004).
21. Sapelli and Torche (2002).
22. Elacqua, Schneider, and Buckley (2006).
23. Gallego and Hernando (2008); Berry, Levinsohn, and Pakes (2004).

ond, our estimates of preferences are generated from a setup in which the whole school system operates under a choice system that has been in place for a long time. This allows us to avoid biases created by allocation contexts in which stated preferences may not be strategic-proof (which may be a problem in some of the papers cited above). This therefore allows us to really estimate preference parameters.

We model the school choice of a household as a discrete choice of a single school. The utility function specification is based on the random utility model developed by McFadden and the specification of Berry, Levinsohn, and Pakes, which includes choice-specific unobservable characteristics.[24] We now present a brief description of the implementation of this idea in the context of school choices in Chile.[25]

Let $\mathbf{X}_j = \{x_{j1}, x_{j2}, \ldots, x_{jK}\}$ represent the set of observable characteristics (including monthly copayment) of school $j \in \{1, 2, \ldots, J\}$, respectively, and let d_{ij} represent the distance from the center of the municipality of household $i \in \{1, 2, \ldots, I\}$ to school j. Then the (indirect) utility to household i of its child attending school j is given by

$$u_{ij} = \sum_{k=1}^{K} \beta_{ik} x_{ik} + \gamma_i d_{ij} + \xi_j + \varepsilon_{ij}, \tag{1}$$

where ξ_j is the unobserved (by the econometrician) quality or characteristic of school j that is valued exactly the same by all households and is known to both the school owner and the household. The ε_{ij} term is an individual-specific preference shock for school j. This last term is assumed to have an extreme value type I distribution and is known by the household only.

The valuation of the school's characteristics is allowed to vary with the household's own characteristics, $\mathbf{Z}_i = \{z_{i1}, z_{i2}, \ldots, z_{iR}\}$, according to

$$\beta_{ik} = \overline{\beta}_k + \sum_{r=1}^{R} \beta_{rk} z_{ir} \tag{2}$$

and

$$\beta_{ik} = \overline{\gamma}_k + \sum_{r=1}^{R} \gamma_{rk} z_{ir}. \tag{3}$$

Substituting equations 2 and 3 in equation 1 and defining

$$\delta_j = \sum_{k=1}^{K} \overline{\beta}_k x_{jk} + \xi_j, \tag{4}$$

24. See McFadden (1974); Berry, Levinsohn, and Pakes (2004).
25. See Gallego and Hernando (2008) for a more detailed description.

we get

$$u_{ij} = \delta_j + \sum_{rk} \beta_{rk} z_{ir} x_{jk} + \overline{\gamma} d_{ij} + \sum_r \gamma_r z_{ir} d_{ij} + \varepsilon_{ij}. \tag{5}$$

Households are assumed to choose the school that maximizes equation 5. Since ξ_j is known to both the school owner (or administrator) and the household, it is likely to be correlated with school characteristics, particularly with its copayment. This is why we cannot estimate equation 4 directly and obtain consistent estimators; instead, a two-stage procedure is needed.

In our earlier work, we apply this procedure to fourth graders attending schools in Santiago in 2002.[26] We use data on students' education outcomes, their backgrounds, their parents' preferences, and school characteristics from the dataset of the 2002 SIMCE (Sistema de Medición de la Calidad de la Educación) test, which was administered to fourth graders. We use the school average of the math and Spanish portions of the test (standardized to have an average of zero and a standard deviation of one) as our measure of academic outcomes. We use income per household member and mother's education to measure the socioeconomic background of students and the average and variance of these variables at the school level to capture the socioeconomic characteristics of schools.[27] We also use the mother's age, the student's gender, and a proxy for parents' preferences for the teaching of religious values to capture other student-specific factors that may affect school preferences. Finally, we use a dummy that takes a value of one if parents expect their children to continue their education beyond high school as a proxy for parents' expectations of students.

To measure other attributes of the school, we use the average at the school level of the following variables: a proxy for the use of disciplinary measures in the school, the amount of the students' copayment, and a proxy for the teaching of religious values. We also include a dummy variable that takes a value of one if the school is a single-gender school and a dummy that takes a value of one if the school participates in a government-funded extended-day program.

26. Gallego and Hernando (2008).

27. Our model considers preferences for peers directly, rather than peer effects as they are commonly conceived in the literature. That is, we allow parents to have preferences for their offspring's classmates' characteristics inasmuch as they provide desirable effects on overall student welfare (such as better connections, an enriching environment, and so forth), and not because of any potential externalities or spillovers from one student's learning process to others in the same classroom or school. This distinction is very important for the validity of our interpretation of our estimates as preference parameters.

We use information on the distance from each school to the center of the municipality in which the family lives. This variable measures the linear distance of each school to the most populated place in the municipality, so it provides an imperfect proxy for the distance from the student's home to all the schools.[28] We also compute the distance from each school to a subway station and then use this information to create a dummy that takes a value of one if the school is less than 500 meters from a subway station.[29]

The Berry-Levinsohn-Pakes framework may not readily lend itself to application in all school choice systems. For example, schools may not be able to significantly expand their market share as assumed by the model, which may be a concern in school systems that are not in, or close to, a long-run equilibrium. Also, since the model we consider and estimate does not have random coefficients, our estimates still suffer from independence of irrelevant alternatives (IIA). Nevertheless, since we allow preferences to vary with household characteristics, our model has significantly more granularity than McFadden's classic red bus–blue bus example.[30] In effect, IIA is only present for sets of households that are observationally equivalent. This is a minor concern since we have significant variance in the characteristics of all households in our sample.

Finally, our model estimates the parameters of an indirect utility function assuming that it is the solution of a classical utility maximization problem. Under that assumption, our estimated coefficients may be deemed structural, and using those parameters to simulate decisions made in different setups (counterfactuals) is a valid exercise, even if no active choice is taking place.[31] If, however, households not only decide what school their children must attend, but also provide some other inputs relevant to the educational process

28. We do not have information on the population distribution within municipalities, so we assume that zones that are more dense in terms of street intersections are also likely to be more dense in population, and we then calculate the center by giving equal weight to each intersection. Our geographic information system has some information about whether the intersection is in a residential, commercial, or industrial area, but those data were too noisy to be useful.

29. See Gallego and Hernando (2008) for details of the estimation procedure and its outcomes.

30. McFadden (1974).

31. If our parameter estimates really measure preferences, then we can still compute the (indirect) utility of an individual in situations in which he or she is not making an active decision (for example, school assignment by means of a lottery). This is the case because the utility of attending a school (which can be computed from our estimates) depends on a combination of school and household characteristics and not on the process through which a student ends up attending a particular school.

TABLE 1. Semi-Structural Estimates: Main Effects from IV Regressions

Variable	*Coefficient*	*Standard error*	*z statistic*
Income per capita (× 1,000)	0.0190	0.0107	1.78
Std. dev. income per capita	−0.0042	0.0044	−0.96
Mother's education	−0.2261	0.1509	−1.50
Std. dev. mother's education	−0.2307	0.1197	−1.93
SIMCE test scores	2.6823	0.7673	3.50
Religious values	−1.5453	0.4596	−3.36
Single gender	−1.2079	0.2495	−4.84
Distance to subway	0.7594	0.2042	3.72
Distance to school	−1.084	0.004	−269.339
Copayment	−0.2212	0.0276	−8.02
Discipline	0.7380	0.1669	4.42
Extended school day	0.0138	0.1082	0.13

Source: Gallego and Hernando (2008).

(such as homework support and in-home teaching), then the coefficients of the indirect utility function are complicated functions of preferences and technological parameters that do not reveal preferences. This problem especially affects the coefficients of the school's test scores and copayments (and the direction of the specific biases is not obvious).[32] Nevertheless, this problem only accrues when household inputs are determined simultaneously with the school decision. If all the inputs are predetermined (like the student's level of knowledge prior to admission or preschool attendance), then our estimates are still correct and our simulations are valid. This problem can be solved by micro-founding the utility function and trying to recover the deep structural parameters from semi-structural estimates. That is, however, a complicated task that is beyond the scope of this work and as such is left for future research.

Tables 1 and 2 present a summary of our earlier results, which suggest that parents tend to value most of the attributes mentioned above and confirm the presence of significant heterogeneity. For instance, the two attributes that seem to have the highest standardized impact on welfare are performance on cognitive tests and distance to school. A one-standard-deviation increase in cognitive skills increases parents' willingness to pay by about US$17.00 a month (in 2002 dollars). Similarly, a one-standard-deviation decrease in the distance to school (roughly equivalent to 2 kilometers) increases willingness to pay by US$14.00 a month.

32. We thank Melissa Tartari for pointing this out.

TABLE 2. Semi-Structural Estimates: Interaction Effects[a]

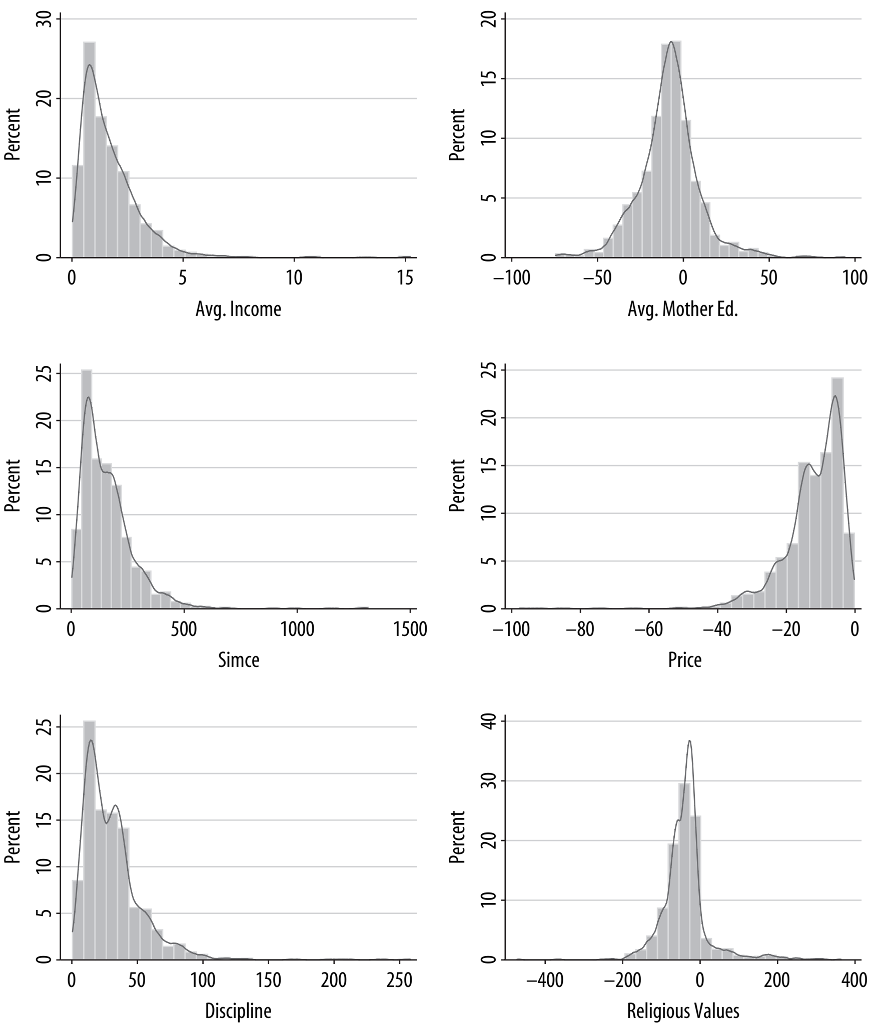
	Student-level variable					
School-level variable	*Income per capita*	*Mother's education*	*Mother's age*	*Female*	*Religious values*	*High expectations*
Income per capita (× 1,000)	0.0353		0.0005			0.0176
	(8.80)		(7.67)			(26.37)
Std. dev. income	0.0001	−0.0003	−0.0001	0.0010	−0.0007	−0.0045
	(34.01)	(−3.67)	(−2.60)	(1.97)	(−0.75)	(−8.40)
Mother's education	0.0036	0.0921	0.0064			0.1288
	(31.25)	(61.08)	(9.67)			(15.84)
Std. dev. mother's education	0.0007	−0.0005	−0.0004	0.0522	0.0929	0.0531
	(2.76)	(−0.14)	(−0.28)	(2.54)	(2.11)	(2.79)
SIMCE test scores	0.0025	−0.0136		−0.1119	0.4081	0.2928
	(8.43)	(−3.16)		(−5.90)	(8.89)	(14.58)
Religious values	−0.0016			0.6426	7.0491	
	(−2.70)			(11.17)	(82.11)	
Distance to subway	−0.0009			−0.1226	−0.1160	0.0825
	(−3.00)			(−3.80)	(−2.03)	(2.93)
Distance to school	0.0010	0.0179	0.0038		0.1249	0.0721
	(27.09)	(26.28)	(13.07)		(19.27)	(14.04)
Copayment			−0.0006	−0.0058		0.0132
			(−5.66)	(−5.03)		(12.60)
Discipline				−0.3943		
				(−21.63)		
Extended school day				0.0696		
				(5.87)		
Single gender				0.7661		
				(34.50)		

Source: Gallego and Hernando (2008).
a. *Z* statistics are in parentheses.

These average results conceal a great deal of heterogeneity in preferences. Figure 1 presents the average marginal effects at the school level. For instance, while cognitive skills seem to be a normal good, closeness to school is an inferior good. Therefore, students from affluent families tend to travel farther and attend schools with higher test results than do students from lower income brackets. Similarly, parents that expect their child to do better in school tend to travel farther and are willing to pay more for schools. Another interesting result is that parents of female students tend to put more weight on noncognitive skills than on cognitive skills, and they place a higher value on a single-sex school than do parents of male students.

As a benchmark, we estimate a reduced-form model in which we study a student's decision to attend a school located outside his or her home municipality. We include as regressors the mean and standard deviation of test

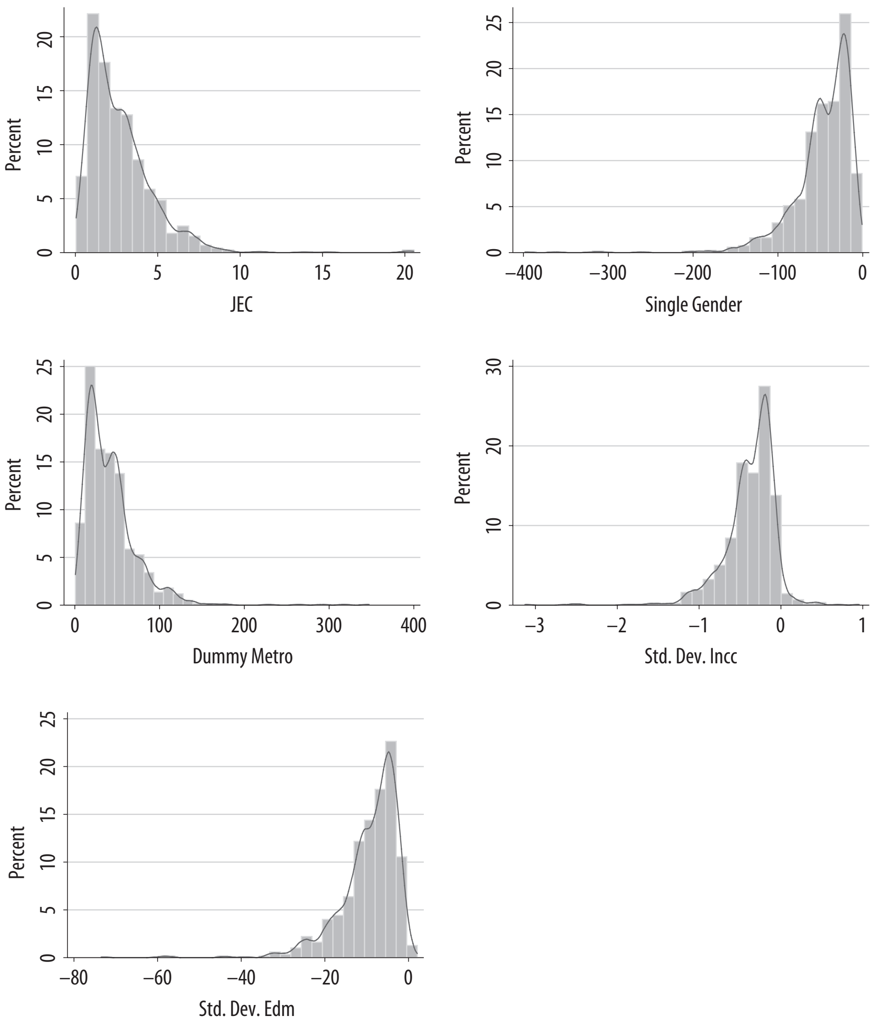
FIGURE 1. Average Marginal Effects, by School



(*continued*)

scores in the home and destination municipality, together with a vector of socioeconomic controls (namely, dummies for the mother's education, the log of household income, and household size). We run probit regressions for the complete sample of fourth graders who took the 2002 SIMCE test and for subsamples of urban and rural areas, areas with little competition among

FIGURE 1. Average Marginal Effects, by School (*Continued*)



schools, and the Metropolitan Area of Santiago. Table 3 presents the standardized marginal effects of each variable (that is, the effect of a one-standard-deviation increase of each variable on the probability of attending school in the home municipality). Our results confirm the semi-structural estimates in the sense that differences in quality seem to be the most important factor driving the decision to attend school in the home or other municipalities. The

TABLE 3. Probit Regressions: Standardized Marginal Effects[a]

Independent variable	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*
Average test score in destination county	−0.236***	−0.249***	0.016	−0.289***	0.077***	−0.303***	0.052***	−0.22***	0.092***	−0.41***	−0.446***
Std. dev. test score in destination county	0.034***	0.023***	−0.003	0.039***	−0.048***	0.032***	−0.054***	0.074**	−0.021	−0.009	−0.022***
Average test score in home county	0.195***	0.202***	−0.045*	0.249***	−0.048***	0.253***	−0.019	0.162***	−0.088***	0.314***	0.335***
Std. dev. test score in home county	−0.023***	−0.015***	0.011	−0.016***	0.047***	−0.015***	0.047***	−0.025	0.031	−0.01*	−0.01
Mother's education: primary	0.013***	0.012***	0.028***	0.01***	0	0.009***	0.007	0.04**	0.005	0.014***	0.015***
Mother's education: higher	−0.002	−0.004	0.009*	−0.002	−0.004	−0.003	−0.005	0.026***	0.002	−0.008**	−0.012***
Log household income	−0.019***	−0.022***	−0.007	−0.019***	−0.023***	−0.022***	−0.025***	−0.013	0	−0.022***	−0.026***
No. household members	−0.013***	−0.012***	0*	−0.01***	0	−0.01***	0	0	0	−0.008***	−0.008*
Summary statistic											
No. observations	197,809	156,687	24,127	112,578	85,231	96,088	60,599	4,814	19,313	75,513	62,399
Pseudo *R* squared	0.247	0.274	0.0149	0.265	0.0419	0.279	0.0643	0.0405	0.0413	0.264	0.266
Urban or rural areas	Both	Urban	Rural	Both	Both	Urban	Urban	Rural	Rural	Both	Urban
High or low competition areas	Both	Both	Both	High	Low	High	Low	High	Low	Both	Both
Regions	All	All	All	All	All	All	All	All	All	Santiago	Santiago

* Statistically significant at the 10 percent level; ** statistically significant at the 5 percent level; *** statistically significant at the 1 percent level.

a. The dependent variable is a dummy that takes a value of 1 if the student attends school in the same county. The destination municipality is the municipality where the student attends school; the home municipality is the municipality where the student lives.

standardized impact on the probability of attending school in another municipality is about 0.20, on average, and it is especially significant in urban areas with a high degree of interschool competition (in which case the estimated effect almost doubles). The other variables present the expected signs and in general are statistically significant, but their economic importance is secondary compared with test scores. The evidence from this reduced-form approach thus confirms our earlier semi-structural estimates.[33]

Simulations

In this section we use our earlier estimates to study a number of counterfactuals related to changes in the design of the school choice system. We use two basic metrics to evaluate each policy change. The first is the computation of the welfare effects of each change for each consumer, that is, the compensating variation. We simply compute the indirect utility for each consumer with and without the policy change, and we convert utils into money by dividing the difference by the coefficient that accompanies the copayment in the utility function for each consumer. These numbers allow us to identify both the changes in total welfare and the distribution of these changes.

The second metric we use is the effect of each policy change on the segregation of the school system. To implement this idea, we use the Duncan dissimilarity index, which is defined as follows:[34]

$$D = \frac{1}{2}\sum_{i=1}^{I}\left|\frac{V_i}{V} - \frac{NV_i}{NV}\right|,$$

where i represents schools and V and NV are the number of vulnerable and nonvulnerable students, respectively.[35] The index can take values in the [0, 1] interval, with zero representing complete desegregation and one complete segregation. The index can be interpreted as the fraction of vulnerable students that would have to switch schools to achieve an even distribution in Santiago, and it has been used to measure segregation in the Chilean school system.[36]

33. Gallego and Hernando (2008).

34. Duncan and Duncan (1955).

35. We define a vulnerable student according to a socioeconomic index (defined below) or the mother's education. Following Valenzuela, Bellei, and de los Rios (2008), we consider students to be vulnerable if they are in the lowest 30 percent of the distribution of each variable.

36. Valenzuela, Bellei, and de los Rios (2008). See also Cutler, Glaeser, and Vigdor (1999) for a detailed discussion on the properties of the Duncan index.

Our first group of simulations is aimed at measuring the value of school choice for Chilean society in general and the students' households in particular. We simulate a series of counterfactuals that eliminate or constrain the choice alternatives. Our first four simulations consider a situation in which students do not have to pay fees directly to schools and students are allocated randomly to the current supply of schools. We consider two different designs for the lottery: a uniform one in which each student has the same probability of being assigned to each school in the municipality and a proportional one in which students have a larger probability of being assigned to larger schools, thus keeping the relative size of each school fixed.

In this context, the static nature of our experiments becomes very important. In effect, we are not considering the potential effects of schools entering or exiting the pool to which students are randomly assigned, and we do not allow students to leave the system (either by choosing not to enroll in any school or by enrolling in unsubsidized private schools). This constraint may cause the dynamic results of these policy changes to differ from the static results in nonobvious ways. For example, if small niche schools that cater to very specific and homogeneous groups of students find that they cannot function successfully in a lottery system, they may leave the market. Since they are very attractive to the group they are designed to serve and (probably) very unattractive to the majority of households, the effect of those schools' closing would be to decrease the utility of some individuals while increasing that of the majority. A similar argument (with reverse effects) may be made if low-quality schools find an incentive to stay in the market longer knowing that, for a while at least, they will still receive students through the lottery system.

In our first scenario, students are assigned uniformly to all the available schools in the municipality, and the government covers any copayments. As a result all schools in the municipality have the same number of students. Segregation is (by design) equal to the geographic segregation of the city, and all schools in a municipality have the same (expected) socioeconomic index distributions. The monthly government cost of this policy is estimated at US$8.77 million (in 2002 dollars).[37] We assume this cost goes to families in the form of lump sum taxes in proportion to the taxes they actually pay.[38]

37. We compute this number using a nominal exchange rate of 689.24 pesos to the dollar and an estimate of the number of students that attend school in the Metropolitan Area of Santiago.

38. We take the mean tax rate by income decile from Engel, Galetovic, and Raddatz (1999) using income deciles from the 2003 CASEN survey (and we adjust 2003 figures to 2002 using the variation in nominal wages). Our assumption is that the relative tax rates by income deciles presented in Engel, Galetovic, and Raddatz (1999) are relevant for 2002.

In our second scenario, students are assigned to schools in proportion to the size of the school, so the relative size of each school is preserved within the municipality. Again, a lottery generates homogeneous schools so segregation indexes are similar to the municipality segregation by construction and the socioeconomic index distribution is the same across schools.

Our third and fourth scenarios are similar to the first two, but we assume that other agents cover any copayments (in both the lottery and the choice alternatives).[39] We perform these simulations for two reasons. First, they measure changes in social welfare, assuming that all collected taxes go to the schools and the marginal cost per student is constant. Second, these simulations allow us to disentangle any welfare change into changes in payments the students have to make (in the form of lump-sum taxes or direct copayments to schools) and changes in other attributes of the schools to which they are assigned in equilibrium.

Tables 4, 5, and 6 present a summary of results from our simulations. Figure 2 shows the distribution of the difference in welfare between the choice (counter)factual and each of the specified scenarios.[40] The message of figure 2 is clear: choice is valuable although not all the individuals benefit from it (and not all those who benefit do so equally).[41] The first panel of the figure shows the gain for households in switching from a uniform lottery with lump-sum taxes to a choice system with copayments. As reported in table 4, the average student gains the equivalent of US$4.10 a month (0.9 percent of household income, or about 14.0 percent of the value of the voucher).[42] As a whole, all students increase their surplus to US$3.38 million (1.3 percent of total income), as shown in table 5. Nevertheless, not all students are better off:

39. In these scenarios, we assume that students are allowed to choose schools from the full sample and the government pays any copayments after students make their decisions (that is, students do not know that they will not have to pay the copayments at the time they decide which school to attend).

40. We use the expression *(counter)factual* to refer to our modified baseline because in reality (the factual case), households still have to pay top-ups. Since we have eliminated copayments in this comparison, neither the no-choice nor the choice scenario is a factual one.

41. The following exercises do not include any ex post information about the idiosyncratic shocks in tastes (that is, pseudo-residuals) that we could derive from the estimation procedure. That is, the results presented herein are averages across the population and across preference shocks and, in that sense, represent expected values for the whole population, not just for the sample used.

42. An alternative way of evaluating benefits is to compute the new present value of this monthly flow. Assuming that the students attend school from first through twelfth grade, the present value of this flow is $446 ($350) when the annual real interest rate is 5 percent (10 percent). This is equivalent to roughly one (0.77) month's income.

TABLE 4. Value of Choice: Average Student's Compensating Variation under Different Scenarios

Scenario	*Compensating variation (CV)*	*CV / income (percent)*	*Percentage of students with negative CV*	*CV if CV < 0*	*CV / income if CV < 0 (percent)*	*CV if CV > 0*	*CV / income if CV > 0 (percent)*
1	4.10	−0.1	40.2	−3.98	−3.5	9.54	2.1
2	0.94	−1.8	59.7	−5.04	−4.1	9.81	1.6
3	4.34	0.9	36.8	−2.12	−1.4	8.10	2.2
4	1.69	−0.6	63.5	−3.12	−2.2	10.05	2.1
5	43.87	26.7	11.8	−4.98	−2.6	50.41	30.7

40.2 percent of the students will prefer the lottery to the choice system, and the average student in this group loses the equivalent of US$4.00 a month (3.5 percent of household income for the group). This stems from two effects that take place when choice is allowed: first, a higher segregation level emerges, which in time means that students with lower socioeconomic indexes end up in schools with less desirable peers; and second, students have to pay fees that are above the lump sum taxes needed to finance the lottery system. Scenarios 3 and 4 show that both effects are important, as discussed below.

Scenario 2 in tables 4 and 5 tells a similar story in the case in which students are assigned to schools proportionally to the schools' sizes. In this case the gains from choice are much more moderate, though, at only US$0.78 million a month (0.3 percent of their income). Gains are also much more concentrated. Consequently, 59.7 percent of the individuals would actually prefer the lottery to the choice system, since the average student loses the equivalent of US$5.00 a month (4.1 percent of household income) by moving to the choice system. The more moderate gains from choice in this case are due to

TABLE 5. Value of Choice: Total Benefits under Different Scenarios
Millions of US dollars

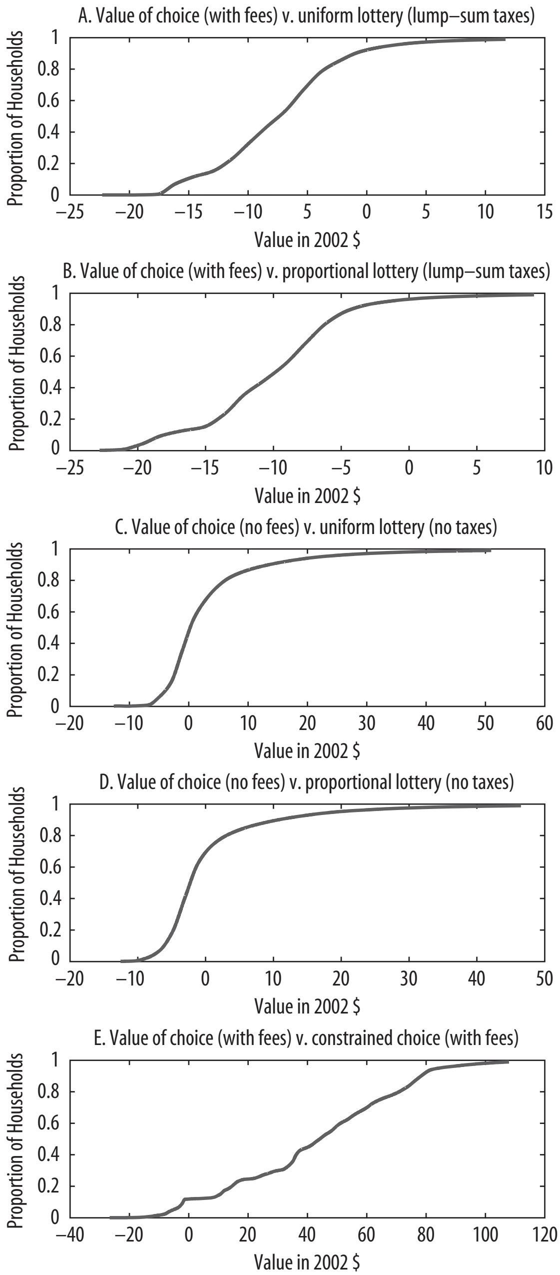
Scenario	*Total benefits*	*Total benefits / total income (percent)*	*Benefits if CV < 0*	*Benefits / income if CV < 0 (percent)*	*Benefits if CV > 0*	*Benefits / income if CV > 0 (percent)*
1	3.38	1.3	−1.3	−2.3	4.70	2.3
2	0.78	0.3	−2.5	−2.6	3.26	1.9
3	3.58	1.3	−0.6	−1.0	4.22	2.1
4	1.39	0.5	−1.6	−1.4	3.02	2.0
5	36.20	13.6	−0.5	−1.3	36.69	16.1

TABLE 6. Value of Choice: Average Compensating Variation, by Mother's Education Level, Quintile Income, and Student Vulnerability

	Scenario 1		*Scenario 2*		*Scenario 3*		*Scenario 4*		*Scenario 5*	
Category	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*
Mother's education level										
1	2.15	0.2	−0.81	−2.1	0.48	0.4	−2.14	−1.7	48.51	40.0
2	1.84	−0.9	−1.28	−2.6	2.31	0.4	−0.34	−1.1	44.17	25.5
3	2.75	−0.5	−0.45	−2.0	3.71	0.8	1.01	−0.5	42.84	22.1
4	8.42	0.7	5.04	−0.4	11.80	2.7	9.12	1.8	38.13	14.1
5	10.89	0.9	7.47	−0.1	13.59	2.8	10.94	2.0	37.97	13.4
6	22.24	2.1	18.49	1.4	22.30	3.0	19.70	2.5	33.22	8.0
7	40.51	3.4	36.41	2.8	40.23	5.0	37.69	4.6	27.15	7.6
Income quintile										
1	−2.28	−3.2	−4.99	−6.8	0.35	0.5	−2.21	−3.0	47.77	64.6
2	0.25	−0.3	−2.73	−1.9	0.83	0.4	−1.81	−1.0	45.70	25.5
3	0.60	0.1	−2.46	−1.2	1.59	0.7	−1.08	−0.5	45.33	19.7
4	3.45	0.8	0.18	−0.2	3.79	1.1	1.07	0.3	43.43	13.4
5	19.49	2.1	15.66	1.5	16.05	2.0	13.37	1.6	36.51	6.3
Student vulnerability[a]										
0	5.07	−0.1	1.82	−1.5	5.55	1.0	2.88	−0.2	42.22	20.6
1	0.93	−0.2	−1.93	−2.9	0.37	0.4	−2.23	−2.0	49.28	46.9

a. Student vulnerability is measured as family socioeconomic status.

FIGURE 2. The Value of Choice: Counterfactual Scenarios



the fact that bigger schools tend to be preferable to smaller schools, so a lottery that allocates more students to bigger schools has lower welfare losses than a lottery that does not consider school size.[43]

Panels C and D in figure 2 and scenarios 3 and 4 in tables 4 and 5 show the cases in which students do not have to pay copayments or lump sum taxes. Not surprisingly, comparisons here are much more favorable to the choice system because students do not have to make copayments, which are, on average, above lump-sum taxes (the average student has to pay an additional US$0.24 a month). In scenario 3, 36.8 percent of the students would prefer the lottery over the choice system. The average student gains the equivalent of US$4.34 a month (1.3 percent of the average household income), and the total increase in surplus is US$3.58 million a month (1.3 percent of all income). The respective figures for scenario 4 are 63.5 percent of students preferring the lottery to the choice system, an average surplus gain of US$1.69, and a total surplus increase of US$1.4 million.

These simulations consider a situation in which students have to attend schools in the same municipality in which they live. Scenario 5 illustrates the effects of that policy: we compare unrestricted choice with copayments and choice restricted to schools within the same municipality. Panel E in figure 2 presents the results. In this case, 11.8 percent of the students are better off with the constrained choice (probably because they have better peers in their schools), and they are willing to pay US$0.50 more for this system than for the full choice system (1.3 percent of household income). On average, though, unconstrained choice still is more valuable than its constrained counterpart: the average student is willing to pay US$43.9 a month (26.7 percent of income), for a total social value of US$36.2 million. This shows that geographic mobility is especially valuable for students.

In summary, figure 2 shows that choice is valuable from a social standpoint. Not all students benefit from it, however, and of those who do benefit, not all benefit to the same extent. We now explore the obvious question of who benefits from the school choice system.

To address this question, we decomposed the welfare gains of choice in each of the alternative systems by the sample income quintile, the mother's education, and the socioeconomic index of each student (see table 6).[44] In the

43. This result also supports the assumption of Gallego and Hernando (2008) that demand factors drive student allocations and, therefore, school size.

44. These income quintiles are not relative to the whole population, but only to the sample in question.

first scenario, only students from the first (or lowest) income quintile lose from switching to the choice alternative. This is due to the fact that students have to pay fees that are higher, on average, than lump-sum taxes, as confirmed by the third scenario. In all the other groups, students benefit from moving to a choice alternative with and without copayments, and the students with the highest income benefit the most from school choice. For instance, while students in the top income quintile are willing to pay US$19.50 a month (2.1 percent of their household income) for choice, students in the lowest income quintile should be paid US$2.30 a month (3.2 percent of their household income) to accept the choice system. An even steeper gradient appears when we consider mother's education groups (with the exception of students whose mothers have primary education only, who pay higher lump-sum taxes than copayments). However, all the groups benefit from switching to the choice alternative, as is also the case when we classify students by socioeconomic vulnerability.

Scenarios 2 and 4 amplify the results in scenarios 1 and 3. In this case, only students from the highest two quintiles and students whose mothers have at least a high school degree benefit from choice, on average, confirming our previous claim. These results imply that more affluent students gain the most from school choice.

The results from the last scenario are different from the first four. We find that limiting geographic mobility is most harmful to less affluent students. In other words, poorer students place the highest value on the opportunity to move to other municipalities, probably because some good school opportunities are located outside their own municipality. For instance, relatively affluent municipalities in Santiago such as downtown Santiago, Providencia, Las Condes, Ñuñoa, and Vitacura tend to receive a large share of students from less affluent municipalities. This scenario thus highlights a situation in which expanding choice disproportionally benefits the poor.

To analyze the effects of restricting choice on segregation, we compute the Duncan segregation index at the city level under two different scenarios: lotteries and municipality-restricted choice.[45] As expected from our earlier results, school choice generally tends to increase segregation significantly. For instance, the Duncan index for lotteries reaches a level of 0.18 (similar to the geographic segregation of households in Santiago), whereas allowing unrestricted choice increases the segregation level to about 0.39. This shows that

45. As previously discussed, by construction a lottery without fees produces the same segregation level as the municipal distribution itself.

school choice on the demand side significantly increases segregation. Interestingly, however, restricting the geographic mobility of students increases segregation, as the Duncan index reaches a level of about 0.43. This confirms our previous results that less affluent students value choice the most even when they have to pay fees, since it allows them to move to areas of the city with better attributes.

All in all, these results suggest that there is a positive value of choice, that this value seems to be relatively high, but that choice mainly benefits the more affluent students. In contrast, geographic mobility within a school choice system is more beneficial to less affluent students and decreases segregation. In all these simulations, however, we assume the school choice system does not affect the supply of schools. In the next simulation, students are allocated to schools in their municipality using lotteries, but the supply of voucher schools is limited to allow only 15 percent of the municipality students to attend them.[46] In most municipalities, this implies that one or two voucher schools are needed to accommodate the 15 percent enrollment. We allocated all the students to public schools and to these voucher schools using the same two lotteries as in the previous scenarios—namely, a uniform lottery and a proportional lottery based on their current relative sizes. In addition, we assume that all schools are free in order to isolate the supply effects.

The results are presented in the first two columns of tables 7 and 8. This exercise suggests that the increased number of voucher schools is valued by consumers at an average of US$7.00 a month in the uniform lottery. Not all the students benefit from this increase in the supply of schools, however: about 14 percent of students decrease their welfare by the equivalent of US$1.40 a month. The social surplus increases by about US$5.8 million. All these values decrease in the case of the proportional lottery, mimicking our previous results.

In terms of the effects on different groups, as reported in table 9, compensating variation is positive for all the subgroups of the population, but it is larger for more affluent, more educated, and nonvulnerable groups. This is to be expected, since voucher schools tend to serve more affluent students. However, the welfare effects of school entry are positive even for vulnerable

46. To restrict the supply to 15 percent, we chose the necessary number of voucher schools from among the biggest schools of the municipality. This design is purposely biased against school choice given that schools with higher enrollment are preferable to smaller schools, as previously discussed. An alternative would to be to choose randomly among voucher schools.

TABLE 7. Policy Simulations: Average Student's Compensating Variation

Simulation	*Compensating variation (CV)*	*CV / income (percent)*	*Percentage of students with negative CV*	*CV if CV < 0*	*CV / income if CV < 0 (percent)*	*CV if CV > 0*	*CV / income if CV > 0 (percent)*
Decrease in voucher schools' enrollment							
Uniform lottery (scenario 1)	7.01	2.3	14.3	−1.37	−0.8	8.40	2.8
Proportional lottery (scenario 2)	5.66	1.5	28.3	−1.47	−1.0	8.47	2.4
No fees							
No effects on SIMCE (scenario 1)	10.84	6.0	0.3	−3.77	−0.2	10.88	6.0
Low value of voucher (scenario 2)	8.09	4.6	0.7	−3.47	−0.3	8.17	4.6
High value of voucher (scenario 3)	8.66	4.9	0.6	−3.57	−0.3	8.73	4.9
Differentiated voucher							
Effects on SIMCE (scenario 1)	2.16	2.0	22.9	−0.42	−0.1	2.93	2.6
No effects on SIMCE (scenario 2)	1.56	1.6	73.3	−0.40	−0.2	6.93	6.4

TABLE 8. Policy Simulations: Total Benefits under Different Scenarios

Millions of US dollars

Simulation	*Total benefits*	*Total benefits / total income (percent)*	*Benefits if CV < 0*	*Benefits / income if CV < 0 (percent)*	*Benefits if CV > 0*	*Benefits / income if CV > 0 (percent)*
Decrease in voucher schools' enrollment						
Uniform lottery (scenario 1)	5.78	0.02	−0.16	−0.6	5.94	2.5
Proportional lottery (scenario 2)	4.67	0.02	−0.34	−0.7	5.01	2.3
No fees						
No effects on SIMCE (scenario 1)	8.95	0.03	−0.01	−0.2	8.95	3.4
Low value of voucher (scenario 2)	6.68	0.03	−0.02	−0.3	6.70	2.6
High value of voucher (scenario 3)	7.15	0.03	−0.02	−0.3	7.16	2.8
Differentiated voucher						
Effects on SIMCE (scenario 1)	1.79	0.01	−0.08	−0.1	1.87	1.2
No effects on SIMCE (scenario 2)	1.29	0.00	−0.24	−0.1	1.53	3.8

TABLE 9. Decrease in Voucher School Enrollment: Average Compensating Variation, by Category

	Scenario 1		*Scenario 2*	
Category	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*
Mother's education level				
1	2.62	2.0	1.20	0.9
2	5.01	1.8	3.66	1.0
3	6.49	2.1	5.15	1.4
4	15.12	3.8	13.84	3.3
5	16.92	3.8	15.68	3.4
6	25.86	3.7	24.62	3.5
7	43.14	5.7	41.91	5.4
Income quintile				
1	2.41	3.3	1.05	1.4
2	3.18	1.7	1.81	1.0
3	4.18	1.8	2.80	1.2
4	6.72	2.0	5.35	1.6
5	19.62	2.6	18.34	2.4
Student vulnerability				
0	8.42	2.2	7.09	1.6
1	2.38	2.3	0.97	1.0

students, so any cream-skimming effects from the entry of voucher schools are smaller than the benefits of other voucher school attributes.

Overall, the results of these simulations suggest that while school choice seems to be valuable to consumers, there is a lot of heterogeneity along at least two dimensions: the different characteristics of the Chilean school choice system seem to be valued in different ways by different households, and different groups of consumers value school choice in different ways. For instance, while the increase in the supply of voucher schools is valued positively by all student groups, school choice with the supply of schools fixed at the current level seems to benefit only the more affluent groups. In contrast, geographic mobility benefits the less affluent students the most. These results suggest a potential role for redistribution among groups.

Our next exercise is to explore the potential role of top-ups on the allocation of students and their welfare and to evaluate the effects of a progressive policy (namely, increasing the value of the voucher for vulnerable students). To study the potential effect of top-ups on student welfare and segregation we simulate a situation in which schools are not allowed to charge copayments on top of the vouchers. We analyze two scenarios: one in which the decrease in school revenue has no effect on school quality (that is, the government finances all copayments) and one in which school quality decreases as a consequence of the drop in the funds received.[47]

We make two additional assumptions related to the potential allocation of slots for schools that face excess demand. First, we assume the school capacity to be

$$C = \left\lceil \frac{E}{45} \right\rceil \times 45,$$

where $\lceil\ \rceil$ is the ceiling function (which rounds up a number to the next whole number if the number is not already an integer), and E is the school's enrollment. The ceiling reflects the fact that, by regulation, schools must not have more than forty-five students in their classrooms.[48] This gives us the maximum number of students that can be allocated to a particular school.

The second assumption is a specific rule to allocate slots to students applying to the school. We construct a strategy-proof lottery procedure along the lines of the deferred-acceptance Gale-Shapley algorithm proposed by Abdulkadiroğlu and others for schools.[49] In this lottery, students apply to schools according to their utility-maximizing (logit) probabilities (in which we interpret a logit probability, P_{ij}, as the probability of student i applying to school j, rather than attending school j). If school j is overenrolled at a rate of x_j (that is, it has $x_j < 1$ slots available for each applicant), then each applicant is accepted to that school with probability x_j. The remaining probability of $P_{ij}(1 - x)$ is distributed, for each student, to the underenrolled schools in a way such that the ratio of the probability of applying to any pair of schools remains constant (this is the classic conditional logit result). If this redistribution of probabilities of application creates new overenrolled schools, these are incorporated in the set of overenrolled schools and the whole process is repeated. This guarantees that no student has an incentive not to apply to his or her preferred schools in the order of preference.

Our results are presented in tables 7, 8, and 10. Overall, the transfer increases consumer welfare in the case in which quality does not decrease. When quality does decrease, the effects are still positive, but smaller. Most interestingly, the distributional effects of this policy suggest that middle-class

47. The second scenario is based on estimates of the variation in school productivity corresponding to socioeconomic status from Gallego (2006).

48. Urquiola and Verhoogen (2007) exploit this regulation in a regression discontinuity design.

49. Abdulkadiroğlu and others (2005).

TABLE 10. No Fees: Average Compensating Variation, by Category

	Scenario 1		Scenario 2		Scenario 3	
Category	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*
Mother's education level						
1	9.57	7.4	7.24	5.7	7.73	6.0
2	11.34	6.3	8.49	4.8	9.08	5.1
3	11.45	5.7	8.51	4.3	9.12	4.5
4	11.35	4.0	8.27	3.0	8.91	3.2
5	11.31	3.8	8.26	2.8	8.89	3.0
6	11.16	2.4	8.11	1.8	8.74	1.9
7	12.29	2.4	9.37	1.8	9.97	1.9
Income quintile						
1	9.73	13.1	7.43	10.0	7.91	10.7
2	10.66	5.9	8.06	4.5	8.60	4.8
3	11.28	4.9	8.48	3.7	9.06	3.9
4	11.55	3.5	8.57	2.6	9.19	2.8
5	11.26	1.9	8.08	1.4	8.74	1.5
Student vulnerability						
0	11.31	5.2	8.40	3.9	9.00	4.2
1	9.30	8.6	7.07	6.6	7.54	7.0

students tend to benefit the most from this policy (see columns 3 and 4 in table 10). Students in both the richest and poorest groups tend to benefit, but by less than middle-class students. This result reflects a number of factors. First, vulnerable students do not tend to pay copayments in the current system, so they do not benefit directly from the abolition of fees. Second, in the absence of fees, rich students tend to travel more than before to get to better schools. Finally, fees in Chile are relatively low (the mean copayment among students that pay is close to US$11.00), so the decrease in quality should not be significant. Consequently, the middle class benefits the most from the abolition of copayments, since they pay higher top-ups than poor students and their marginal utility of income is higher than that of rich students.

In terms of the effects on segregation, our model predicts that the abolition of fees would reduce the Duncan index from 0.39 to about 0.34, which is far above the geographic segregation of Santiago (about 0.18). The effects of abolishing fees on segregation is thus moderate at most, and this result lends further support to the idea that most school segregation is driven by demand-side factors. In these simulations, schools cannot select students and charge copayments, yet the segregation level is still high and close to the current unrestricted system.[50]

Finally, we study the effects of the implementation of a differentiated voucher system in which vulnerable students receive a larger voucher than nonvulnerable students. We increase the voucher for these students from US$40.00 to US$63.00. We calibrate this change and school eligibility to the recently approved law.[51] In one case, we assume that the new resources do not affect school quality, but only reduce the copayment paid by students. In the second case, we assume that test scores increase proportionally to the effective increase in resources (that is, the difference between the top-up and the amount of the differentiated voucher.) As in previous simulations, we allow the estimated productivity of school expenditures to vary by income and education groups.[52] We further assume that all the extra resources are spent on increasing test scores uniformly among both vulnerable and nonvulnerable students in the school—that is, there is an externality from beneficiaries to nonbeneficiaries.

Tables 7, 8, and 11 present the results of these simulations. The overall effect is positive, with the average student gaining an equivalent of US$2.20, with a total increase of social value of about $1.8 million a month. There is, however, some heterogeneity in this result. Vulnerable students (who are direct beneficiaries of the special voucher) benefit the most, with an average increase in welfare of between US$8.00 and US$9.00, depending on the potential impact on quality. Nonvulnerable students benefit by a small amount if test scores increase and suffer by a small amount if test scores do not increase. These decreases in welfare are due to the reallocation of these students to other, less desirable schools. Interestingly, the increase in welfare for vulnerable students as a result of this policy is bigger than the losses associated with some of the previous simulations (see tables 4 and 5). In other words,

50. The Duncan index based only on the application to schools is about 0.36, which means that the random lottery is able to reduce segregation only by a small margin. This result resembles the findings in Chakrabarti (2005), who studies the determinants of participation in the Milwaukee voucher school program. Given that this program does not allow schools to charge more than the voucher or to select students, the author studies whether demand-side factors affect the likelihood of applying for a voucher. She finds strong evidence of self-selection by mother's education and some measures of student ability, but no evidence of any impact of income on the probability of applying for a voucher.

51. Schools that want to receive the differentiated voucher for a beneficiary student cannot charge a top-up to that student.

52. The productivity estimates are from Gallego (2006).

TABLE 11. Differentiated Voucher: Average Compensating Variation, by Category

	Scenario 1		Scenario 2	
Category	*CV*	*CV / income (percent)*	*CV*	*CV / income (percent)*
Mother's education level				
1	6.07	5.5	5.24	4.8
2	1.01	0.9	0.41	0.5
3	0.58	0.5	0.02	0.2
4	–0.27	0.0	–0.60	–0.2
5	–0.26	0.0	–0.57	–0.2
6	–0.40	–0.1	–0.61	–0.1
7	–0.53	–0.1	–0.65	–0.2
Income quintile				
1	4.81	6.5	4.03	5.5
2	2.75	1.7	2.05	1.3
3	1.95	0.9	1.31	0.6
4	0.87	0.3	0.33	0.1
5	–0.05	0.0	–0.36	0.0
Student vulnerability				
0	0.16	0.1	–0.38	–0.2
1	8.71	8.0	7.90	7.3

a differentiated voucher of the magnitude and extension proposed in the recently approved law represents a progressive policy that compensates the losers in a school choice system.

Conclusions

The results of these simulations suggest that school choice, at least as it has been implemented in Chile, increases overall student welfare, but there is a lot of heterogeneity in the size and even the sign of the welfare changes. While some of the features of the system, such as geographic mobility, seem to be progressive policies that benefit the poor the most, others, such as allowing complete choice, seem to be regressive while still others, such as charging top-ups to the voucher, affect mostly middle-class students. As previously discussed, the high socioeconomic segregation of the school system in Chile seems to be driven mainly by demand-side factors, as shown by the fact that a potential abolition of fees and the use of lotteries in the context of free application to all schools do not seem to decrease segregation significantly.

Our methodology of combining structural estimates of preferences and policy simulations is new in the literature on the quantitative assessment of the effects of school choice on student welfare. We use a multidimensional approach to explore the effects of several features of school choice on welfare and translate the effects to monetary equivalents. However, our analysis has some limitations that should be addressed in future research. First, we do not model explicitly the supply side. For instance, we do not directly study the effects of school choice on the supply of attributes (such as the effects of interschool competition on school quality). Second, we consider a static model in which students and schools are not allowed to enter or exit the market. Finally, we assume that we are estimating stable deep preferences of consumers, but it may well be the case that parents are not maximizing their true utility function (for instance, as a result of informational problems).